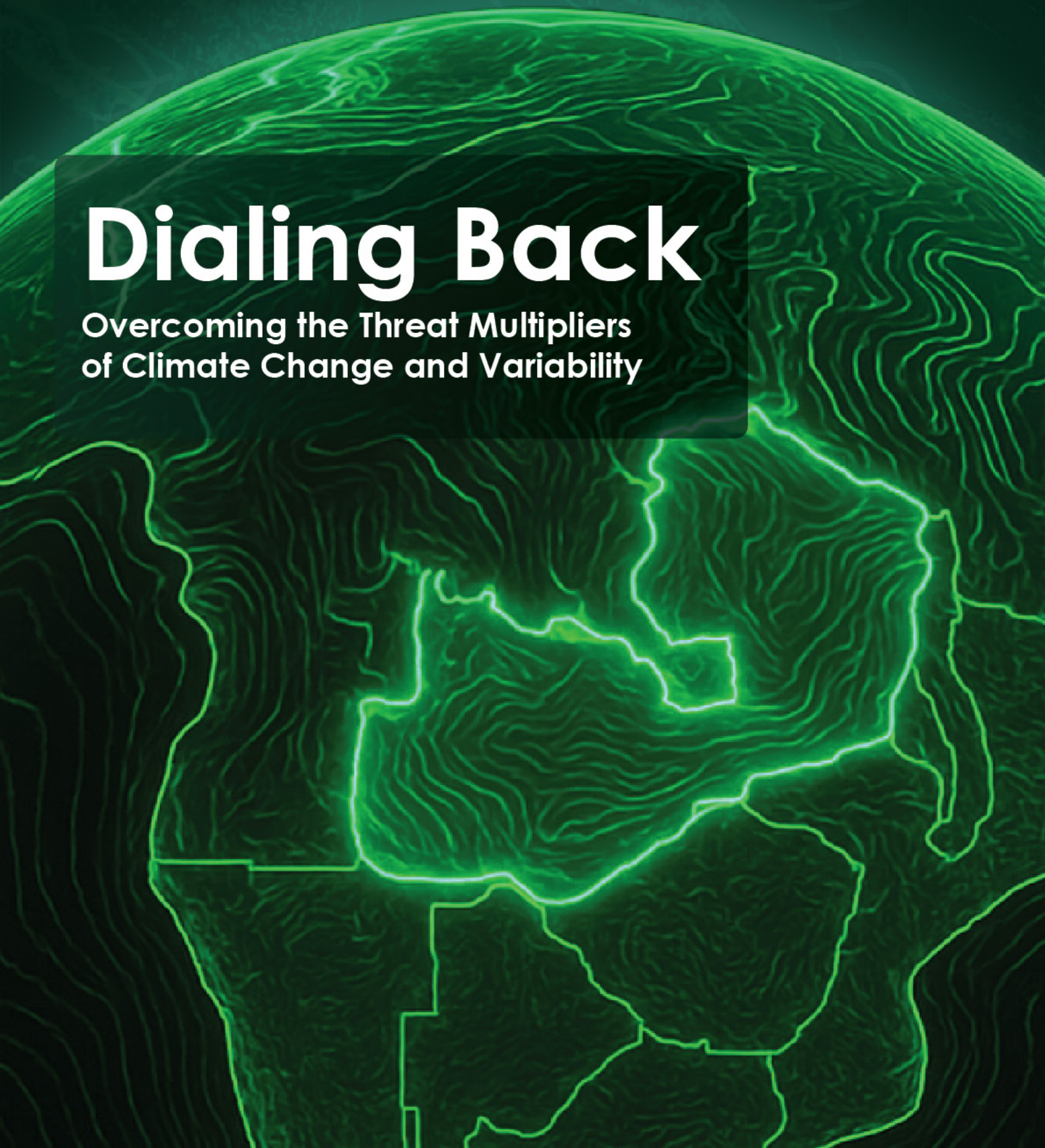
ZAMBIA

NATIONAL HUMAN DEVELOPMENT REPORT 2025

UNDP

Dialing Back

Overcoming the Threat Multipliers of Climate Change and Variability



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Zambia National Human Development Report 2025

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Acronyms and Abbreviations

ADM0	National Level Administrative Unit
ADM1	Provincial Level Administrative Unit
AfDB	African Development Bank
AIDS	Acquired Immunodeficiency Syndrome
BAU	Business as Usual
BUR	Zambia's Biennial Update Report
CBD	Convention on Biodiversity
CCKP	Climate Change Knowledge Portal
CCKP	Climate Change Knowledge Portal
CCKP	Climate Change Knowledge Portal
CCRS	Climate Change Response Strategy
CMIP6	Coupled Model Intercomparison Project Phase 6
CRIDF	Climate Resilient Infrastructure Development Facility
CRS	Climate Resilience Scenario
ERA5	ECMWF Reanalysis 5th Generation
ERA5-Land	ECMWF Reanalysis 5th Generation – Land Component
EWSs	Early Warning Systems
GCF	Green Climate Fund
GCM	Global Climate Models
GDI	Gender Development Index
GDP	Gross Domestic Product
GEF	Global Environment Facility
GET FiT	Global Energy Transfer Feed-in Tariff
GGS	Green Growth Strategy
GHDR	Global Human Development Report
GHG	Greenhouse Gas
GII	Gender Inequality Index
GVA	Gross Value Added
HDI	Human Development Index
HDR	Human Development Report
HIV	Human ImmunoDeficiency Virus
IFC	International Finance Corporation
IHDI	Inequality-adjusted Human Development Index
ILO STAT	International Labour Organization Statistics Database
IPCC	Intergovernmental Panel on Climate Change
iSD	Integrated Sustainable Development NGO: Non-Governmental Organisation
ISIC	International Standard Industrial Classification
LandScan	High-resolution Global Population Database
LCU	Local Currency Unit
MI	Millennium Institute
MPI	Multidimensional Poverty Index
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contributions

NPCC	National Policy on Climate Change
PHDI	Planetary Pressures-Adjusted Human Development Index
REDD+	Reducing emissions from deforestation and forest degradation
REFiT	Renewable Energy Feed-in Tariff
RMSPE	Root Mean Square Per cent Error
ROI	Return On Investment
SCRALA	Strengthening Climate Resilience of Agricultural Livelihoods in Agro-Ecological Regions
SDGs	Sustainable Development Goals
SIPRI	International Peace Research Institute
SNV	Stichting Nederlandse Vrijwilligers ("Foundation of Netherlands Volunteers")
SPEI	Standardized Precipitation Evapotranspiration Index
SPEI	Standardised Precipitation Index
SPI	Standardized Precipitation Index
SSP	Shared Socio-economic Pathways
SSP	Socio-economic Pathways
SSP	Scaling Solar Project
Uc	Theil's Covariance Proportion
Um	Theil's Bias Proportion
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
Us	Theil's Variance Proportion
WID	World Inequality Database
WMO	World Meteorological Organization
ZIPAR	Zambia Institute for Policy Analysis and Research
ZMW	Zambian Kwacha
ZNHDR	Zambian National Human Development Report

Foreword

It is my singular honour and privilege to present our eighth National Human Development Report (NHDR) to the people of Zambia under the title, "Dialling back: Overcoming the threat multipliers of climate change and variability." As the country recovers from one of the most devastating droughts in almost two decades, this report could not have come at a more opportune time. It is significant that this eighth NHDR for Zambia is the first report the country is presenting since 2016, a remarkable nine years having elapsed. Unlike previous reports, this eighth NHDR presents robust scientific evidence of the cascading effects the country faces from climate change. It also presents various policy options and investment pathways, which we have no choice but to adopt in order to realise the goals of sustainable development under our eighth *National Development Plan* and *Vision 2030*.

The Government of the Republic of Zambia continues to make strides in building the capacity of the country into becoming a prosperous middle-income nation by the year 2030. However, the past few years have posed major challenges and threats even as we strive towards the realization of sustainable development within the borders of our great country. We continue to face the ignominious challenge of rising poverty, unemployment and inequality, coupled with high national debt levels that narrow the budget for socio-economic development. Against the backdrop of such a severe fiscal environment, climate change and weather variability continue to act as threat multipliers, further complicating pre-existing vulnerabilities.

While it remains axiomatic that Zambia, like most of the rest of the continent, emits less than 1% of global emissions, the country remains extremely vulnerable to the impacts of climate change. As will be apparent in the report, the extent and specific manifestations of climate change in Zambia have been apparent since 1971, with various levels of increase in temperatures and rainfall patterns recorded. Equally, the report unequivocally states that future projections are not any better, as more frequent and severe agricultural droughts at national and sub-national levels will occur.

Amidst that grim picture of climate change threat multiplication, I have no doubt that there are opportunities to avert the climate crisis and create better opportunities for the people of Zambia. Our Nationally Determined Contribution (NDC) under the Paris Agreement and the National Green Growth Strategy (GGS) are policies that are at the forefront of the government's transition to a low-carbon development pathway, a resilient and socially inclusive economy, by 2030. The eighth NHDR provides a forward-looking view on climate variability and the long-term impact of these policies on the people of Zambia and the country. It acknowledges the policy foundation already built and calls for strengthened collaboration between the public and private sector; cooperating partners, civil society organisations, academia and all stakeholders for a better Zambia.

The Government of Zambia reaffirms its commitment to tackling climate change, with the continued support of various partners. In this light, I would like to express my gratitude to UNDP Zambia for its support in preparing this eighth NHDR. I hope and expect that the report will generate national and local dialogue around policies that accelerate human development and serve as a key reference document as we begin to enhance the mobilisation of resources under the GGC and NDC frameworks. Moreover, this report should play a critical role in the planning and development of the ninth National Development Plan.

Hon. Dr. Situmbeko Musokotwane MP
Minister of Finance and National Planning

Preface

Zambia is confronted with the mounting challenges of climate change and variability, which could negatively impact on the country's development trajectory. The climatic changes are also exacerbating existing vulnerabilities and generating new risks to human livelihoods, economic growth, and the overall quest for sustainable development. The interplay and linkages between climate change and other socio-economic factors create a complex web of risks that make it even more urgent to address these issues through coordinated, inclusive, and sustainable actions. It is in this context that Zambia's eighth National Human Development Report (NHDR) (2025), under the theme "Overcoming the Threat Multipliers of Climate Change and Variability" seeks to stimulate a national conversation on climate change, emphasizing the policies and actions required to safeguard the future of the country. The report also calls for the creation of new partnerships and a commitment to innovative solutions that will allow Zambia to achieve its human development goals while navigating the looming climate crisis. Importantly, and central to this endeavour is the integration of climate resilience into national development strategies.

The report deployed the Integrated Sustainable Development (iSD) model by Millennium Institute to the Zambian context to better understand and quantify the impact of climate change on national development. This report provides valuable insights into how the country can better integrate climate resilience strategies into its development frameworks and achieve more climate-resilient scenarios in the foreseeable future. The analysis highlights and underscores the imperative of investing in Climate Resilience Scenarios (CRSs) which would result in substantial improvements in key development areas such as education, healthcare, and poverty reduction, while also positioning Zambia to meet its long-term sustainability goals. Nevertheless, the report also recognises that the realisation of this potential requires overcoming several challenges, including limited funding, institutional capacities and fragmentation across key sectors. These challenges are particularly pronounced given the fiscal constraints Zambia faces, making the need for external financing even more pressing.

This report presents a thorough assessment of Zambia's current climate resilience efforts, identifying gaps in policy integration and implementation, and provides actionable recommendations for improving the country's adaptive capacity. Key recommendations include promoting cross-sector collaboration, diversifying funding sources, expanding renewable energy projects, building local capacity, and enhancing monitoring and evaluation mechanisms.

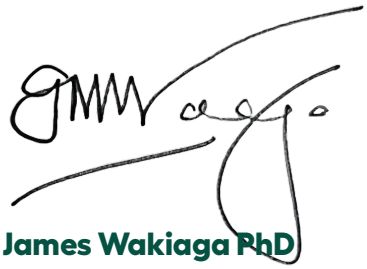
This report highlights significant regional disparities in human development across Zambia. North Western, Lusaka, and Southern provinces outperform the national HDI average of 0.588, driven by higher incomes, better education, and improved health services - largely supported by mining and urban infrastructure. In contrast, Eastern Province has the lowest HDI, reflecting persistent poverty, low educational outcomes, and vulnerability to climate-related shocks in the agricultural sector.

As climate change increasingly disrupts communities across Zambia, this report serves as a call to action for all stakeholders - government, private sector, civil society, and international partners - to work together towards building a climate-resilient future. The findings underscore the importance of addressing climate change as a central priority in Zambia's development agenda, offering a clear pathway to enhance resilience and ensure a sustainable, prosperous future for all.

Through this report, we hope to contribute to the global dialogue on climate change and its impacts on vulnerable nations. By leveraging high-resolution data products and forward-looking climate projections, Zambia can better prepare for the uncertain future that lies ahead. The integration of climate resilience into national development plans is not just an opportunity: it is a necessity to safeguard the livelihoods of the people of Zambia and the sustainability of its natural resources.

This report has also brought together some of Zambia's leading experts across various disciplines to explore and articulate the complex relationship between climate variability and human development. As such, it serves as a rich resource for policymakers, academics, industry leaders, and all those with a vested interest in Zambia's development journey. It is my hope that this report will inspire continued dialogue, deeper policy analysis, and the production of timely, relevant data to support informed decision-making.

I would like to express my gratitude to all the experts, stakeholders, technical reviewers, editors, and partners who have contributed to this important work. I extend my sincere appreciation to all of them, as well as to our colleagues across the UN system and development partners, particularly the UNDP technical team, whose tireless coordination and support were invaluable throughout this process. The commitment and collaboration have made this report possible, and I hope it will serve as a foundation for future action, policy development, and further research.



James Wakiaga PhD
Resident Representative

Acknowledgements

The preparation of the eighth Human Development Report (HDR) for Zambia is a testament to the collective wisdom, dedication, and collaboration of numerous individuals, institutions, and partners. This Report would not have been possible without their invaluable contributions, and we express our heartfelt gratitude to all who have played a role in shaping it.

First and foremost, special recognition is given to the Government of Zambia, through the Ministry of Finance and National Planning (MoFNP), the Zambia Institute for Policy Analysis and Research (ZIPAR), ID Insight, and all the UN agencies that participated in the initial brown bag meeting to discuss the concept note for the 2025 report.

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The report also benefitted from the voices of stakeholders amplified through consultations, seminars, and brainstorming sessions. We thank all participants—government officials, development partners, civil society representatives, think tanks, academic institutions, and individuals—for their insights and for connecting us with key constituencies.

Their collective input has made this report a truly collaborative endeavour.

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Finally, we express our sincere appreciation to the people of Zambia, whose resilience and aspirations lie at the heart of this report. It has been a privilege to work alongside such a dedicated team of professionals and partners. This National Human Development Report (NHDR) belongs to all who have contributed their time, ideas, and passion, and, most importantly, to the Zambian people who inspire us to strive for a more sustainable and equitable future.

Key Messages in the Report

1

The issue at hand

Zambia is grappling with the intensifying impacts of climate change and variability, which act as potent threat multipliers across multiple sectors, ultimately, hamstringing progress towards Sustainable Development Goals (SDGs) and the Vision 2030. The threat multiplier effects of climate change translate into a complex interplay of vulnerabilities, including a decline in agricultural production, diminished economic growth, increased poverty and inequality, forced displacement dur to floods and drought, food insecurity, and compromised public health, among others.

2

The stark reality of climate change and variability

Zambia has recorded a steady rise in annual temperatures with daily minimum, average and maximum temperatures all increasing by at least 1°C since 1971. These daily temperatures are further projected to rise by an additional range of 2.5°C to 4.7°C under moderate to high greenhouse gas emissions scenarios by the turn of the century.

The number of days with temperatures over 35°C is expected to increase by 62 days while days with temperatures above 42°C are expected to increase by 4 days. Hot and humid days could increase by 11 days leading to a 30 -50% decline in labour productivity by the end of the century under moderate to high greenhouse gas emissions scenarios.

Maximum single-day rainfall has risen by 11 mm with projected further increase by 3.8 to 6.2 mm by end of century while heavy rainfall days (over 20mm) have increased by 2.3 days per year and are expected to rise by an additional 1.0 to 2.2 days annually by end of century.

Zambia has also registered an increase in consecutive dry days annually lengthening by 19 days since 1971 with projections indicating an additional lengthening of 5-6 days by the end of the century, on average, with high potential variability.

These extreme weather conditions are directly impacting lives and livelihoods of Zambians with an estimated 500,000 people being at risk from 1-in-100-year flood events while some 200,000 people are exposed to floodwaters at least 1 meter deep with the highest level of exposure being in Southern, Northern, Western, and Lusaka provinces highlighting the unique vulnerability to climatic shocks of rural populations who rely on rainfed agriculture for their livelihoods.

3

Turning the tide and dialling back the multiplier effects of climate change and variability

Zambia's Human Development Index (HDI) can be improved by 1% by 2030 and by 3% by 2050 through the implementation of existing policies, principally the Nationally Determined Contribution (NDC) and the National Green Growth Strategy (NGGS) with significant gains in life expectancy, education, and income.

From a baseline (2024) SDGs achievement of 50%, these policies, implemented together, would lead to an increase of 2% in SDG achievement by 2030 driven largely by advances in No Poverty (SDG 1), Zero Hunger (SDG 2), improved access to clean water and sanitation (SDG 6) and sustainable cities and communities (SDG 11).

Over the long run, however, the policies would lead to an overall increase (against baseline) of 5% in SDG attainment by 2050 driven by increases in SDG 1 (no poverty), SDG 2 (zero hunger), SDG 7 (Clean energy), SDG 8 (Decent work and economic growth), SDG 9 (industry, innovation and infrastructure),SDG 13 (climate action)and SDG 15 (Life on land).

4

Policy drivers of SDGs attainment

When policy interventions are considered separately, thus eliminating tradeoffs across goals, the positive attainment of SDG 1 (Zero poverty) is mainly attributable, in large measure, to expenditure on 'general transfers' and 'waste'; attainment in SDG 2 (no hunger) to expenditure in 'agricultural training'; SDG 6 (clean water and sanitation) to water and sanitation access; SDG 11 to expenditure on waste; and, finally, the negative attainment of SDG 17 is attributable to the lower 'proportion of domestic budget funded by tax' since the additional funding is assumed to be sources from external financing sources – ODA and FDI.

5

Sectoral effects of climate change policies

The climate change policies are also projected to have significant effects on social outcomes with total population being lower by some 500 000 people due to improved access to education, healthcare and family planning.

These policies also have the potential to enhance GDP growth by an additional 1.8 percent per year, creating an additional 875, 000 jobs across sectors with a resultant increase in GDP per capita of ZMW 3,900/person/year by 2050. The policies also have the potential to narrow the government deficit by -0.5% by 2050 and reduce the domestic debt-to-GDP ratio by 8%, indicating a more sustainable fiscal trajectory.

The policies can also accelerate poverty reduction by a further 13 percent primarily due to increased access to basic facilities and transfers through farmer household support programs as well modest reduction of 2.3% in the Gini coefficient owing to modest improvement in household income for the lower percentiles.

The mining sector can experience a 4 billion ZMW increase in gross value by 2050, with total metal ore extraction increasing by 102 million tonnes per year by 2050 due to improved electricity generation (predominantly solar), industry innovation and gross capital formation.

Agricultural gross value add increases by 3.5 billion ZMW by 2050, as adaptation and mitigation strategies enhance crop yields and boost cereal and non-cereal production.

The policies have the potential to contribute directly to climate change mitigation by reducing total greenhouse gas emissions by 9.6 million tonnes/year by 2050 and moderating the loss of forest cover leading to a net gain of four million hectares by 2050.

Investments in the energy sector under these policies are expected to add 14 TWh/year in private sector led electricity generation by 2050, primarily through solar and hydro energy as well as wind and other renewable energy sources. This is expected to increase access to electricity to 75% of the population by 2050, while also creating opportunities for increased electricity exports.

6

Policy design and implementation effectiveness hold the key

National climate change policies, while largely aligned to the MEAs, often fall short in terms of comprehensives, level of ambition, budgetary allocations, targeting of interventions and cross-sectoral coordination. There is, therefore, a need to strengthen national institutional capacities, enhance sectoral integration and coordination especially between the key sectors of water, agriculture and energy; enhance resource mobilisation particularly from the domestic market. Policies should also be updated regularly to ensure continuous alignment with national priorities and global goals.

There is need for strengthened governance structures and enhanced private sector participation in climate change initiatives including through the development of a finance compact and forging of strategic partnerships to mobilize resources and ensure long-term sustainability. The development of innovative financial instruments like green bonds and a National Green Fund, along with incentives and risk-sharing mechanisms to attract private-sector investment is critically needed.

With regards to technology, there is need to promote proven indigenous knowledge systems while also leveraging advanced technologies such as GIS mapping and early warning systems and enhanced monitoring and evaluation, by establishing systems to track climate finance, assess project outcomes, and measure the impact of policies. There is need to strengthen local capacity by equipping communities and institutions with essential skills, and empowering youth to foster innovation and promote intergenerational knowledge exchange.

Given the country's significant fiscal constraints and debt position, climate change response will rely heavily on external financing – grant funding and foreign direct investments underscoring the vital role of international support in advancing climate action in Zambia.

Chapter 1

Human Development and the Compounding Effects of Climate Change and Variability

1.1 The Compounding Effects of Climate Change

Zambia, like much of the African continent, is grappling with the intensifying impacts of climate change and variability. The compounding effects of climate change are already evident, with climate-induced challenges exacerbating existing vulnerabilities and creating new risks to human development, security, and the overarching aim of sustainable development.

Historical data examined for a period spanning slightly more than fifty years (1971-2024) for the key climate indices of temperature and rainfall confirm that Zambia is exposed to a suite of climate hazards that can potentially exacerbate other livelihood predicaments such as poverty, lack of access to basic needs and resources, including clean water, food, health care and education among others.

Despite Zambia being classified as a net-carbon sink, the 2020 University of Notre Dame Global Adaptation Initiative Index (GAII) ranked Zambia as the 41st most vulnerable country to climate change out of 182 nations (University of Notre Dame, 2025). This classification reflects the country's heightened exposure to climate shocks, including floods, prolonged droughts and intense temperatures. Notably, severe droughts in 2015, 2018, and 2024 have led to national emergencies, with the 2024 drought being marked the most severe in the country's history.

1.1.1 Climate Change as a "Threat Multiplier"

This report conceptualises and frames climate change as a "threat multiplier" primarily because its impacts often transcend the environmental goods and services sector and have serious debilitating consequences in the wider socio-economic ecosystem, both directly and indirectly.

The direct and indirect impacts of climate change on the wider economic and social development ecosystem will be further amplified in subsequent chapters of the report.

As far back as 2019, the United Nations (UN) already recognised climate change as a key driver of national peace and security (United Nations, 2019). Accordingly, the UN emphasized the urgency of addressing climate threat multipliers in national development planning. 'Climate threat multipliers' were then defined as "the mechanisms through which climate change amplifies pre-existing socio-economic vulnerabilities and emerging development challenges" (United Nations, 2019). In Zambia, this definition translates into a complex interplay of factors, including diminished economic growth, increased poverty and inequality, forced displacement, food insecurity, and compromised public health. These multilayered and interconnected challenges pose a significant barrier to achieving the Sustainable Development Goals (SDGs) and Zambia's development policy blueprint, the Zambia Vision 2030 (Republic of Zambia, 2006).

The formal use of the term 'threat multiplier' can be traced to the Centre for Naval Analyses Military Advisory Board 2007 report titled 'National Security and the Threat of Climate Change'(The CNA Coperation, 2007). It was initially used to describe how climate change effects interact with and have the potential to exacerbate pre-existing threats and other drivers of instability, contributing to security risks (Goodman & Baudu, 2023). Specifically, the board examined the linkages between climate change and insecurity, recognising that climate-related risks intersect with political, social, economic, and demographic factors. However, the term's usage has since evolved and is presently widely used by scholars and practitioners to encompass not only climate change implications for security, but also the broader development realm.

In a report titled, Environment of Peace: Security in a New Era of Risk, the Stockholm International Peace Research Institute (SIPRI) observed that "security and environmental integrity are both headed in the wrong direction, to the detriment of every country and our collective common good (SIPRI, 2022). They developed a pathway through which climate change could lead to insecurity, as shown in **Figure 1.1**.

In short, SIPRI showed that climate change create "pathways" leading to deteriorating livelihood conditions, prompting migration and mobility as people seek alternative locations with better living conditions. Besides, the phenomenon creates armed group tactics as different social interests compete for scarce resources, while elite approaches could lead to exploitation and resource mismanagement, ultimately resulting in general insecurity.

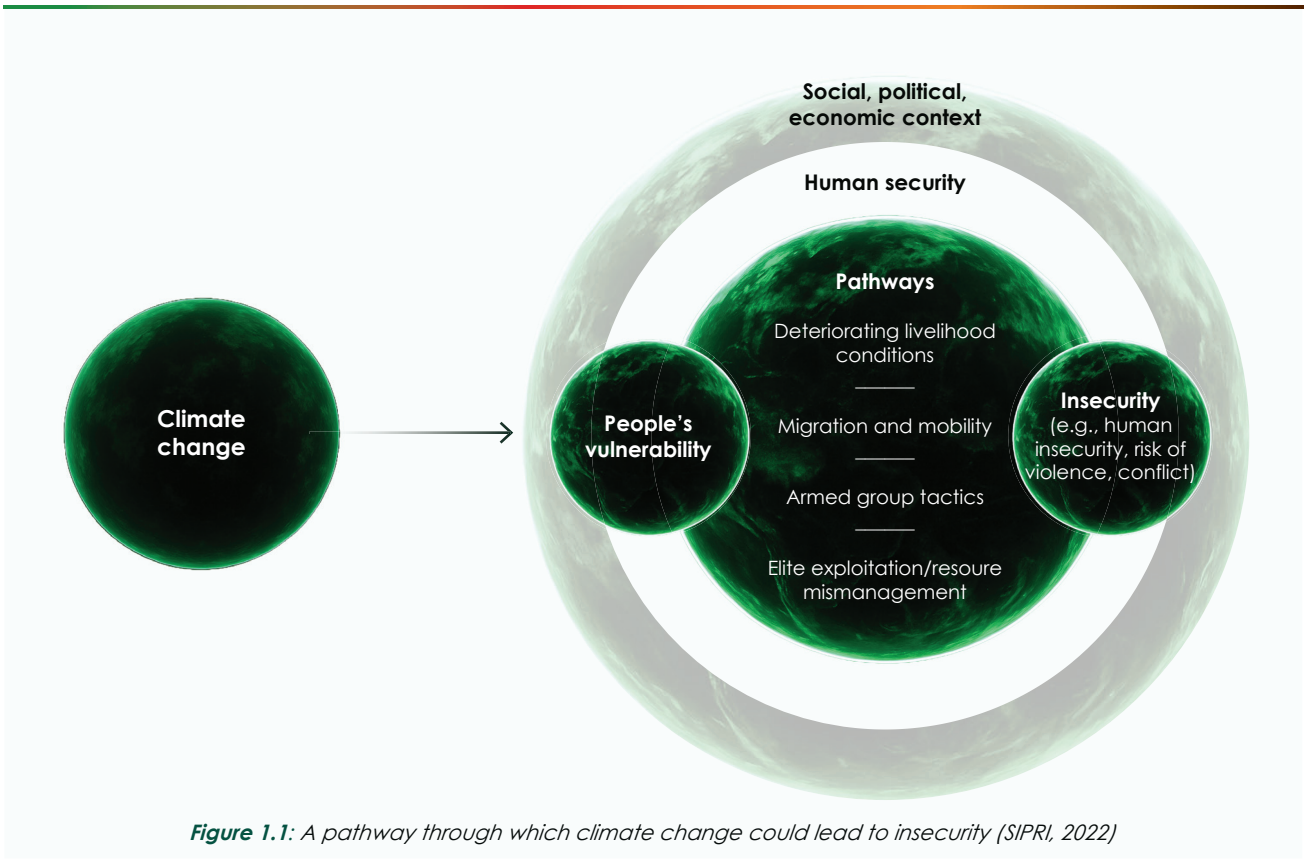


***Figure 1.1**: A pathway through which climate change could lead to insecurity (SIPRI, 2022)*

1.2 Human Development and the Development of Nations

As is fairly well known, the United Nations Development Programme (UNDP) pioneered its Human Development Report (HDR) in 1990, inspired by, among others, the approaches developed by Amartya Sen and Mahbub ul Haq (Haq, 2008).

Since then, the HDRs have focused on diverse topics related to human and national development.[1] A running theme in all the reports, however, is that "Development is about People." The HDRs have highlighted the fact that nations that have attained and sustained high levels of development have all focused on the development and well-being of their people. The reports have argued that human development is about expanding people's choices and enabling them to live full and creative lives with freedom and dignity.

[1] The latest one, the 2023/2024 Report titled *"Breaking the gridlock: Reimagining cooperation in a polarized world"* was launched on April 13, 2024.

It was, however, the 2020 HDR edition titled "The Next Frontier: Human Development and the Anthropocene" (Baumann, 2021) which broke new ground by emphasising that development isn't just about people but rather about the intricate relationship between people and the planet. The report doubled down on the belief that people's agency and empowerment hold the key to living in balance with the planet in a fairer world. It posited that we are at an unprecedented moment in history in which human activity has become a dominant force shaping the planet. These impacts interact with existing inequalities, threatening significant reversals in development. To address these challenges, the report called for bold new paths that promote human development while easing planetary pressures.

Since 1990, the National Human Development Report (NHDR) teams have also helped advance the human development conceptual framework and apply it to the most pressing and unique developmental challenges facing individual countries. It is in this context that Zambia's eighth NHDR will centre-focus one of the most pressing challenges of our time: climate change because of its direct impact on present and future development pathways.

1.2.1 Human Progress Measurements

In the tradition established by Amartya Sen and Mahbub ul Haq, the NHDRs routinely present human development measurements, the basis of which spatial comparisons can be made. These indices or measurements have grown far beyond what the pioneers had in mind and in a sense, reflect the UNDPs response to both praises and criticisms of the indices (Stanton, 2007). In general, the indices very much depend on data availability for each country, itself often a tall order in many developing countries. To date, the following six are the most well-known signifiers or measurements of human development:

The Human Development Index (HDI);

The Human Development Index (HDI);

The Inequality-adjusted Human Development Index (IHDI);

Planetary Pressures-Adjusted Human Development Index (PHDI);

Gender Inequality Index (GII);

Gender Development Index (GDI); and

Multidimensional Poverty Index (MPI)

In this report, focus is more on the Human Development Index permutations occasioned on the country, as a result of the increasing threat of climate change. The analyses and computation of the indices were informed by local data sources where available and complimented with global data sources.

In a nutshell, the HDI measures the average achievements in three basic dimensions of human development: a long and healthy life; access to knowledge; and a decent standard of living: which Amartya Sen characterised as the "capability" approach . The I-HDI adjusts the HDI for inequality in the distribution of each dimension across the population. The PHDI, in turn, accounts for excessive human pressures on the planet by adjusting the level of human development, measured by the HDI, for carbon dioxide emissions and material footprint. The GDI is the ratio of female to male HDI values, while the GII reflects gender-based disadvantage in three dimensions: reproductive health, empowerment and labour market. Itis a measure of the loss in potential human development due to inequality between female and male achievements in these dimensions. The MPI, on the other hand, measures multiple deprivations at the individual level in education, health and standard of living. These indices -usually presented as statistical annexes - in the NHDRs offer critical insights that countries can rely on to measure progress and incremental development among their communities but can also be a basis for comparison with peer countries.

1.2.2 A Chequered History with Human Development Reporting

Due to data constraints, Zambia has not always produced its National Human Development Reports (NHDRs). So far, a total of only seven NHDRs have been produced, each one addressing diverse and different topical concerns of the respective times. Thus, the 1997 report focussed on poverty (United Nations, 1997), while in 1998, the focus was on the provision of basic services (United Nations, 1998). Subsequently, in 1999/2000 focus was on 'Employment and Sustainable Livelihoods' (UNDP, 2001), while in 2003, it headlined, 'The Reduction of Poverty and Hunger in Zambia: An Agenda for Enhancing the Achievement of the MDGs' (United Nations, 2003)'. Later issues focused on the Response to HIV and AIDS (United Nations, 2007); Service Delivery for Sustainable Human Development (United Nations, 2011), and; Industrialisation and Human Development (United Nations, 2016). Quite clearly, there have been gaps in some years, but more significant is the fact that Zambia has not produced an NHDR in the last nine years, implying also that the economic policies and the overall national transformation trajectory have not benefited from the crucial developmental measurements or the policy insights and recommendations that have become a major hallmark of the NHDRs.

1.3 Purpose of Zambia's Eighth Human Development Report

The traditional purpose of producing NHDRs is usually to help generate national and local-level debate and dialogue around policies and actions needed to accelerate human development in its entirety. While it is generally recognised that economic growth; increased trade and investments as well as technological advancements are all important considerations in promoting development, they are, nonetheless, merely a means to an end. The end result should be the realization of human development, which, as will be clear in subsequent pages of this report, is about expanding the range of opportunities available to people and the choices that they can make.

People are considered to have experienced human development if they live long and healthy lives; are educated and have access to information; have a decent standard of living; and enjoy political and civil freedoms to participate in the affairs of their communities. The NHDRs therefore have the important aim of engaging people, especially the poor and deprived; government decision-makers; civil society; the business communities; academia; and the public at large, in building new visions, partnerships, and actions for the realisation of this expanded notion of human development. In keeping with this tradition, Zambia's eighth NHDR aims to stimulate national dialogue and debates on the policies and actions needed to overcome the threat multipliers of climate change and engage all stakeholders in building new visions, partnerships, and actions to accelerate the realisation of the totality of human development. Zambia's eighth NHDR will contribute to debate, dialogue and the evolution of implementation strategies for addressing the threat multipliers of climate change and variability. Specifically, this eighth NHDR presents and covers the following topics and themes:

This context and background setting chapter;

The historical manifestations of climate change, as well as future projections, based primarily on analysis of satellite data;

The nature, extent and actual manifestations, including the effects of climate change and variability;

Analysis of the national policy responses to identify gaps, their effectiveness and enumerating proposals for addressing the noted and potential threat multipliers;

Critical analysis of the potential impact of Zambia's climate change policy responses on the economy, society and the environment, and;

The results of computation of the measures of human development that is HDI, I-HDI, GII, GDI and MPI at national and sub-national levels (provincial level) to highlight spatial, temporal and gender dimensions of under-development, poverty and deprivation.

1.4 A Snapshot of Zambia as a Country

Zambia spans a total land area of 752,614 km² and is endowed with rich natural resources, extensive forest cover, and significant freshwater reserves covering roughly 9,220 km² of land (Republic of Zambia, 2024). The country's terrain consists of a high plateau, interspersed with hills and mountains and characterized by tropical climate. Zambia experiences two primary seasons, the rainy season (November–April) and the dry season, with moderate conditions in between (Republic of Zambia, 2023). The country's population stands at 19.6 million, with 60% residing in rural areas and 40% in urban centres (Republic of Zambia, 2024).

Zambia's Human Development Index (HDI) has steadily improved, rising from 0.471 in 2005 to 0.595 in 2023 (Global Human Development Report, 2025). This progress is largely attributed to increased life expectancy at birth, which grew from 48.5 to 66.3 years, alongside gains in education. The average number of completed years of schooling rose from 6.3 to 7.4, while the expected years of schooling for a child entering school increased from 10.9 to 11 during this period. Additionally, Zambia is classified as a lower-middle-income country with a Gross National Income (GNI) per capita of USD 1,290 in 2023 (World Bank, 2023).

Zambia's economy is heavily reliant on mining, with copper serving as the primary source of foreign exchange (Republic of Zambia, 2022). Agriculture also plays a crucial role in economic activity, though largely small-scale, with production focused on maize and livestock farming (Republic of Zambia, 2024). Zambia's energy supply constitutes three main sources, namely, petroleum, electricity and biomass. Biomass accounts for the largest share (~60%) of the energy supply, mainly for household consumption. The country's power sector is primarily dependent on hydroelectric power, which accounts for approximately 80% of installed generation capacity, supplemented by alternative sources (Energy Regulation Board, 2023). Access to electricity has improved over time, with the latest statistics indicating an average national electrification rate of 54% in 2024, with increases to 34% and 80% in rural and urban areas, respectively (ZAMSTAT, 2023).

Chapter 2

Climate Change and Extreme Weather Conditions as Threat Multipliers

2.1 Projecting Trends in Climate Change and Likely Multiplier-Effect Pathways

This chapter highlights evidence of climate change in Zambia based on various analyses of historical trends in temperature and rainfall, as well as extreme weather conditions. Historical data and information based on satellite images spanning fifty-three years (1971-2024) have been used to establish trends. Beyond these baseline trends, the chapter also highlights future projections for the medium term (2022-2030) and the longer term (2022-2050) and beyond to project the likely impact in the absence of policy reforms and bold investments that enhance resilience building.

2.1.1 Climate Change in the contemporary context

For the first time on record, global average temperatures breached the 1.5oC threshold in 2024, marking it as the warmest year since the pre-industrial period (1950s) (WMO, 2025). While climate change has gradually altered long-term environmental conditions, the intensification and frequency of extreme climate events have amplified socio-economic vulnerabilities worldwide (Ridder et al., 2022).

The existence of climate change and shifting temporal patterns, technically referred to as variability, remains an ever-present challenge in Zambia. These threats manifest as increased frequency, intensity, and longevity of droughts, with resultant adverse effects on an entire cross-section of development sectors: water availability for livestock and human consumption; agricultural production and food security at national and household levels, among other challenges.

Climate change, therefore, acts as a threat multiplier, amplifying existing vulnerabilities and pushing people deeper into poverty. Droughts, floods, and erratic weather patterns disrupt agricultural production, which is a primary source of income for many Zambians, particularly in rural areas (Nanja, 2017). This leads to food insecurity, loss of livelihoods, and a decline in overall well-being. At the macro level, these manifestations of climate change and extreme weather events strain the already limited fiscal space available to the national government to address the immediate needs of the people. The drought experienced in 2024 is a stark reminder of the urgent need to address the resurgence of climate change and build resilience among vulnerable populations.

The year 2024 was particularly challenging for Zambia due to the onset of one of the worst droughts in the country's history, exacerbating water and energy shortages, disrupting agricultural production and contributing to the spread of cholera (African Center for Biodiversity, 2024). These adverse conditions have had significant consequences for power supply, economic growth, industry and food security, with GDP growth recorded at 2.3% in 2024, revised from the initially targeted 6.6% goal, and a total maize deficit of 2.1 million tonnes (ZIPAR, 2024).

2.2 Defining the Threat Multiplier Pathways

Figure 2.1 below illustrates the key climate threat pathways, emphasising the interconnected effects of climate change on Zambia's socio-economic and environmental systems. The conceptual model captures the key climate threat pathways discussed and mapped with national stakeholders during engagement workshops organized as part of the preparation of this report.

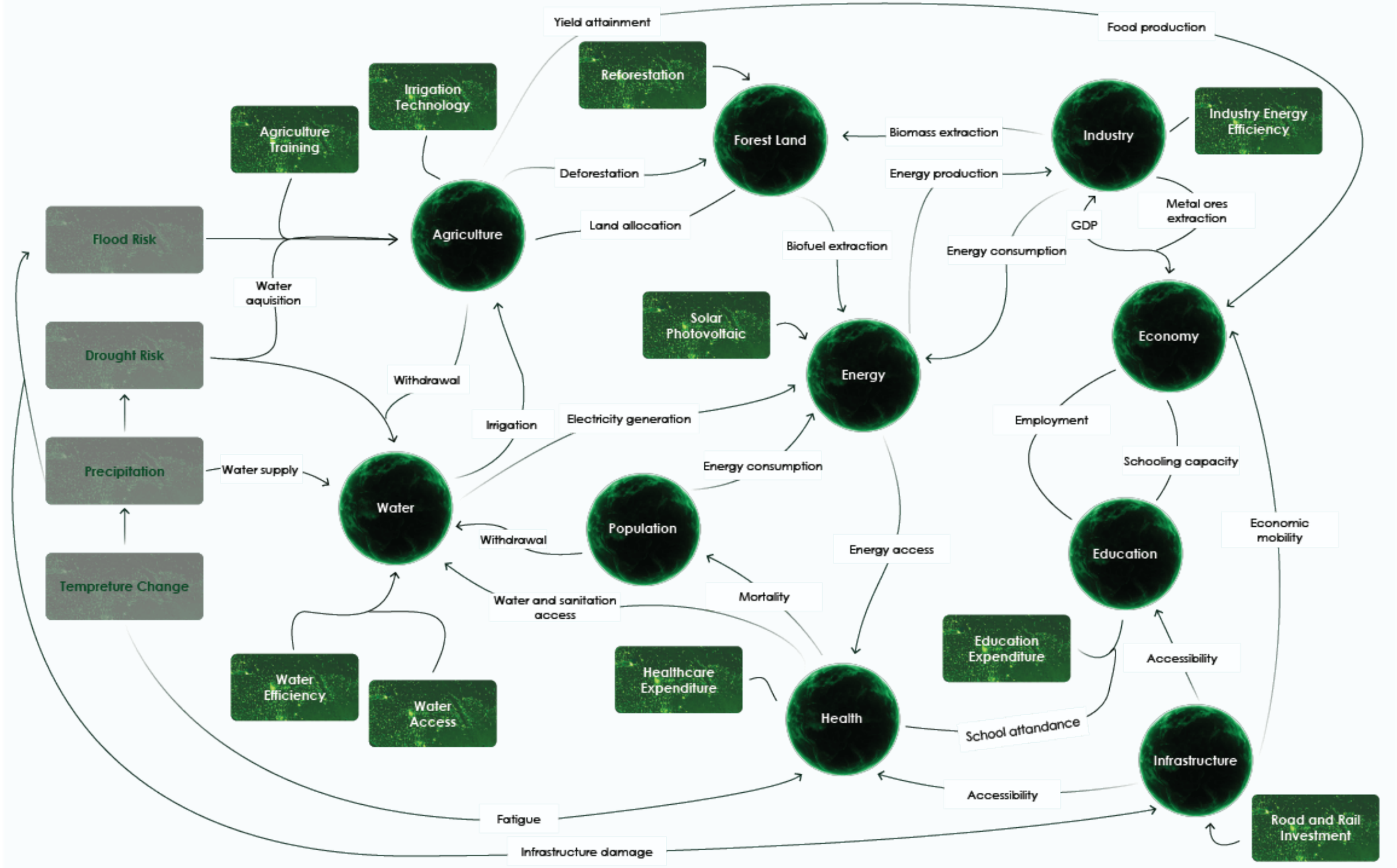


Figure 2.1: Primary climate threat pathways model in relation to key development priorities in Zambia

In the sections that follow, we utilise the interconnectedness between water availability, agriculture, and energy to highlight the causal pathways between climate change and the different sectors of the economy. Climate change variables, such as precipitation and temperature, directly affect the availability of water resources. Reduced water availability constrains both irrigation for agriculture and hydroelectric power generation. These constraints exacerbate economic stress by diminishing agricultural yields and curtailing energy supply, with knock-on effects across other sectors. Water availability also plays a central role in health outcomes. Limited access to clean water has a detrimental impact on sanitation, thereby increasing the prevalence of waterborne diseases and negatively affecting public health. Poor health outcomes reduce labour productivity and place additional strain on the healthcare system. This cycle is further aggravated by climate-induced damage to infrastructure. Disruptions to agricultural supply chains and transport networks slow economic activity, leading to stagnation and compounding existing vulnerabilities within the socio-economic system.

The agriculture-energy feedback dynamics further indicate that agricultural productivity may drive the expansion of farmland into forested areas, leading to deforestation. This, in turn, further diminishes forest cover, amplifies climate variability, and places additional strain on agricultural, particularly forestry, production. Similarly, restricted energy access inhibits economic activity and reinforces poverty and socio-economic vulnerability. As will be seen in chapter four where the report considers appropriate policy actions, the challenges posed by these interconnected pathways also present strategic opportunities for intervention. Targeted measures, such as reforestation, investments in renewable energy, advanced irrigation technologies, and improvements in water-use efficiency, can mitigate the cascading impacts.

2.3 Spatial and Temporal Analysis of Climate Change Patterns

To better understand the manifestations of climate change and extreme weather conditions in Zambia, this report examines two significant patterns, namely temperature changes and trends, as well as rainfall patterns, over space and time; what in technical terms, is referred to as, 'spatio-temporal analysis'. Intense rainfall, for instance, could lead to flooding, while less or its total absence could lead to drought, with the attendant consequences on other sectors of the economy.

Given the high variation in climate patterns and environmental conditions across space, this analysis leverages high-resolution data products for the hazards assessed to create maps that show the hazards in much clearer detail.[3] For future climate projections, an ensemble of 27 different global climate models (GCMs) were utilized from NASA's NEX-GDDP-CMIP6 dataset (Thrasher et al., 2022).[4]

[3] All climate metrics were calculated at national (ADM0), province (ADM1), and district levels (ADM2) units, with spatial boundaries taken from GADM v4.1(Carioli et al., 2024). Calculations were also done for 0.1 x 0.1° and 0.25° x 0.25° global mesh grids masked to the total land area for historical and projected datasets, respectively. For plotting purposes, and to harmonize resolutions between the historical and future projection datasets used, grids are further downscaled to a common 0.05° x 0.05° grid (~5km at the equator) using simple bilinear interpolation. For the historical climate data, we utilized the ERA5-Land Reanalysis Dataset, a common globally, gridded data product that utilizes observational station data, satellite-based measurements and regional climate modelling techniques. This, in turn, is used to create a globally contiguous historical dataset of reconstructed climate conditions for dozens of meteorological variables spanning from 1950 to the present (Muñoz-Sabater et al., 2021). The ERA5-Land product is derived from the ERA5 parent dataset but masked by land area and further downscaled to a 0.1° x 0.1° spatial resolution. For our analysis, we selected a 54-year period from 1971-2024 as our historical reference period.

[4] This suite of climate model data utilizes model outputs from the last climate model intercomparison project from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6). These model outputs are statistically downscaled to a uniform 0.25° x 0.25° (~25km at the equator) global grid to construct the NEX-GDDP data product. Additionally, we analyzed two global greenhouse gas emissions scenarios, represented by moderate (SSP2-4.5) and high (SSP5-8.5) emissions pathways from 2025 to 2099.

2.3.1 Rainfall Trends

The mean annual rainfall is calculated as the average annual total rainfall over the reference period while heavy rainfall days is calculated as the average number of days each year for which rainfall totals exceed 20mm. The mean annual rainfall has not changed in ways with statistical significance between 1971 and 2024 (**Figures 2.2 to 2.7**), and this is not expected to change significantly by the end of the century (2075-2099) under moderate emissions. However, it is expected to increase slightly, with statistical significance, by 25mm per year under high greenhouse gas emissions scenarios.

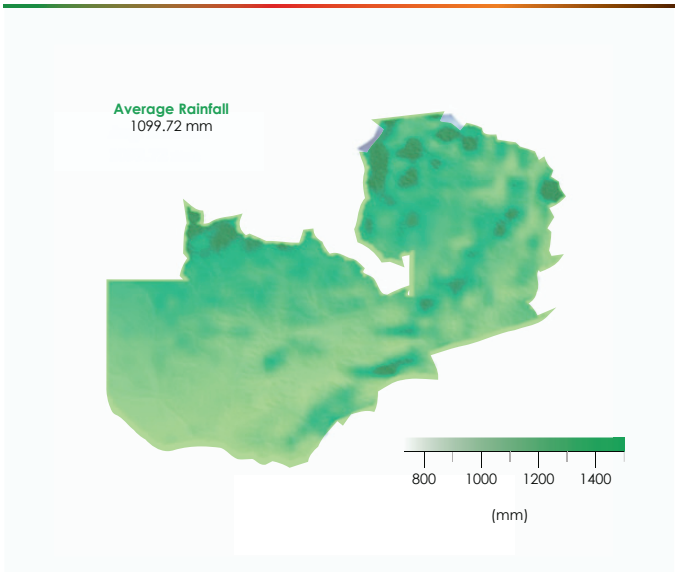


***Figure 2.2**: Annual rainfall, averaged for each year from 1971 to 2024 from ERA5- Land*

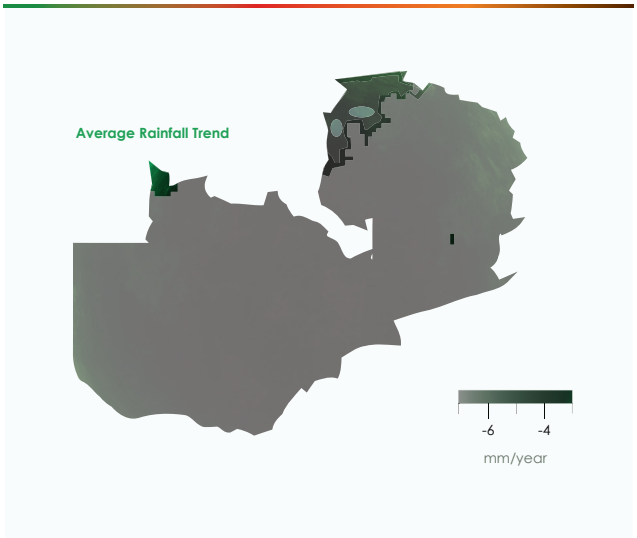


***Figure 2.3**: Average annual rainfall totals trend across the country, with only pixels with statistically significant trends displayed*

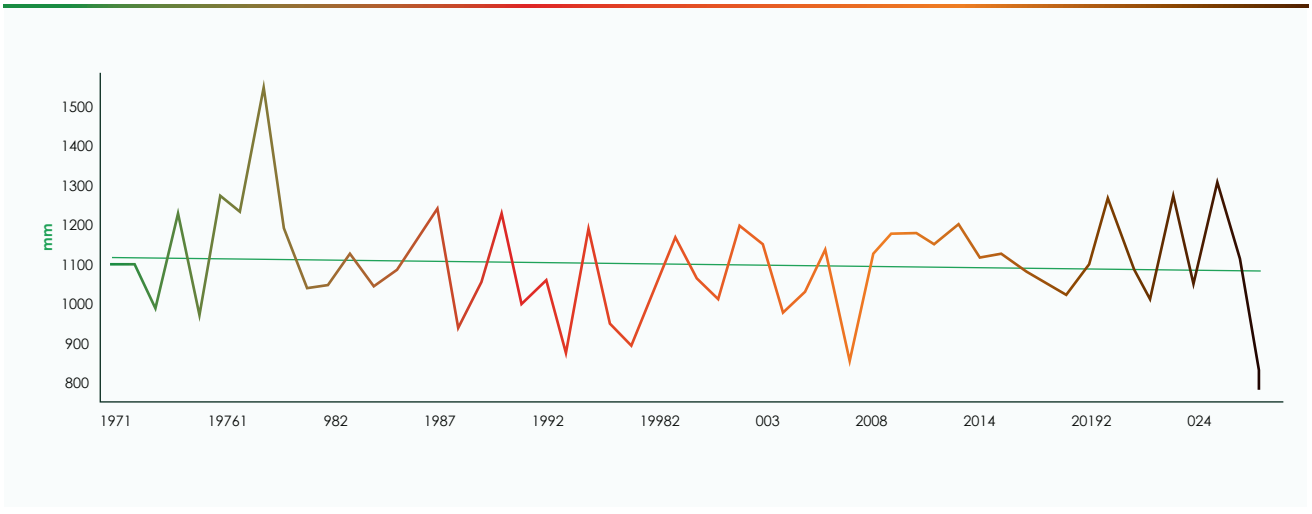


***Figure 2.4**: National average annual values between 1971 and 2024 from ERA5-Land.*

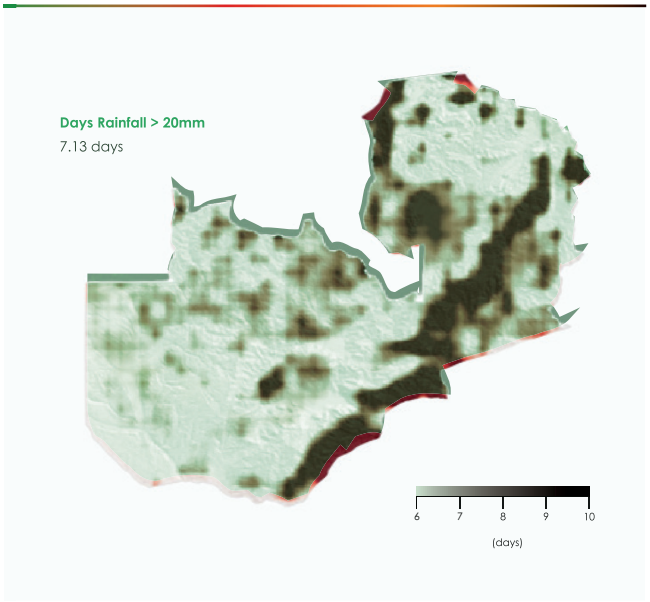


Figure 2.5: Heavy rainfall days (>20mm), averaged for each year from 1971-2024 from ERA5-Land

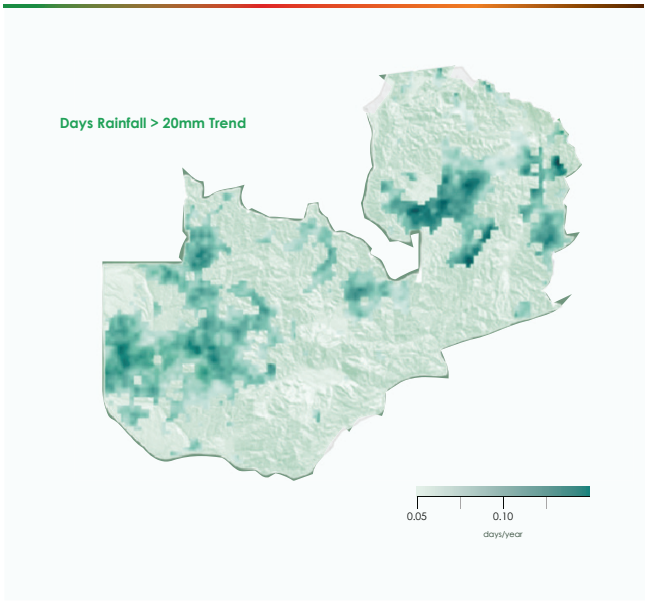


Figure 2.6: Average annual number of heavy rainfall days (>20mm) across the country, with only pixels with statistically significant trends displayed

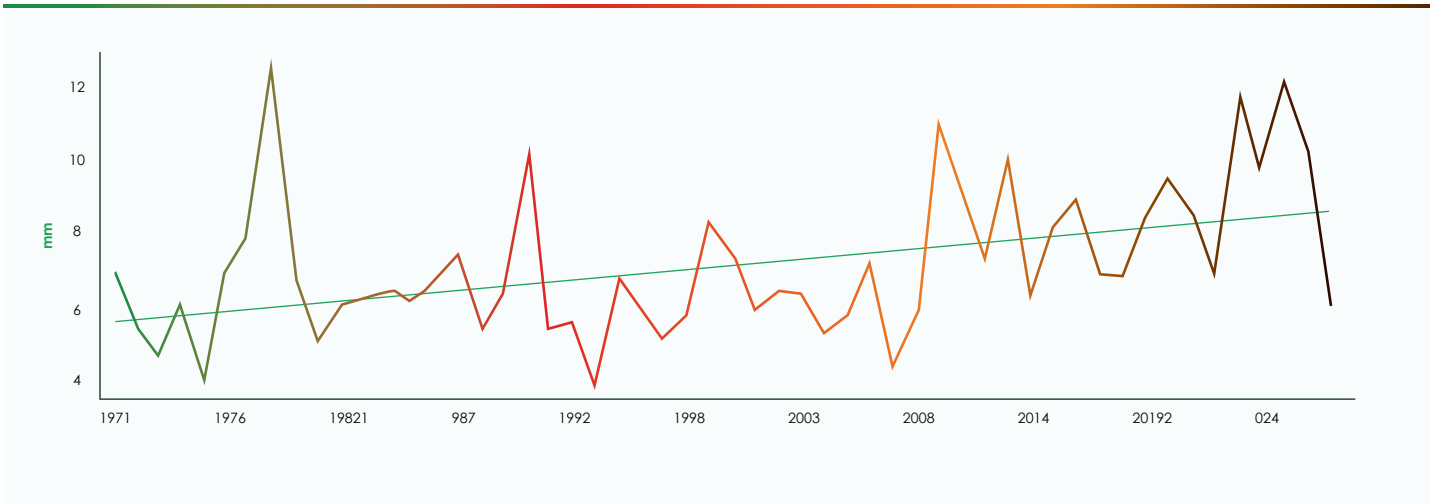


Figure 2.7: National average annual values between 1971 and 2024 from ERA5-Land.

2.3.2 Temperature Trends

Average temperatures were calculated as the annual average of daily mean temperatures in each year across the reference period. Between 1971 and 2024, the mean daily average temperatures increased by +1.04 °C and are expected to increase by +2.56 to +4.67 °C by the end of the century (2075-2099) under moderate to high global GHG emissions pathways, respectively. These levels of increase are statistically significant. On the other hand, between 1971 and 2024, the mean daily minimum temperatures increased by +0.94 °C and are expected to increase by +2.46 to +4.63 °C by the end of the century (2075-2099) under moderate to high global GHG emissions pathways, respectively, again reflecting statistically significant increases. The historical trend for mean temperatures is positive and significant, showing approximately a 1.04°C increase between 1971-2024 nationwide (**Figure 2.8 to 2-11**).

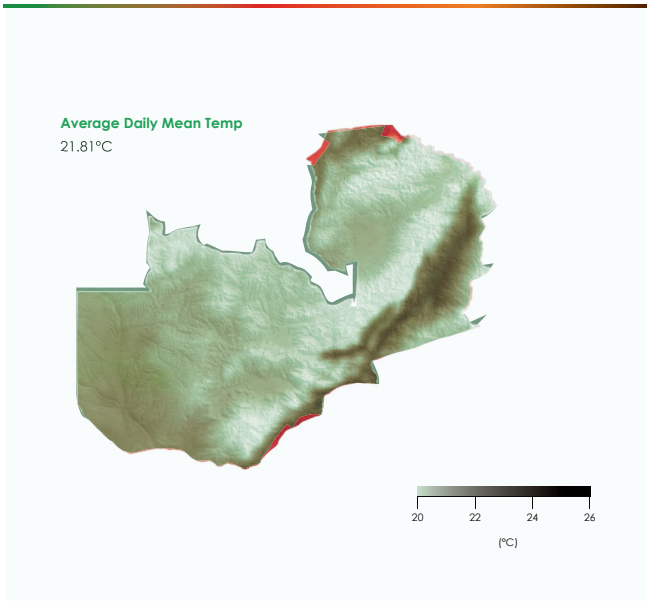


***Figure 2.8**: Average annual daily mean temperature from ERA5-Land*

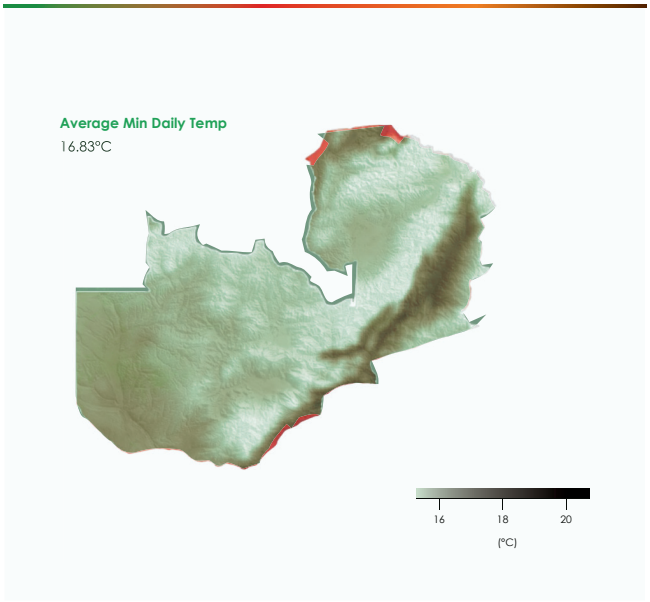


***Figure 2.9**: Average annual daily min temperature between 1971-2024 from ERA5-Land*

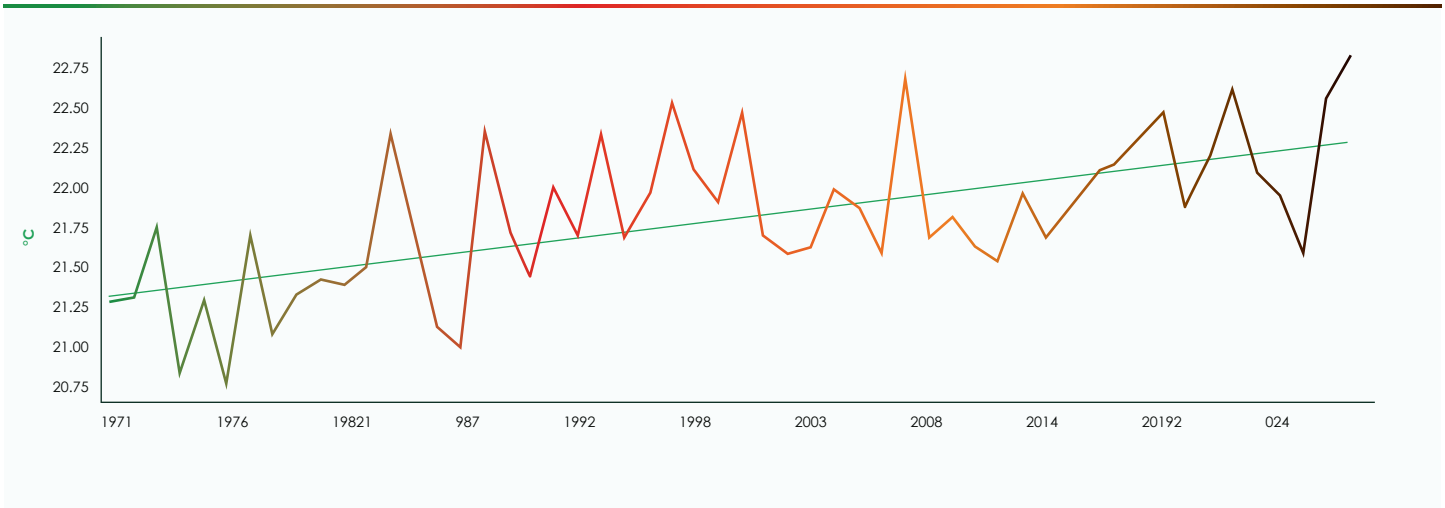


***Figure 2.10**: National average annual values between 1971 and 2024 from ERA5-Land*

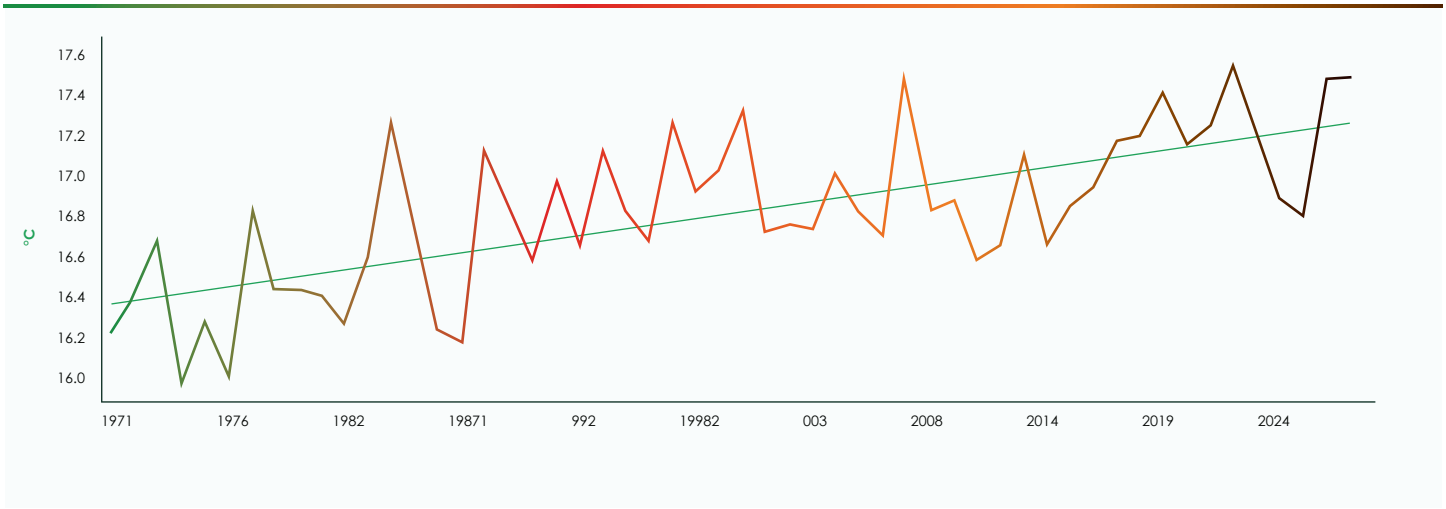


***Figure 2.11**: National average annual values between 1971-2024 from ERA5-Land*

Maximum-minimum temperatures trends

The average maximum temperatures were calculated as the annual average of daily minimum temperatures in each year across the reference period (**Figures 2-12 and 2-13**). The historical trend for minimum temperatures is positive and significant, showing approximately a 0.94°C increase between 1971-2024 nationwide.

The historical trend for maximum temperatures is positive and significant, showing approximately a 1.05°C increase between 1971-2024 nationwide.

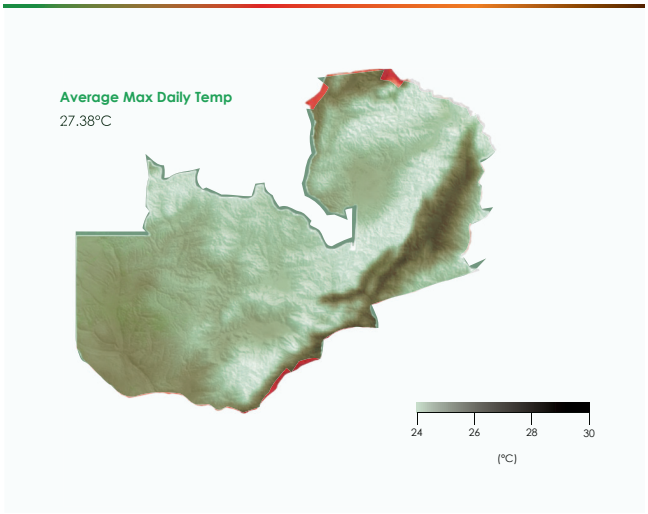


***Figure 2.12**: Average annual daily max temperature between 1971 and 2024 from ERA5- Land*

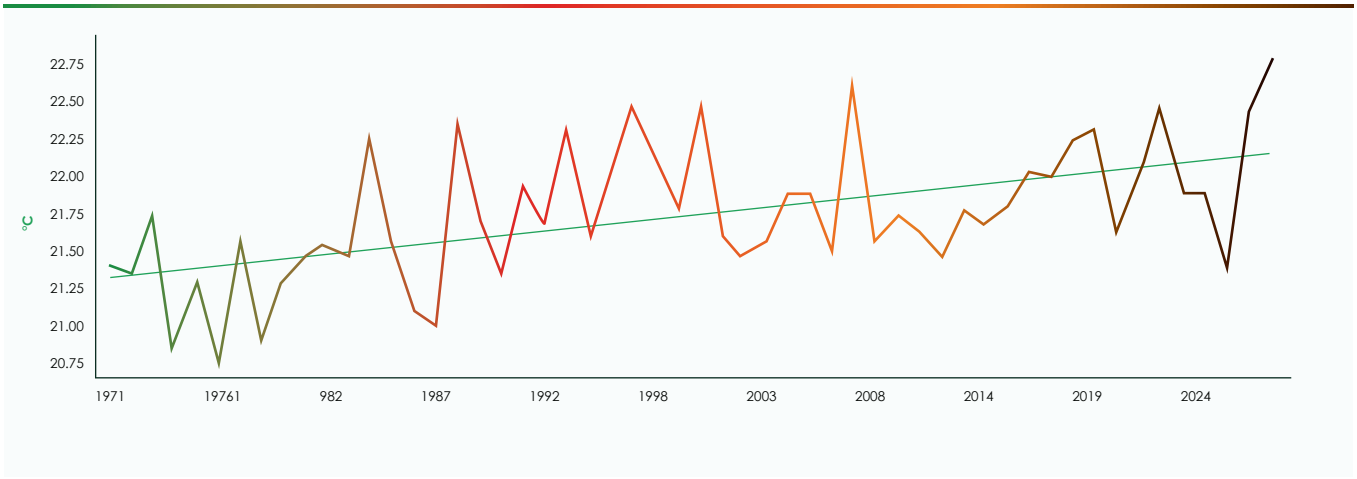


***Figure 2.13**: National average annual maximum temperature values between 1971-2024 from ERA5-Land*

Extreme heat variations (hot days above 35°C)

This was calculated as the number of days where max temperatures are higher than 35°C, usually a measure of high heat stress, (**Figure 2-14 and 2.15**).

The historical trend for hot days exceeding 35°C is positive and significant, showing approximately, an increase of 10.1 days/year between 1971-2024 nationwide.

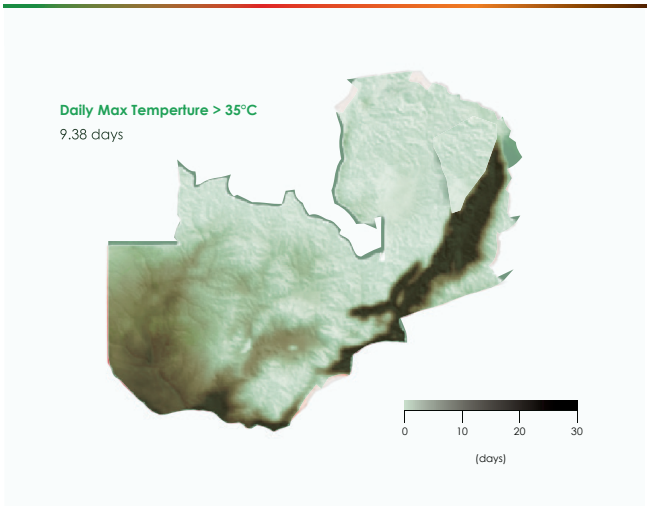


***Figure 2.14**: Number of days where the maximum temperatures exceed 35°C, averaged for each year between 1971-2024 from ERA5-Land*

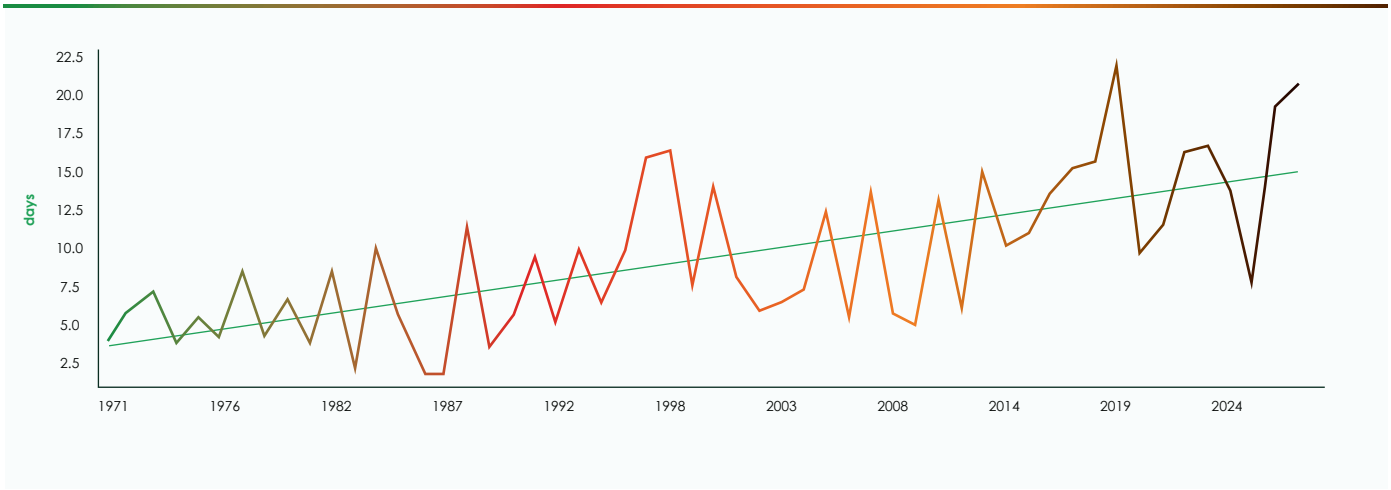


***Figure 2.15**: National average annual values between 1971-2024 from ERA5- Land*

Consecutive Dry Days

Consecutive Dry Days (cdd) is calculated as the average of the lengths of the longest period of consecutive dry (rainfall < 1mm) days within each year, (**Figures 2.16-2.18**). The historical trend for the single-day biggest precipitation event each year is increasing and significant nationwide, showing approximately an increase of 19.1 days between 1971-2024

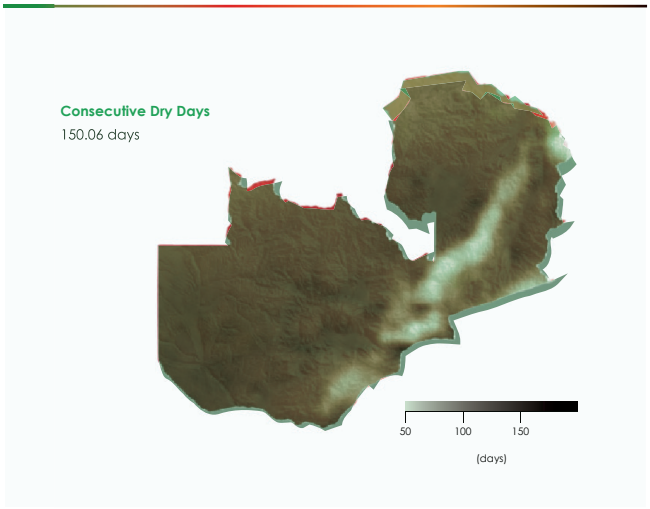


***Figure 2.16**: Longest consecutive dry day period, averaged for each year from 1971- 2024 from ERA5-Land*

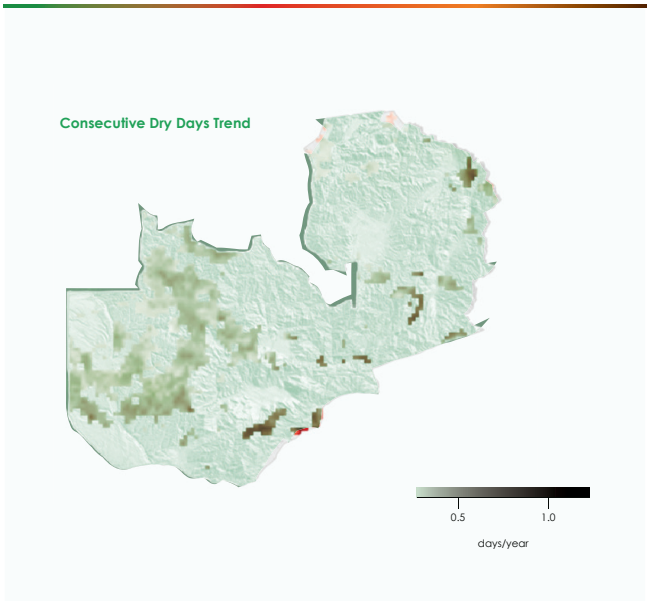
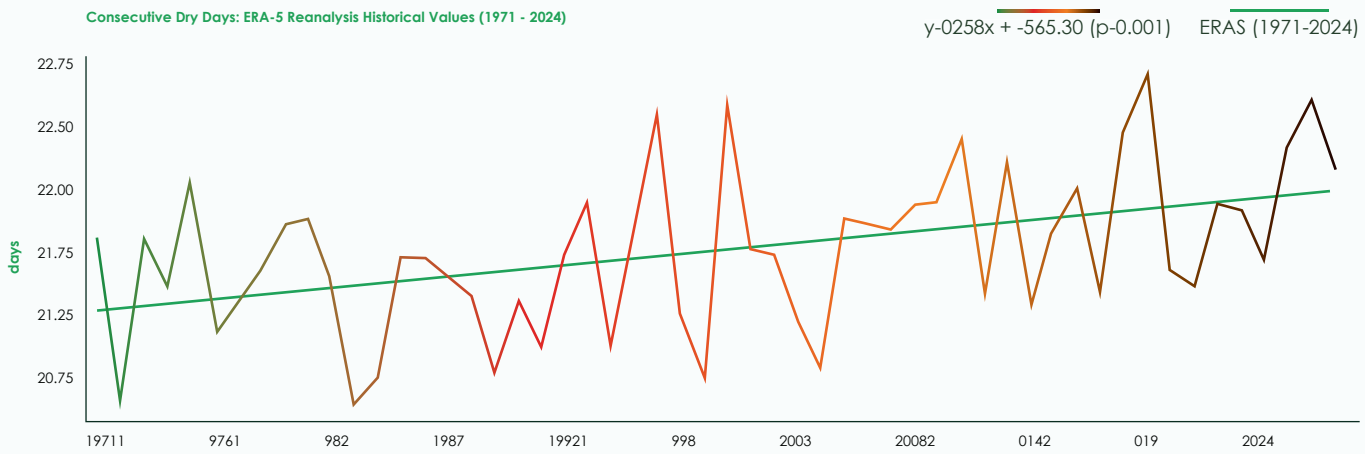


***Figure 2.17**: Average annual length of longest consecutive dry day period across the country, with only pixels with statistically-significant trends displayed*



2.3.3 Historical flooding and risk of flooding

According to 2010 models, over 500,000 people could be affected by a major flood that happens once every 100 years, with 200,000 of them facing floodwaters at least 1 meter deep. Southern, Northern, Western, and Lusaka provinces experience the highest exposure to flood risk, although every province has a non-zero population exposure risk to flood events, as shown in **Figures 2.19 and 2.20**.

Population exposure to flooding by return period values from (0 to 500-year) is shown in **Figures 2.21 and 2.22** for the entire country (ADM0) and by province (ADM1) for flooding thresholds of 0, 50 and 100cm.

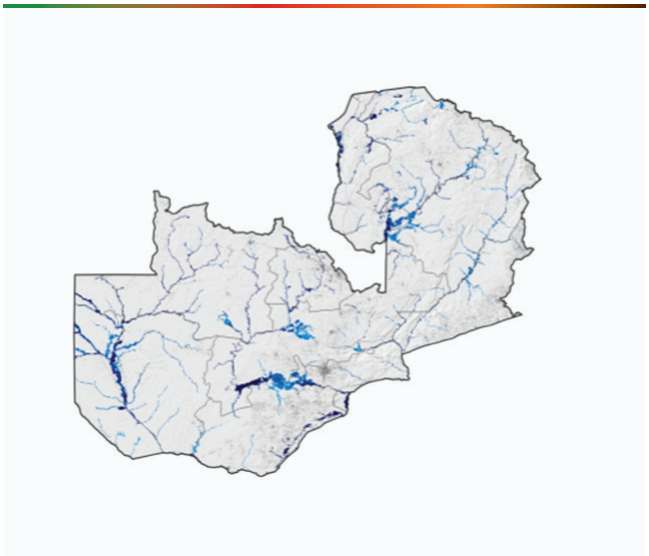


***Figure 2.19**: Flood depths for a 100-year flood across the Zambian region*

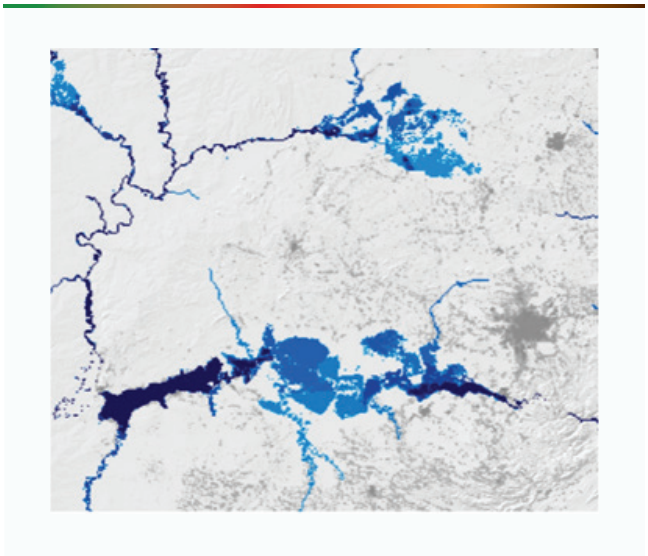


***Figure 2.20**: Flood depths for a 100-year flood near Lusaka, binned by depths above 0, 50 and 100cm*

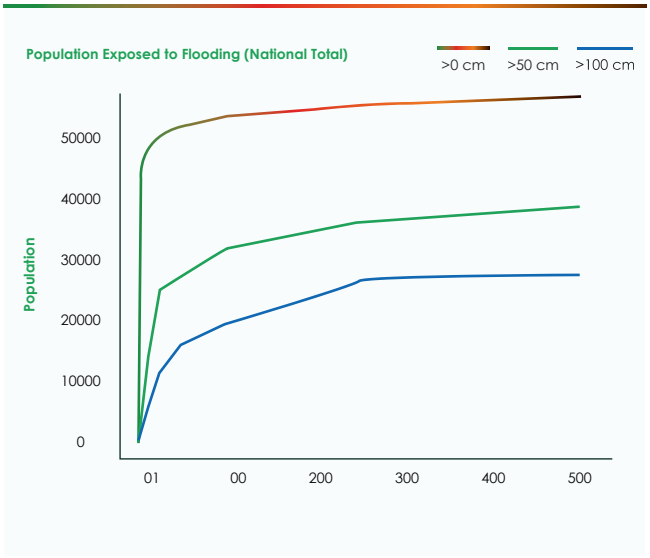


***Figure 2.21**: National population exposed (based on LandScan 2020 population) to floods by return period, binned by depths above 0, 50 and 100cm*

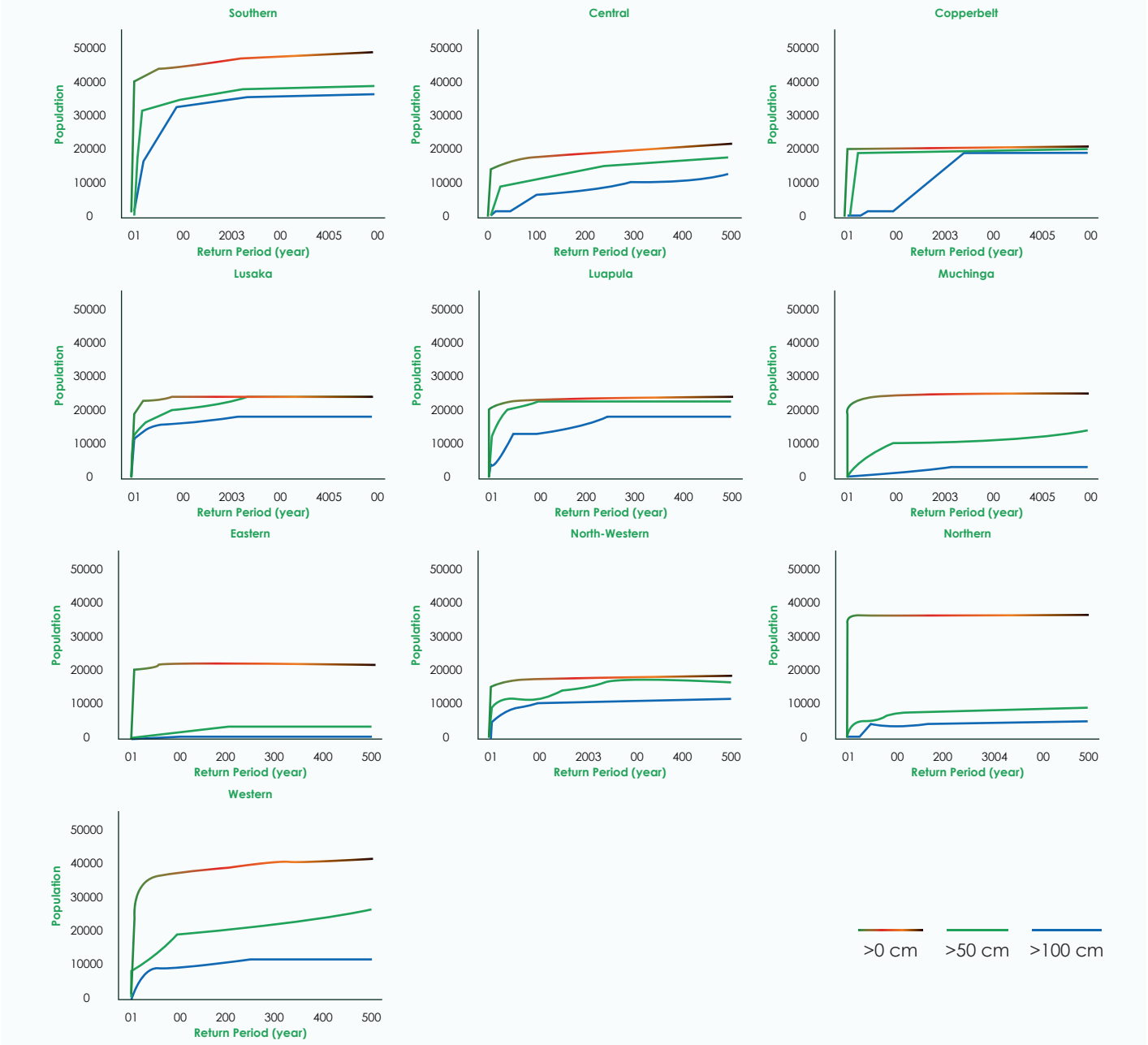


***Figure 2.22**: Provincial population exposure (based on LandScan 2020 population) to floods by return period, binned by depths above 0, 50 and 100cm*

2.4 Projected Climate Trends

Using the Global Climate Models (GCM) and the projected climate ensemble data as explained in the preceding sections, each of the 12-climate metrics were assessed under moderate (SSP2-4.5) and high (SSP5-8.5) global emissions scenarios in near (2025-2049); medium term (2050-2074) and long-term (2075-2099) time horizons. The projected changes (anomalies only) in each variable relative to the historical reference period (1971-2024) are shown and illustrated in **Figures 2.23 to 2.46**.

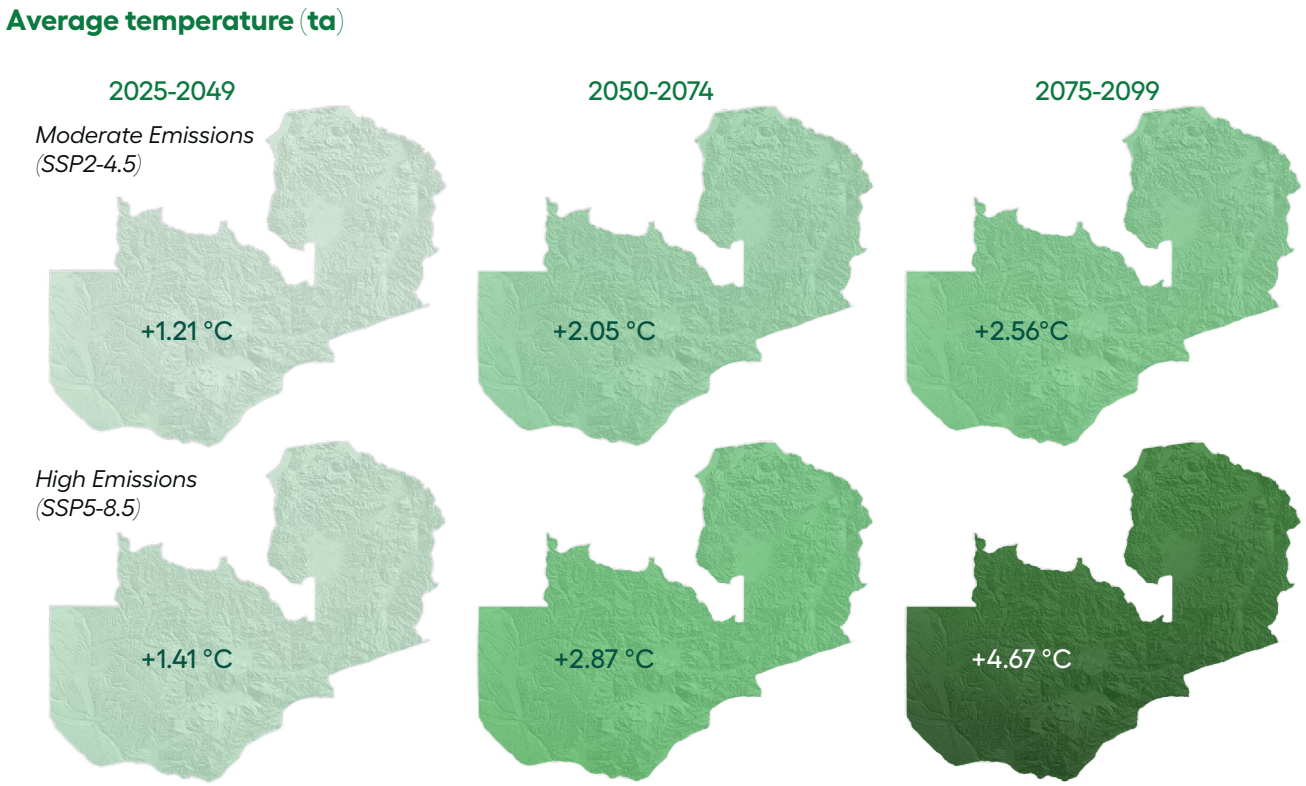


***Figure 2.23**: Projected changes to average annual daily mean temperature between 1971-2024 from ERA5-Land and mean GCM-ensemble values under medium (SSP2- 4.5) and high emissions (SSP5-8.5) scenarios in near-, medium- and long-term time horizons*

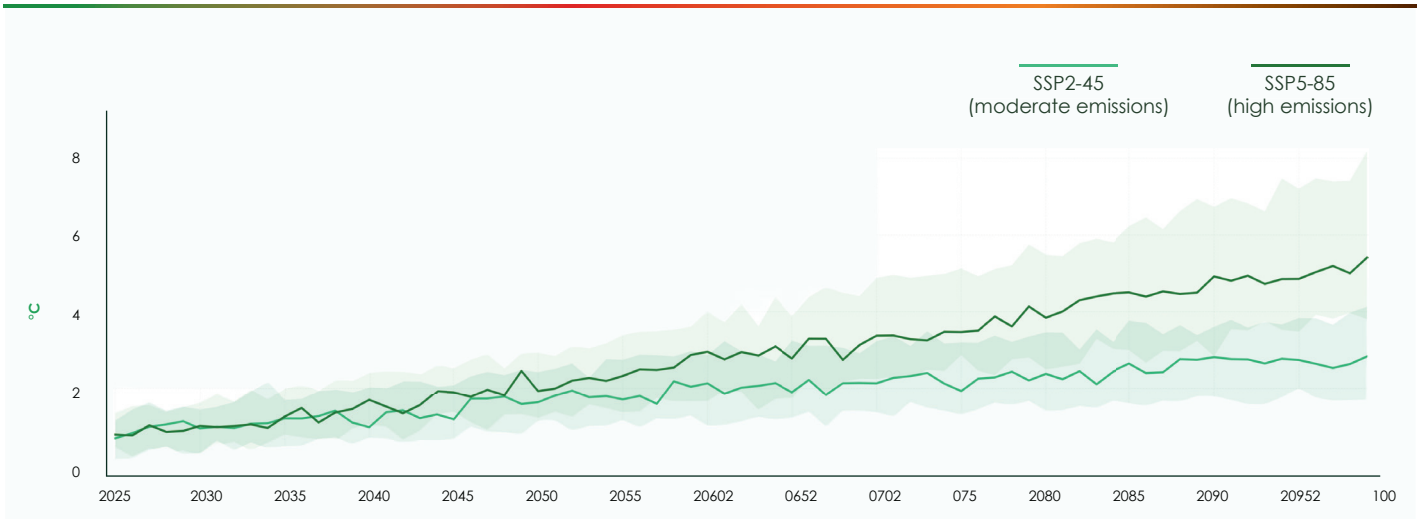


***Figure 2.24**: Projected change to national average annual daily mean temperatures under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Minimum temperature (tn)

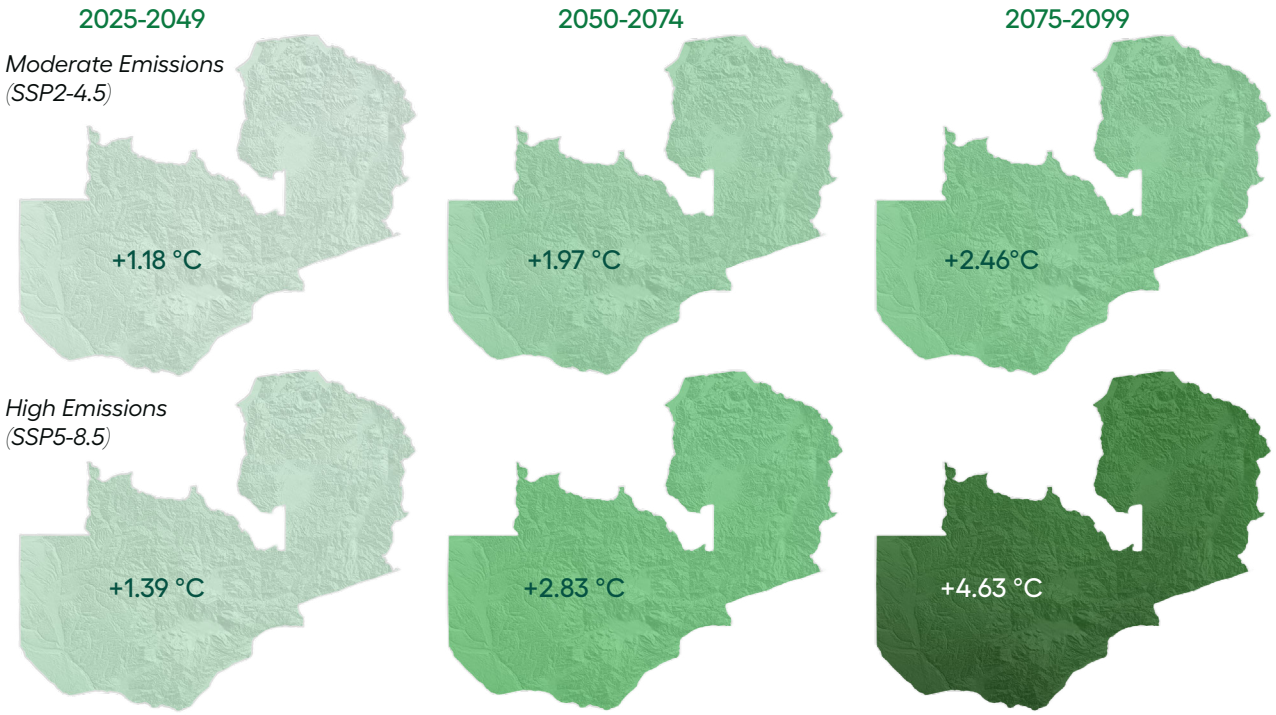


***Figure 2.25**: Projected changes to average annual daily min temperature between 1971-2024 from ERA5-Land and mean GCM-ensemble values under medium (SSP2- 4.5) and high emissions (SSP5-8.5) scenarios in near-, medium- and long-term time horizons*

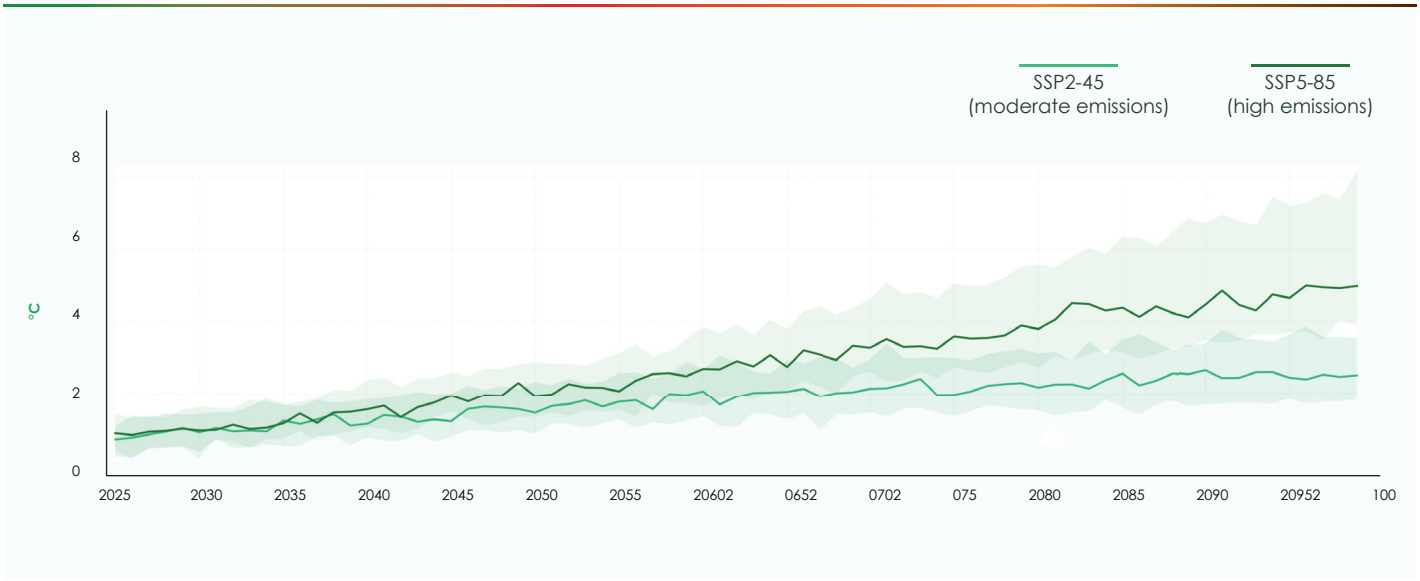


***Figure 2.26**: Projected change to national average annual daily min temperatures under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds.*

Maximum temperature (tx)

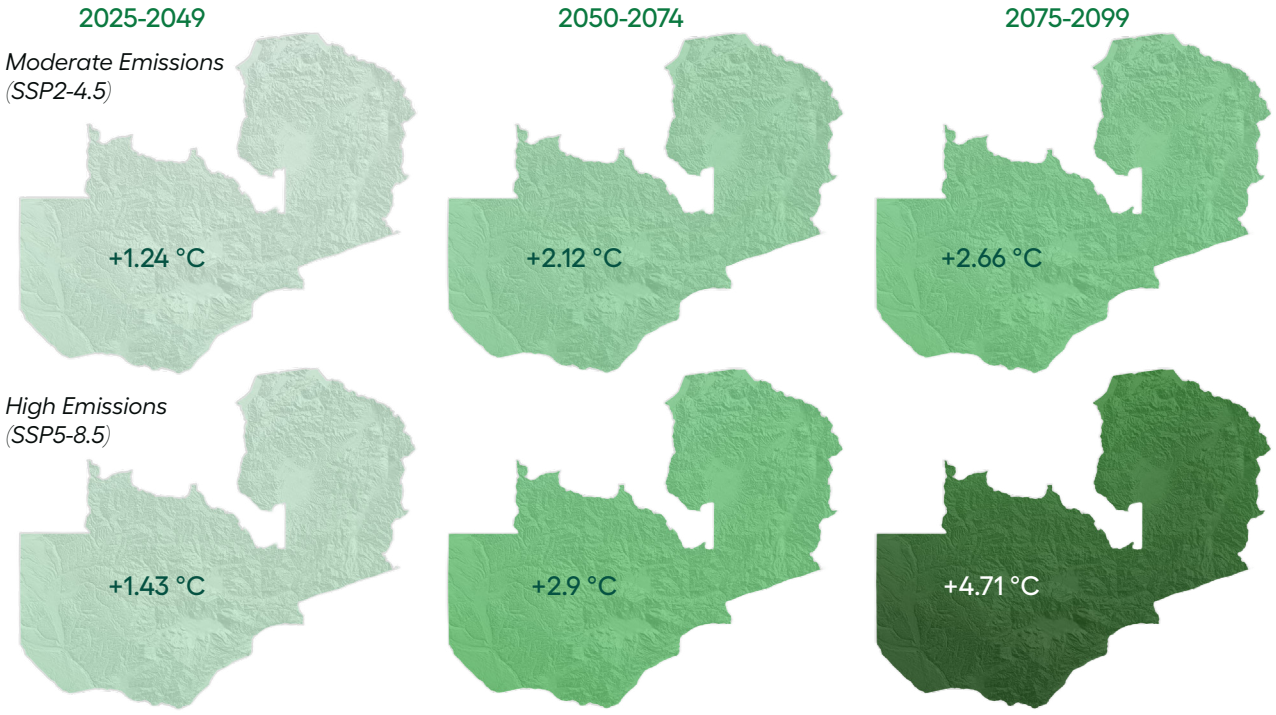


***Figure 2.27**: Projected changes to average annual daily max temperature between 1971-2024 from ERA5-Land and mean GCM-ensemble values under medium (SSP2- 4.5) and high emissions (SSP5-8.5) scenarios in near-, medium- and long-term time horizons*

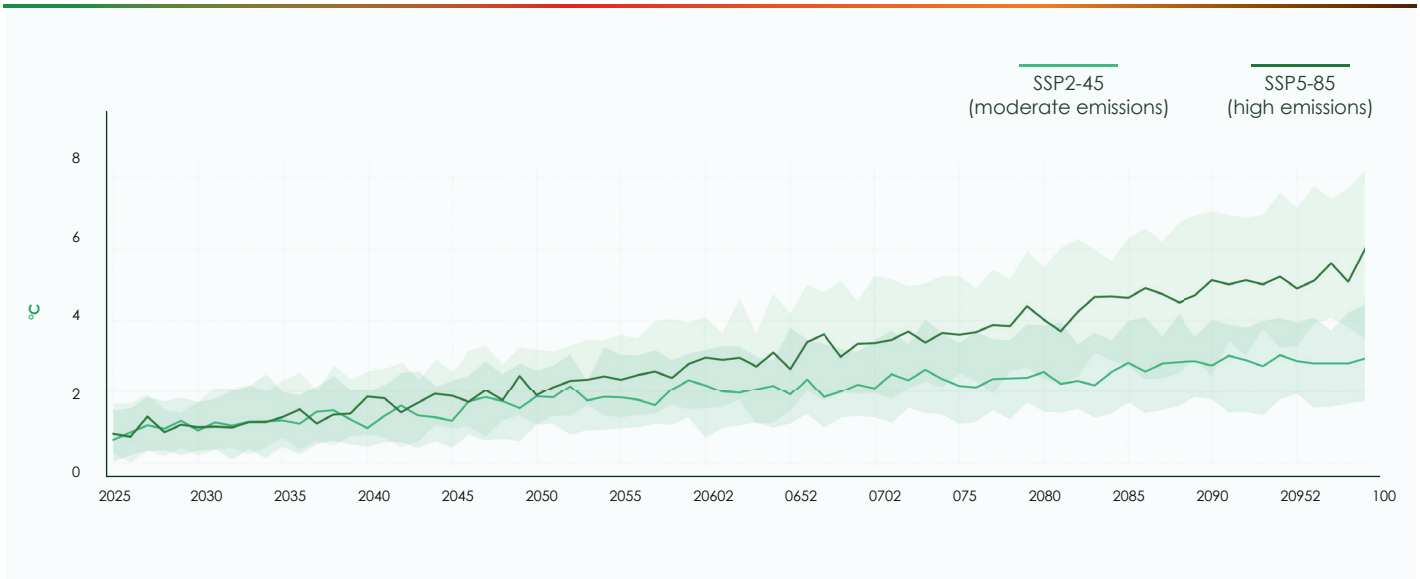


***Figure 2.28**: Projected change to national average annual daily max temperatures under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

***Figure 2.29**: Number of days where max temperatures exceed 35°C, averaged for each year between 1971-2024 from ERA5-Land*

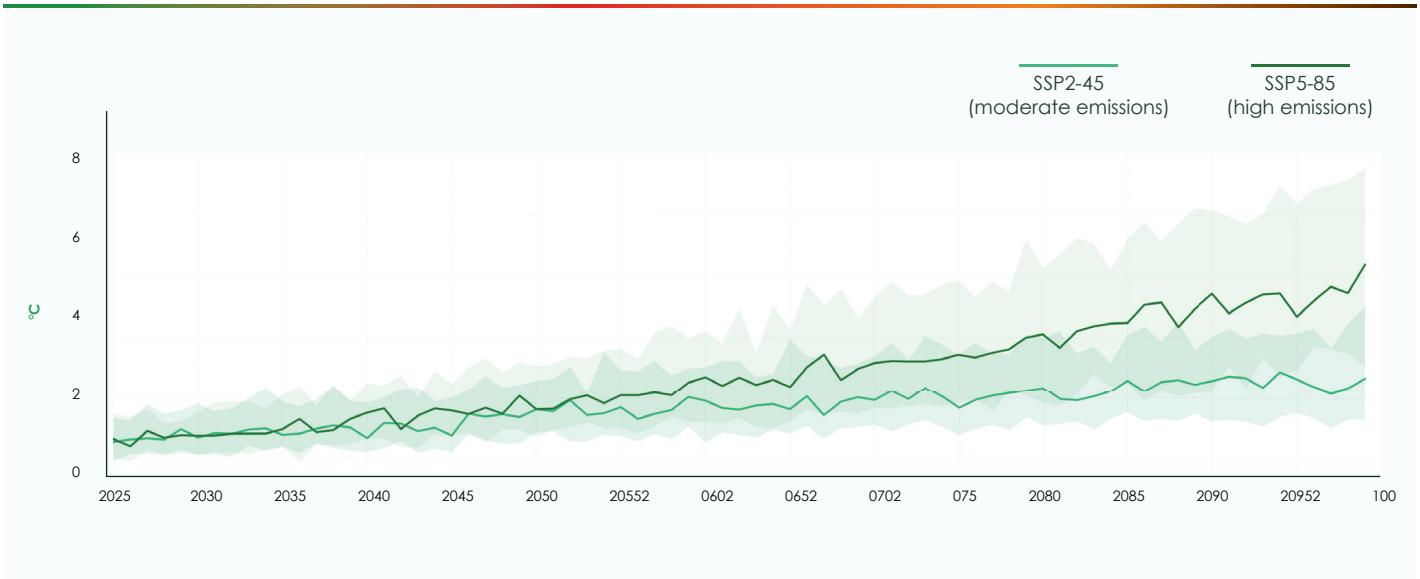


***Figure 2.30**: Projected change to national average annual number of days with max temperatures > 35°C under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Hot Days Above 42°C (hd42)

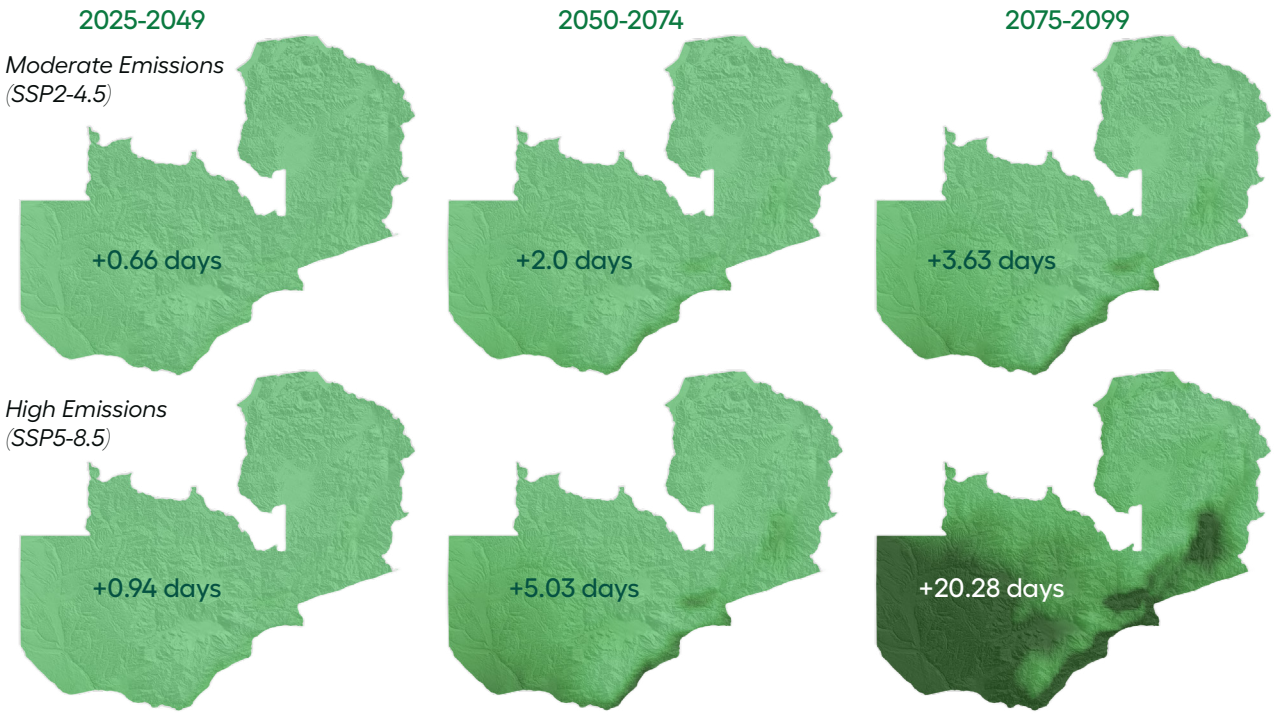


***Figure 2.31**: Number of days where max temperatures exceed 42°C, averaged for each year from 1971-2024 from ERA5-Land*

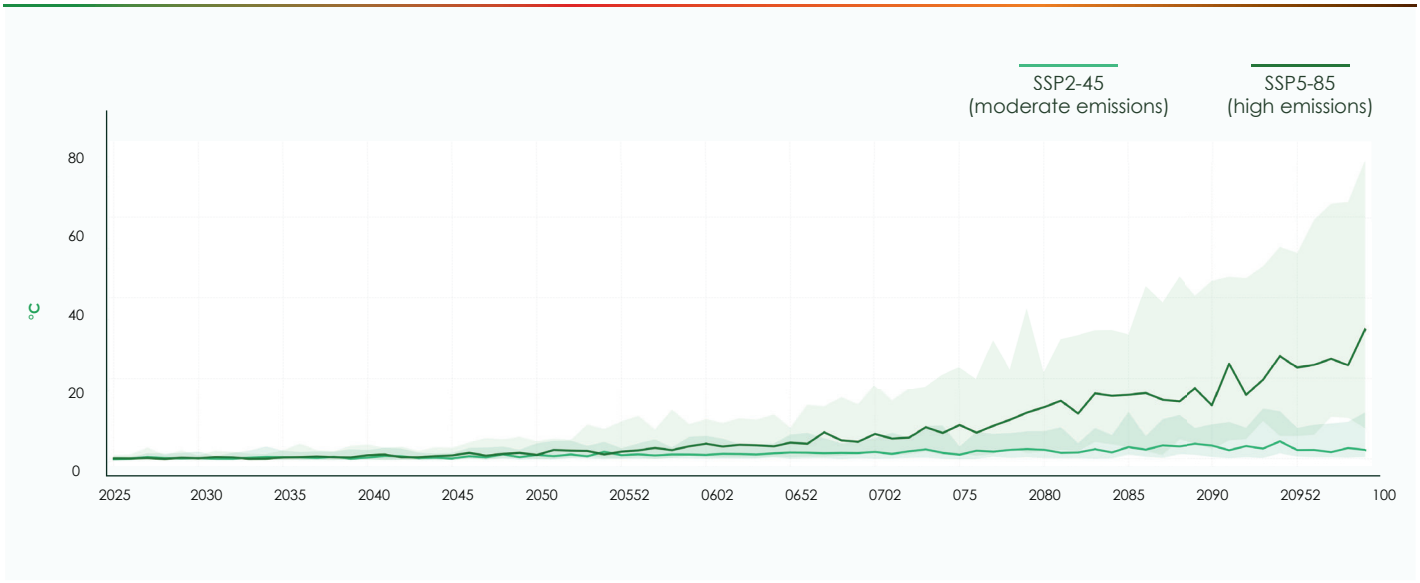


***Figure 2.32**: Projected change to national average annual number of days with max temperatures > 42°C under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

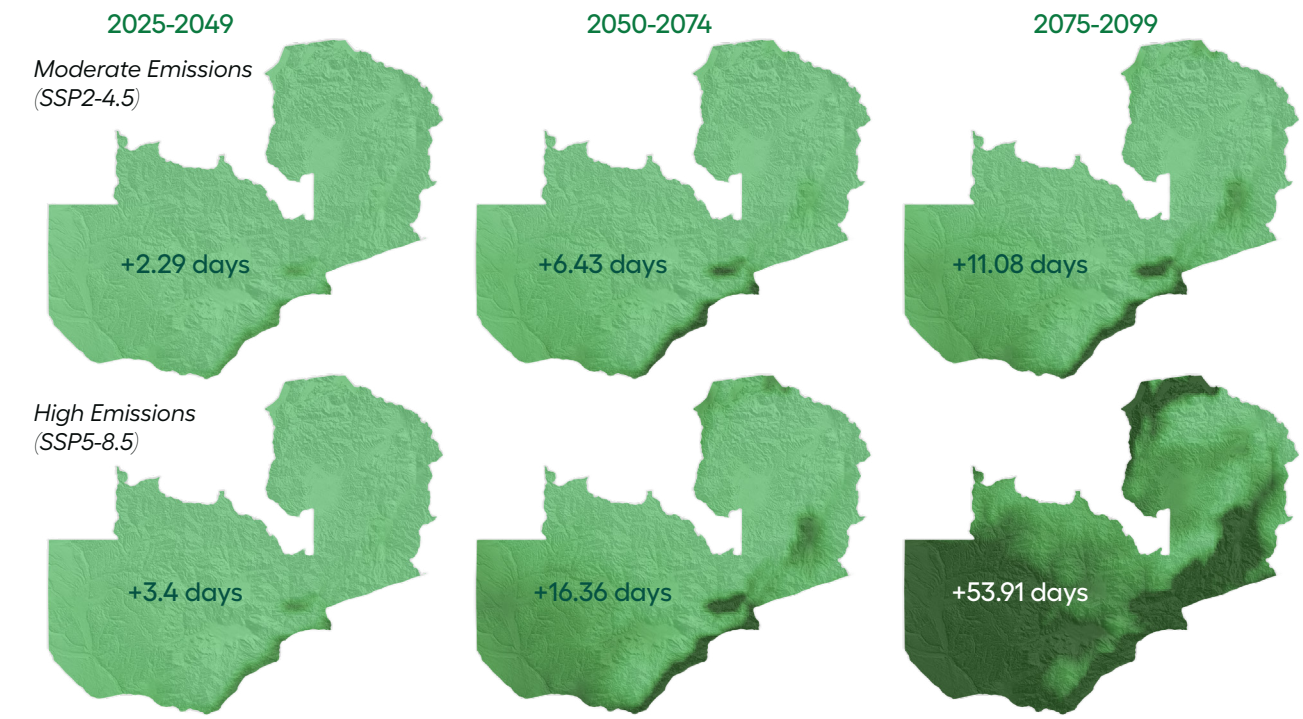


***Figure 2.33**: Annual number of days where the max heat index exceeds 35°C, averaged for each year from 1971-2024 from ERA5-Land*

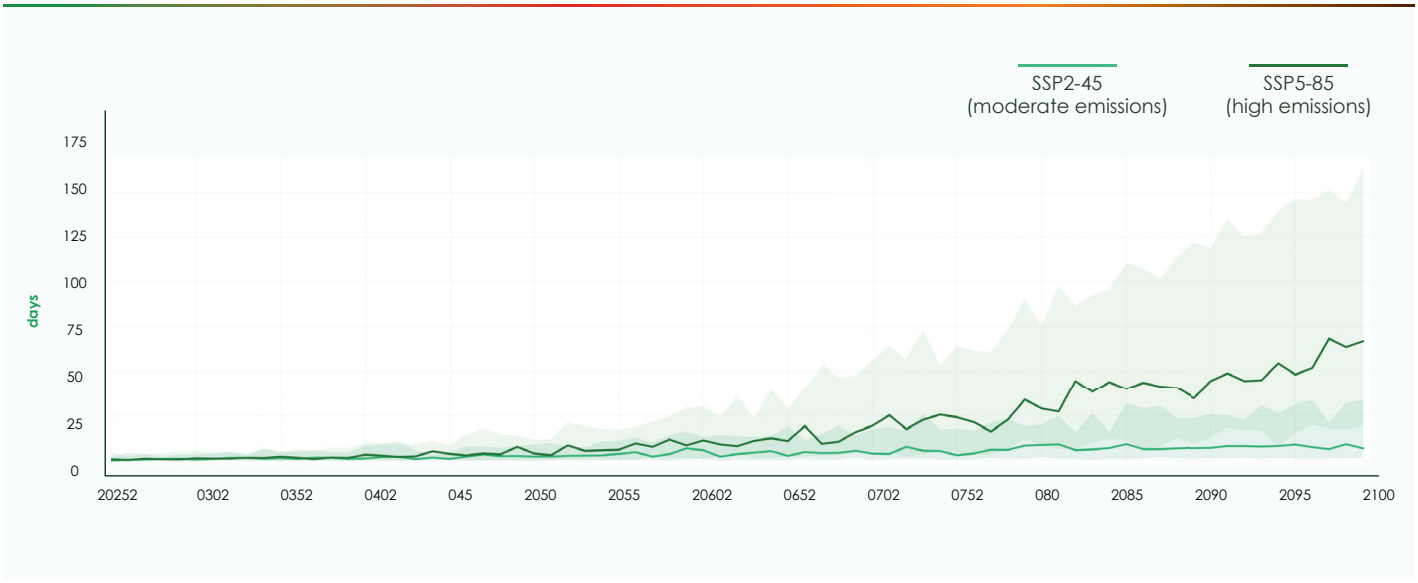


***Figure 2.34**: Projected change to national average annual number of days with max heat index > 42°C under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Average Rainfall (pr)

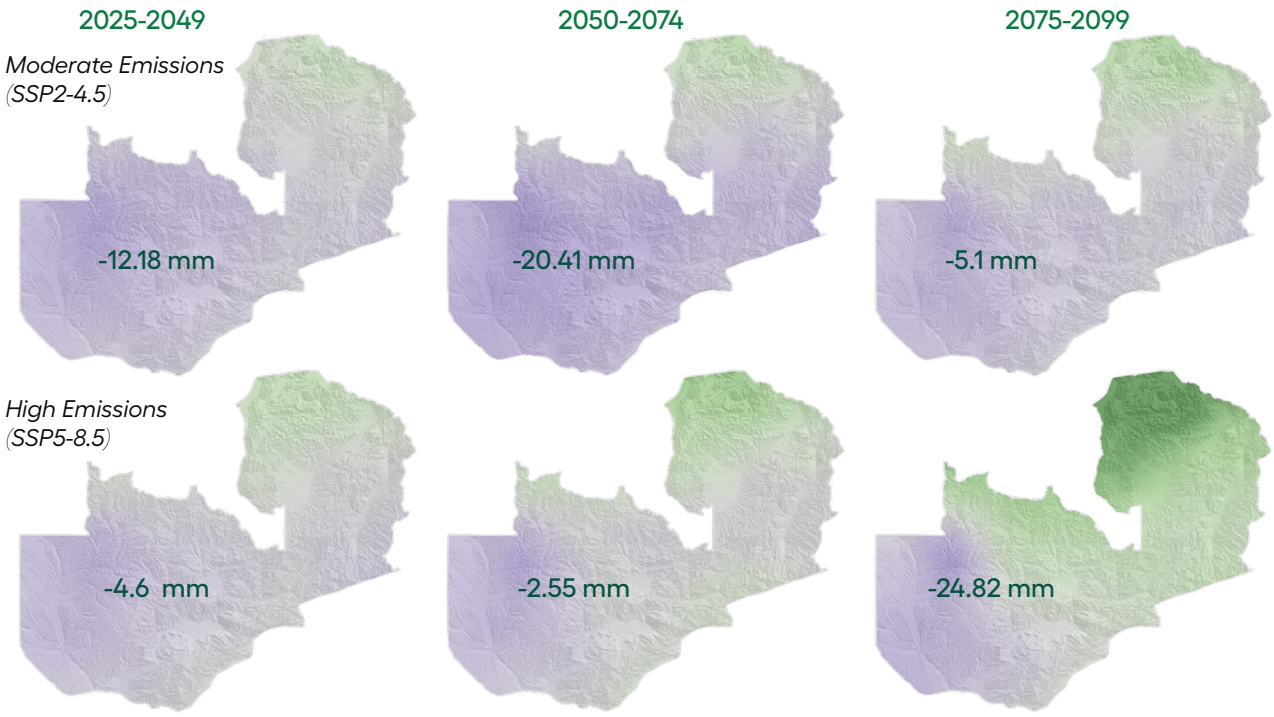


***Figure 2.35**: Annual rainfall, averaged for each year from 1971-2024 from ERA5- Land*

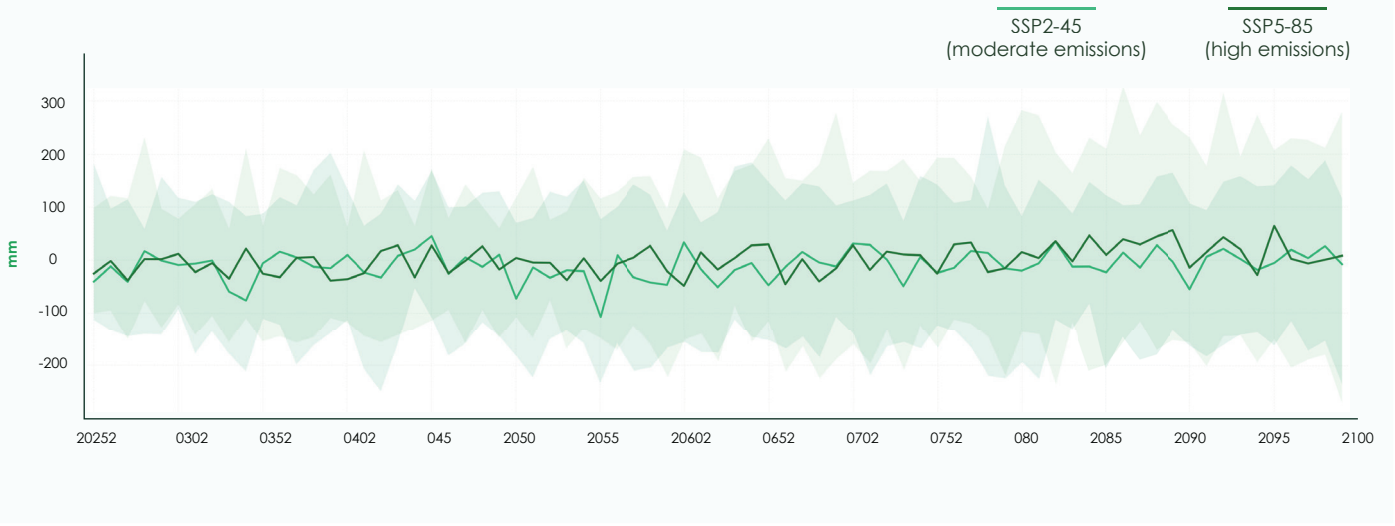


***Figure 2.36**: Projected change to national average annual rainfall under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

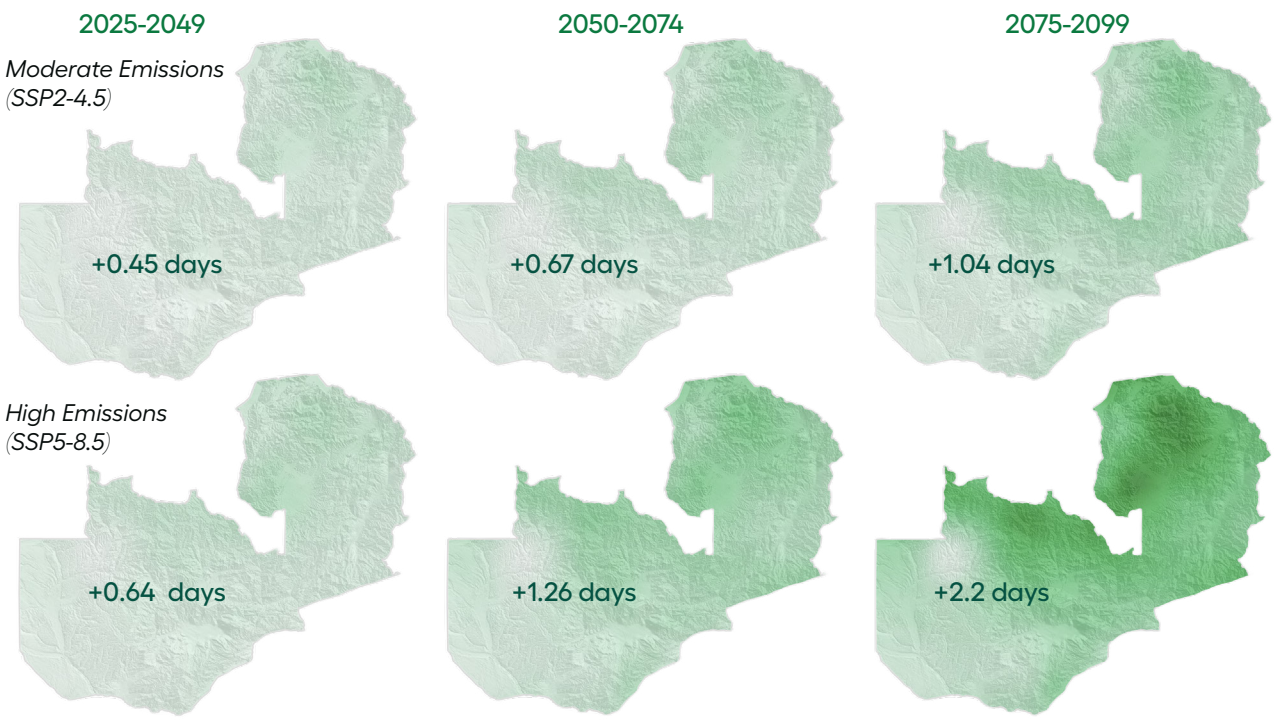


***Figure 2.37**: Heavy rainfall days (>20mm), averaged for each year from 1971-2024 from ERA5-Land*

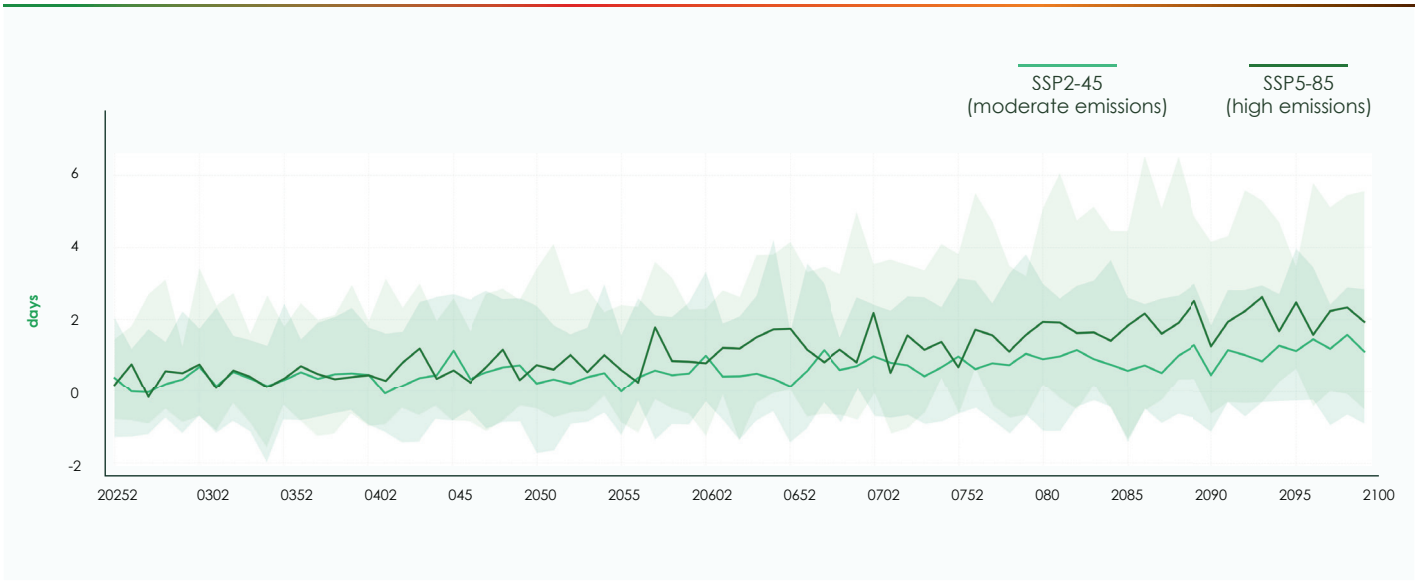


***Figure 2.38**: Projected change to national average annual number of heavy rainfall days (>20mm) under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Single-Day Maximum Rainfall Amount (pptx1)

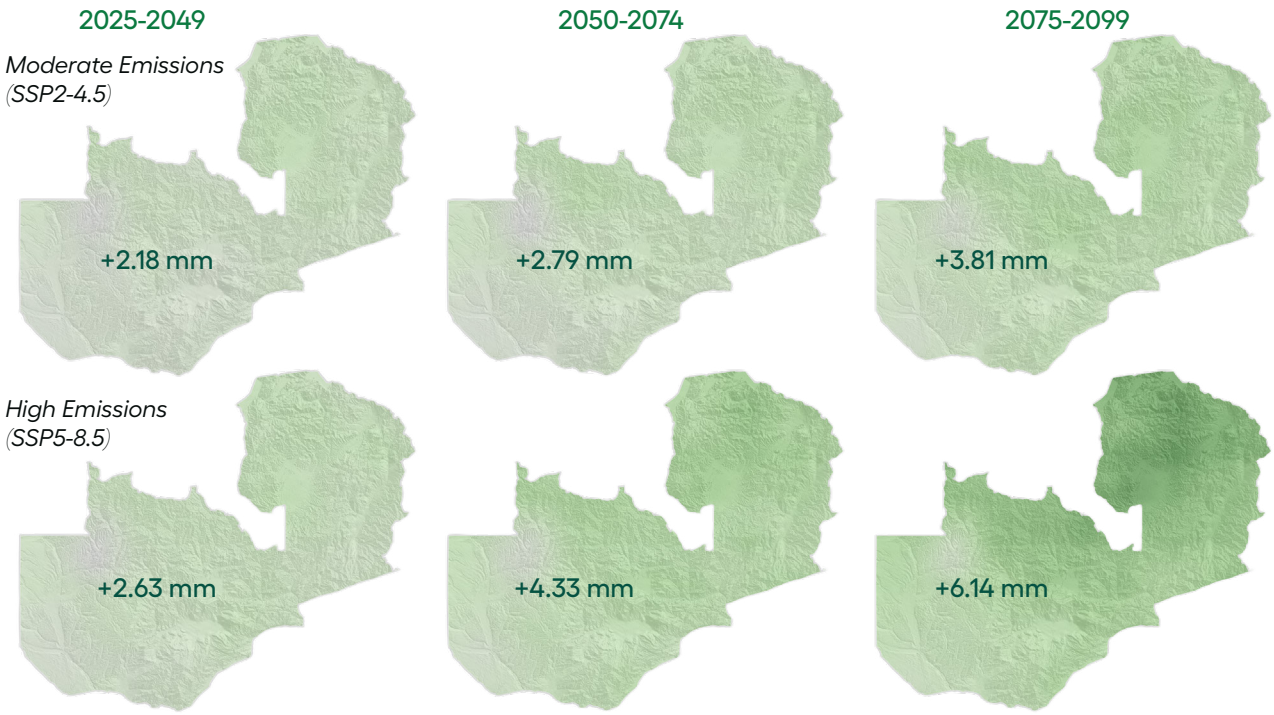


***Figure 2.39**: Single-day rainfall maximums averaged for each year from 1971-2024 from ERA5-Land*

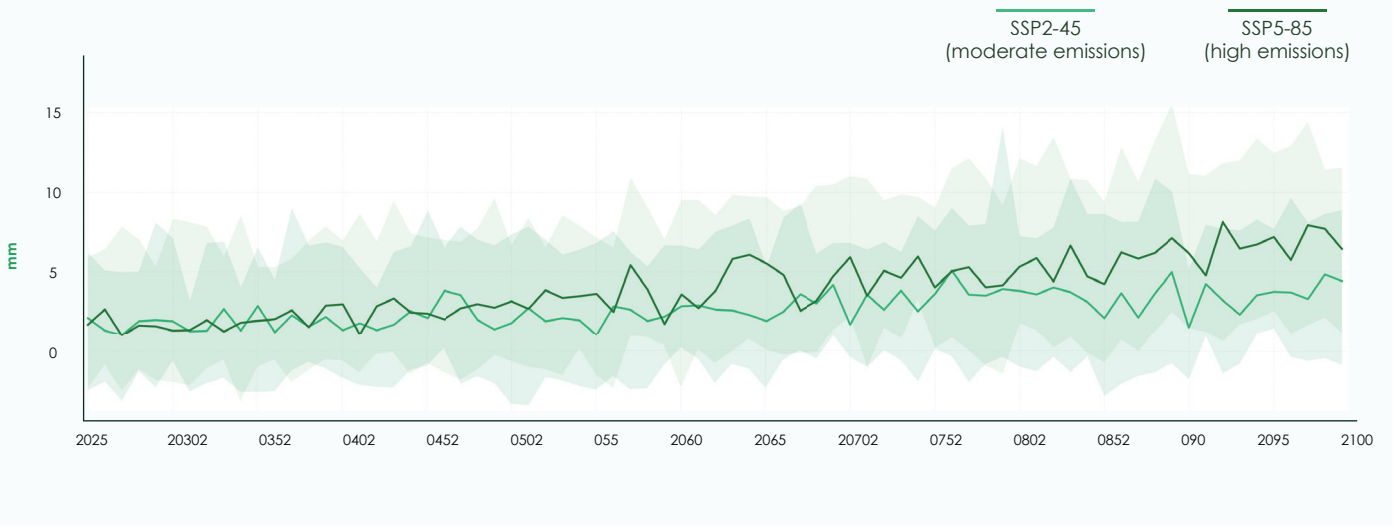


***Figure 2.40**: Projected change to national average single-day rainfall maximum under moderate (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Consecutive Dry Days (cdd)

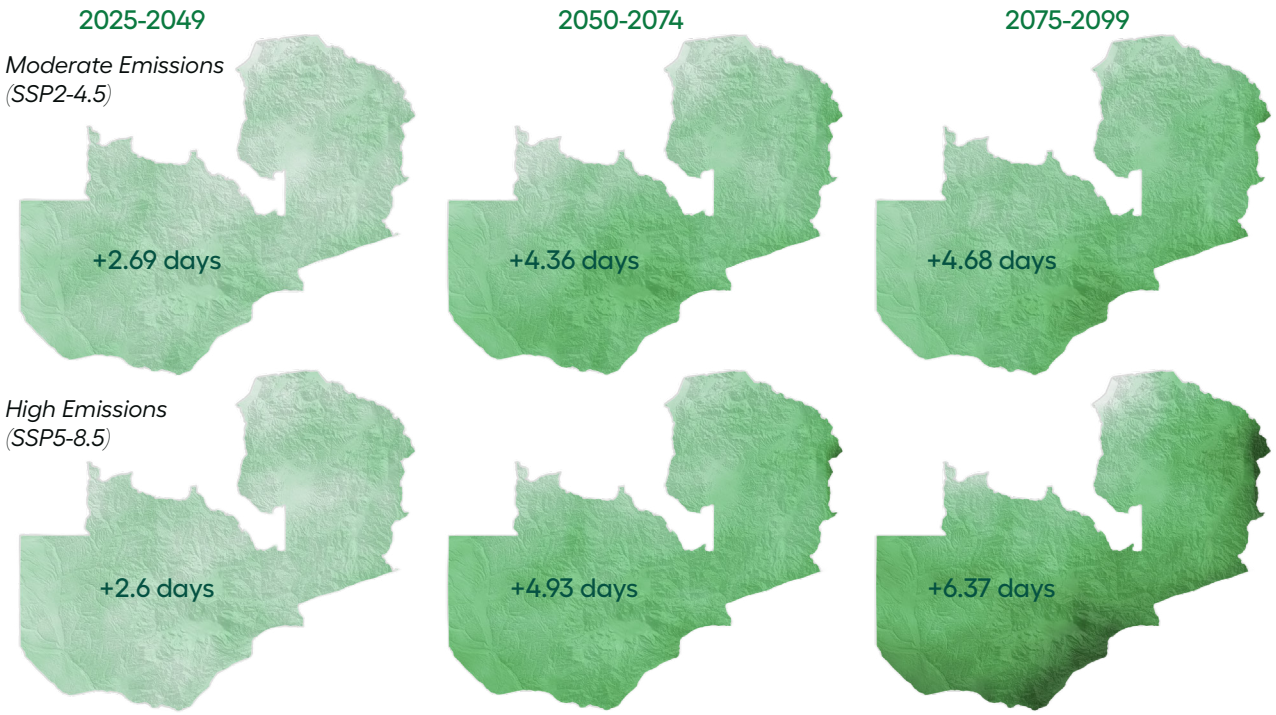


***Figure 2.41**: Longest consecutive dry day period averaged for each year from 1971-2024 from ERA5-Land*

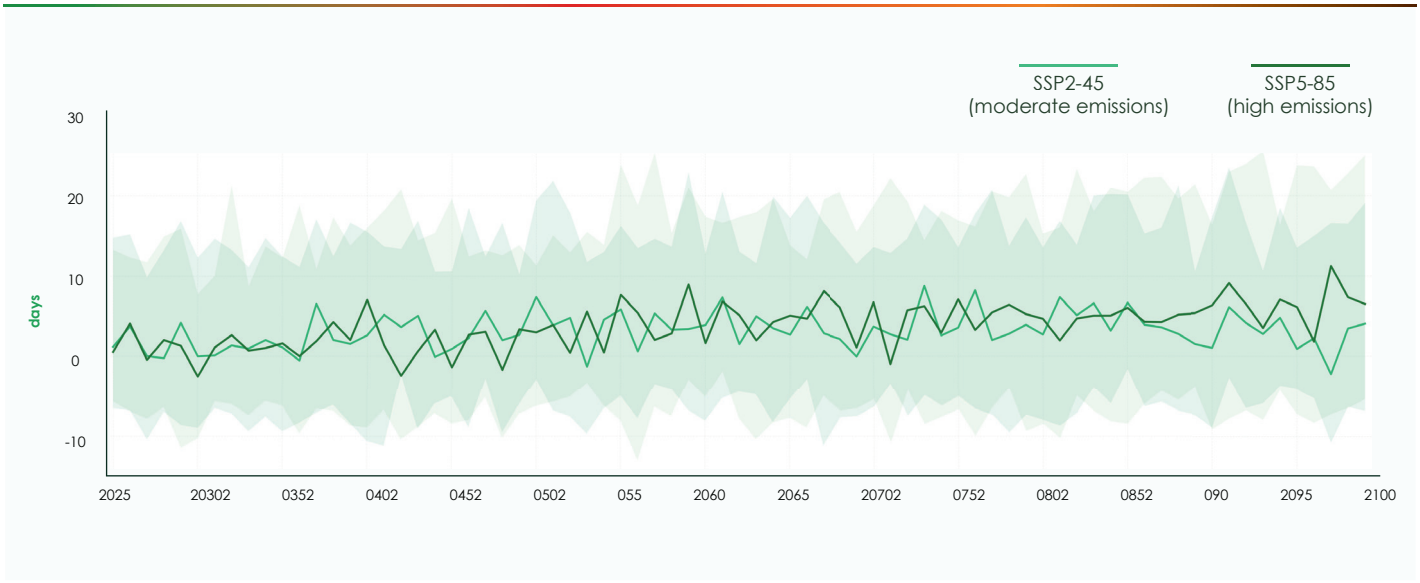


***Figure 2.42**: Projected change to national average consecutive dry day period length under (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025- 2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Standardized Precipitation Index (AvgSPI_12)

The SPI is the average value of the 12-month standardized precipitation index, with values calibrated to the historical reference period (1971-2024). The metric represents a measure of meteorological rainfall surplus or deficit at a 12-month (i.e. annual) cumulative scale with low values representing dry anomalies and high values reflecting wet periods. By definition, these values represent a standard normal distribution of rainfall anomalies with mean zero, standard-deviation of one in the calibration period, such that the average values are zero from 1971-2024, despite the occurrence of drought events throughout this time.

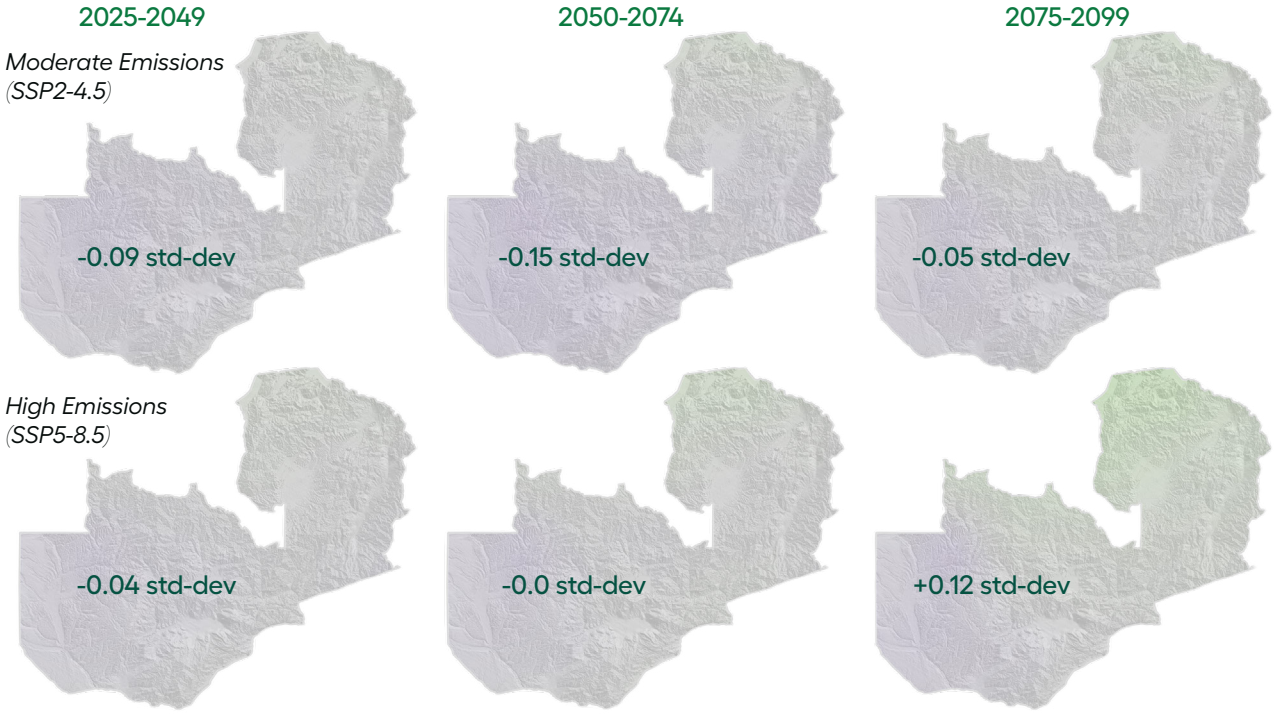


***Figure 2.43**: Standardized Precipitation Index*

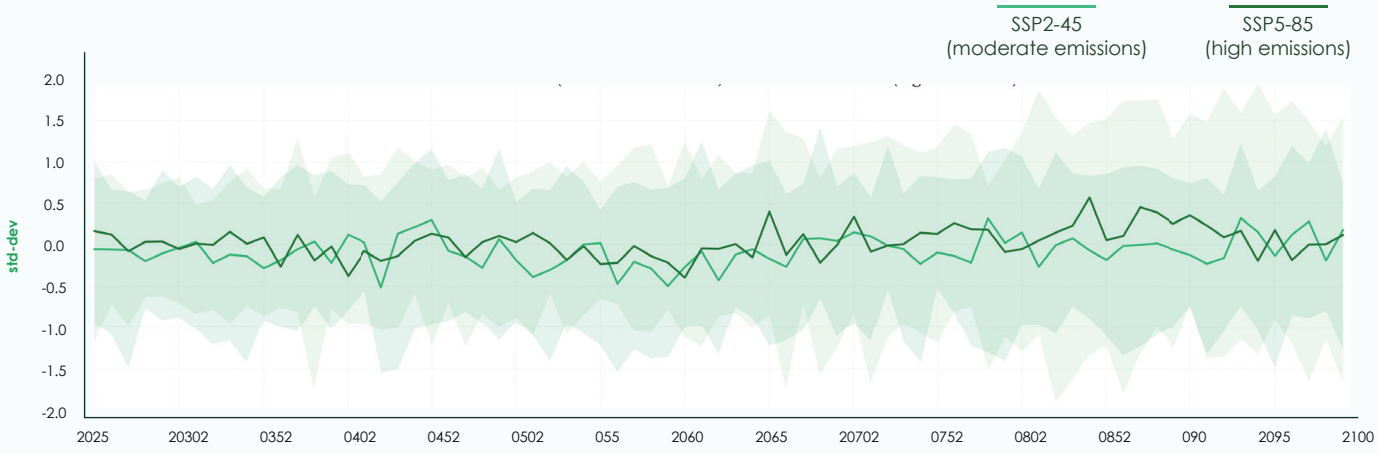


***Figure 2.44**: Projected change to national average SPI_12 under (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

Standardized Precipitation Evapotranspiration Index (AvgSPEI_12)

The SPEI is the average value of the 12-month standardized precipitation evapotranspiration index, with values calibrated to the historical reference period (1971-2024). This metric represents a measure of meteorological and evaporative-demand water balance surplus or deficit at a 12-month (i.e. annual) cumulative scale, more indicative of agriculturally-relevant drought conditions than simple meteorological (rainfall alone) metrics like SPI (Vicente-Serrano et al., 2010) . Like SPI, these values represent a standard normal distribution of rainfall anomalies with mean zero, standard-deviation of one in the calibration period, such that the average values are zero from 1971-2024, despite the occurrence of drought events throughout this time.

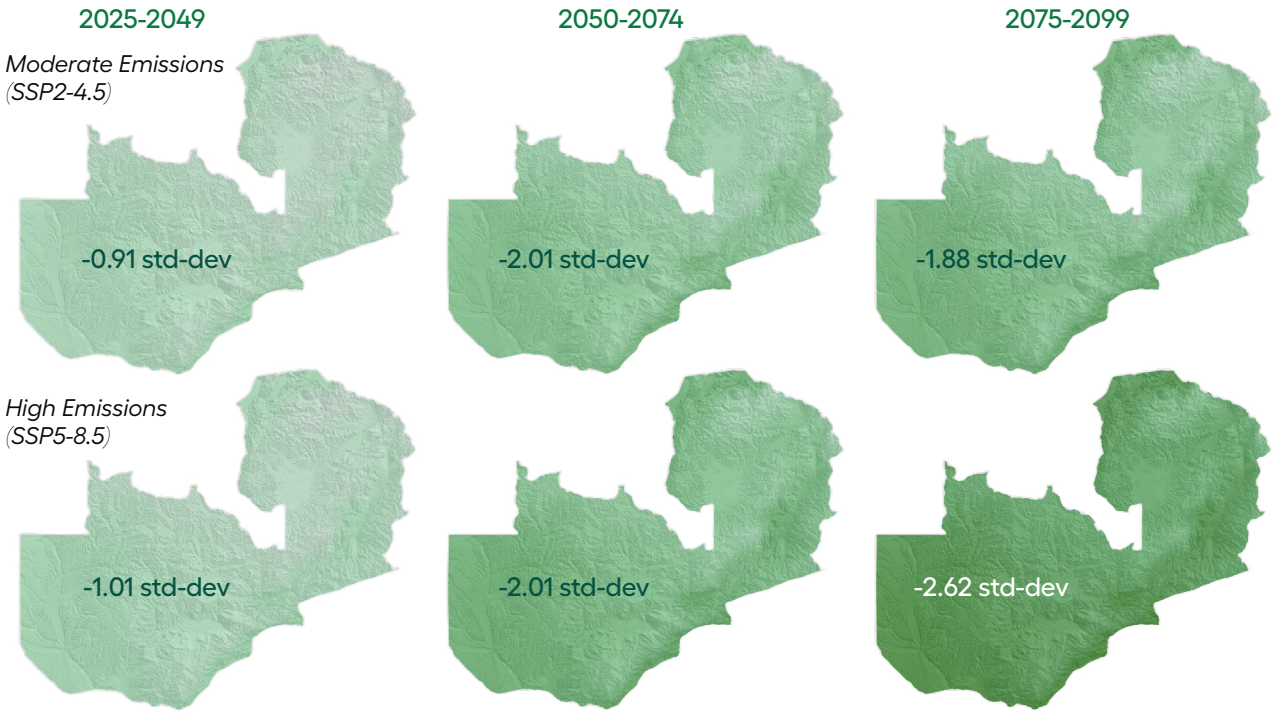


***Figure 2.45**: Standardized Precipitation Evapotranspiration Index*

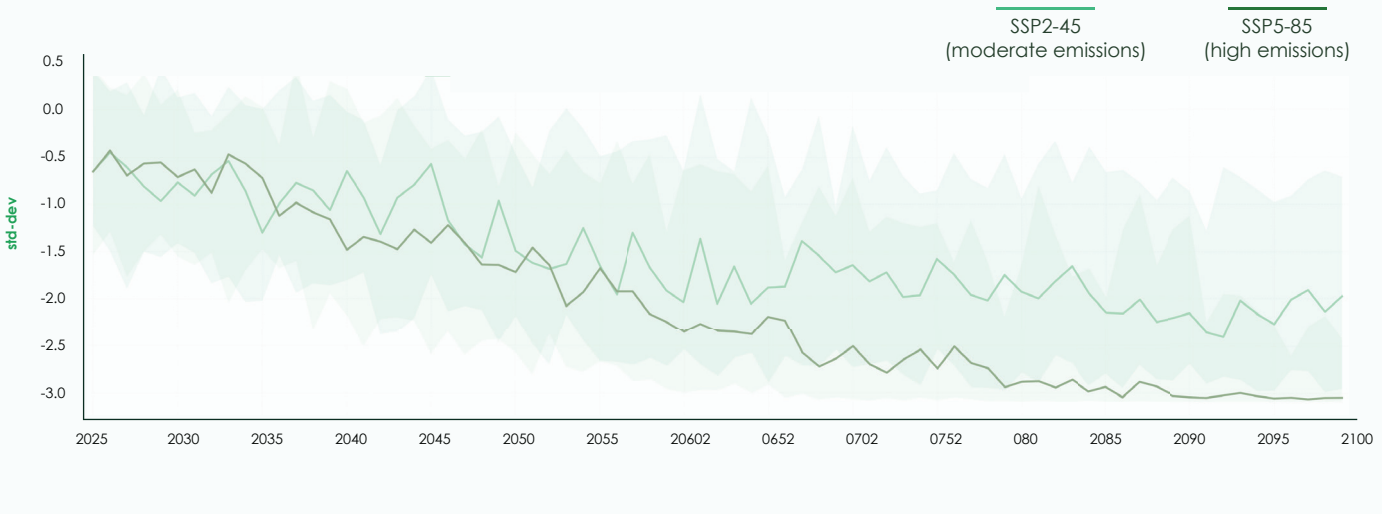


***Figure 2.46**: Projected change to national average SPEI_12 under (SSP2-4.5, orange) and high (SSP5-8.5, red) emissions scenarios from 2025-2099. Bold lines represent the median model value and shading the 10th/90th percentile bounds*

2.5 Policies and Their Projected Impact on Multiplier Effects of Climate Change

In order to understand and appreciate the impacts of polices on the multiplier effects of climate change as highlighted in this chapter, two scenarios were developed under this report: a baseline (Business as Usual) scenario and a policy (Climate Resilience) scenario. These scenarios were developed to facilitate analysis of the impact of policies and programmes on the multiplier effects of climate change. In addition, the scenarios were used in the broader analysis of respective impacts of climate change policy on national human and sustainable development, as well as, on other developmental outcomes.

2.5.1 The Baseline Scenario

The baseline scenario represents a Business-as-Usual (BaU) approach, assuming no changes are made to existing government expenditure, interventions or policies and therefore serves as a benchmark for comparison. The projection period spans from 2022 to 2050, with 2022 chosen as the initial departure point since more recent data were not available. Future climate scenarios and socio-economic conditions were modelled based on the Shared Socio-economic Pathways (SSP) framework that provides varying narratives for future global development. For this analysis, SSP2, which represents the "Middle of the Road" scenario, is assumed.[5] This scenario represents moderate socio-economic growth, where population growth slows, economic development progresses steadily, and technological advancements continue, with limited reforms in governance and sustainability efforts. This is considered suitable for the baseline scenario as it further assumes that historical patterns of development are continued throughout the 21st century.

Figures 2.47 and 2.48 illustrate the key climate variables that initiate the climate change threat pathways in the modular framework applied for this analysis. The variables capture the historical and projected trends for key climate conditions in Zambia. These variables are exogenous to the model, meaning that the underlying climate conditions are not simulated within the model but are derived from external data, specifically the Climate Change Knowledge Portal (CCKP) of the World Bank (World Bank, 2024). This approach is necessary since the model is not designed to simulate climate dynamics and therefore relies on external data from global climate model compilations derived from observations and climate ensembles. This ensures that the climate variables incorporated into the analysis are grounded in robust projections.

Figure 2.47, in particular, illustrates the trends in annual average air temperature for the historical period (2000–2020) based on the latest available data on historical temperature change, and projections until 2050 under the SSP2 scenario. The average temperature exhibits an initial period of relative stability, followed by a steady upward trend beginning around 2020. By 2050, a significant increase in the average temperature becomes apparent, reaching 23.5 °C by 2050, aligning with national warming projections. This rise underscores potential stress on socio-economic systems, as elevated temperatures may exacerbate vulnerabilities across critical sectors such as agriculture, water resources, and public health.

[5] *In terms of climate projections, SSP2 corresponds to mid-range greenhouse gas emissions, leading to moderate warming scenarios (typically, 2.5°C to 3.0°C) above pre-industrial levels by the end of the century, without major mitigation efforts. For Zambia, SSP2 reflects a steady but limited adaptive capacity to climate impacts, serving as a balanced baseline for assessing climate change and policy effectiveness under realistic global conditions.*

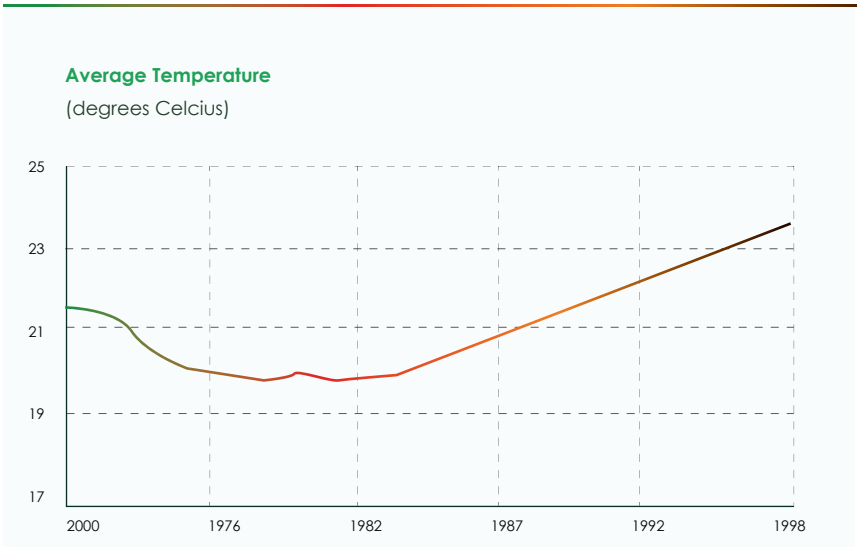


***Figure 2.47**: Trend in annual average surface air temperature in Zambia. Data: World Bank, 2024*

Similarly, **Figures 2.48** illustrate the trend for annual precipitation and related extreme events, measured specifically in terms of 'days of heavy precipitation.' This captures flooding and the standardized precipitation evapotranspiration index (SPEI), which captures drought events.

The historical data shows significant variability in annual precipitation levels, with peaks and troughs indicating alternating wet and dry years. From 2020 onwards, projections show a mean trend in annual precipitation varying around 1200mm/year. According to the 2023 National Adaptation Plan, localized climate studies suggest that the mean annual precipitation has been decreasing at an average rate of 1.9mm per month since 1960 (Republic of Zambia, 2023). The short-term historical period and annual timescale of the CCKP data in this instance, fails to illustrate this long-term declining trend. However, in terms of extreme events, trends in flooding measured as the number of 'days of heavy precipitation' remain relatively low until 2020, but are projected to increase steadily through 2050. This indicates a growing risk of flood-related disruptions, particularly in areas with inadequate drainage or infrastructure.

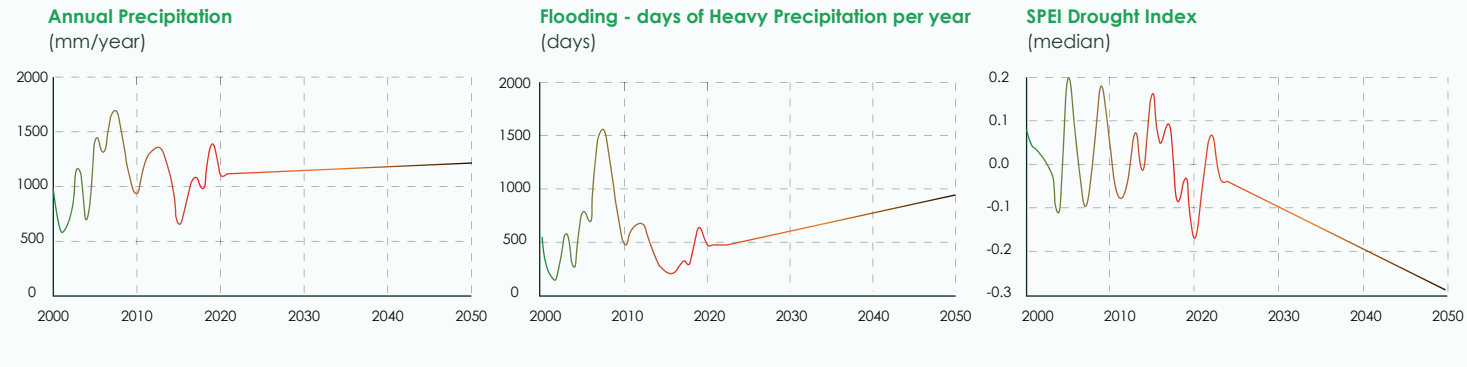


***Figure 2.48**: Annual precipitation (mm/year) (top), days of heavy precipitation per year (middle) and median trend in the SPEI drought index (bottom). Data: World Bank, 2024 I precipitation (mm/year) (top), days of heavy precipitation per year (middle) and median trend in the SPEI drought index (bottom). Data: World Bank, 2024*

2.5.2 The Climate Resilience Scenario

The Policy Scenario, otherwise referred to as the Climate Resilience Scenario (CRS), aims to capture the effects of additional interventions aimed at mitigating and adapting to climate change. The formulation of the CRS was guided by a review of critical policy documents, with particular emphasis on 2021 Nationally Determined Contribution (NDC) framework (Republic of Zambia, 2021) and the National Green Growth Strategy (GGS 2024-2030) (Republic of Zambia, 2024). Both frameworks provide a comprehensive outline of proposed climate adaptation and mitigation interventions, along with the associated implementation costs. These interventions were systematically mapped against the intervention points within a system dynamic modular framework. Specifically, the interventions and associated costs were incorporated into the modular framework as additional government expenditures relative to the baseline expenditure and implemented from present time (2024) until the end of the NDC implementation period (2030).

A key assumption in the CRS is the source of financing for climate interventions. Given Zambia's limited fiscal space and debt position, it is assumed that 80% of the financing required for the NDC and GGS interventions is provided by grant funding, such as international climate finance, development partners, and donor contributions and 20% by the private sector through foreign direct investment. This approach reflects Zambia's current fiscal constraints and acknowledges the role of international support in driving climate action. In effect, this scenario offers a robust framework for understanding how targeted climate resilience interventions can shape Zambia's development trajectory, while providing insights into the potential socio-economic trade-offs and benefits of such interventions. The **Table 2.1** below, shows expenses on key interventions with the expenditure expressed as a percentage of GDP and distributed across the implementation period of 2024-2030. The percentage of GDP is in turn, calculated, relative to total nominal GDP at basic prices over the corresponding period.

***Table 2 1**: Total expenditure allocated to model interventions based on the latest published NDC 2021 and GGS 2024*

Policy Intervention	NDC Expenditure (USD)	GGS Expenditure (USD)	Total expenditure 2024-2030(USD)	% of GDP
General Education	0	2 755 000	2 755 000	0.00
General Health	128 744 093	67 800 000	196 544 093	0.08
General Agriculture	36 043 345	91 250 000	127 293 345	0.05
Fertilizer Subsidies	167 085 818	0	167 085 818	0.07
Water Access	476 849 149	2 029 744 000	2 506 593 149	1.07
Sanitation Access	0	1 260 000 000	1 260 000 000	0.54
Roads A	480 114 928	1 100 500 000	1 580 614 928	0.68
Railways	4 418 184 633	0	4 418 184 633	1.89
Waste Management	377 816 257	1 755 000	379 571 257	0.16
Land Protection	129 133 586	69 337 000	198 470 586	0.08
Reforestation	197 599 880	32 830 000	230 429 880	0.10
Small Photovoltaic	3 604 698	41 600 000	45 204 698	0.02
Large Photovoltaic	923 599 661	3 722 000 000	4 645 599 661	1.99
Large Hydropower	3 426 902 997	0	3 426 902 997	1.47
Large Wind	494 327 586	0	494 327 586	0.21
Large Biomass	307 071 125	56 100 000	363 171 125	0.16
Vehicles Efficiency	0	1 420 000	1 420 000	0.00
Industry Energy	42 451 532	17 600 000	60 051 532	0.03
Households' Energy	7 645 601	11 925 000	19 570 601	0.01
Water Efficiency	61 209 800	834 624 450	895 834 250	0.38
General Transfers	1 956 433 709	750 000	1 957 183 709	0.84
Climate Adaptation	381 212 012	104 730 000	485 942 012	0.21
Agriculture Training	248 652 515	413 375 000	662 027 515	0.28
Other A - Climate	12 447 042	22 323 000	34 770 042	0.01

Policy Intervention	NDC Expenditure (USD)	GGS Expenditure (USD)	Total expenditure 2024-2030(USD)	% of GDP
Other B - Other Energy Investment	2 919 459 343	500 000 000	3 419 459 343	1.46
Other C - Tourism Administration	0	12 080 000	12 080 000	0.01
Other D - Mining Investment	0	14 930 000	14 930 000	0.0

Chapter 3

Effects of Climate Action on Human Development and the Sustainable Development Goals

3.1 Climate Action as a Driver of Human and Sustainable Development

This chapter underlines more directly, the impacts of climate action or more aptly, climate resilience policies, on human development and the attainment of the sustainable development goals. Computation of Human Development Indices (HDI) is now firmly established in the best tradition of UNDP's Human Development Reports. They provide, in simple terms, measurements of progress or regression within countries and communities. As such, HDI measures have become extremely useful barometers for comparing progress both internally, within the country, and also externally between countries. To this end, the chapter examines how key human development indices and the Sustainable Development Goals are either progressed, regressed, or likely to be impacted in light of national climate change policies and programmes.

3.2 Projections of the Human Development Index and Its Components

As highlighted in the previous chapter, the analyses undertaken in order to determine the human development indices are based on two scenarios: a present 'business as usual' (BaU) scenario (baseline) where no policy actions or investments are made to reverse the tide of climate change, vis a vis, a 'climate resilience' scenario where bold and decisive policy actions and investments have, presumably, been undertaken and therefore, informing the outcomes on key national development indicators such as the HDI and SDG outcomes.

Figure 3.1 compares the attainment of the HDI for 2024 (BaU scenario) and the projected outcomes for 2030 and 2050 under the baseline and CRS scenarios. Attainment of the HDI is further disaggregated into its key indices: Life Expectancy, Education, and Gross National Income (GNI). Thus, in 2024, the indices display baseline values reflecting the country's current development status. By 2050, the baseline scenario projects improvements across all indices, indicating gradual progress but limited gains only.

The CRS, represented by the lighter shading above the base projections, demonstrates improvements in all indices, with notable gains in the Life Expectancy (2%), Education Index (2%) and GNI Index (4%). These results highlight the positive impact of implementing targeted climate resilience interventions.

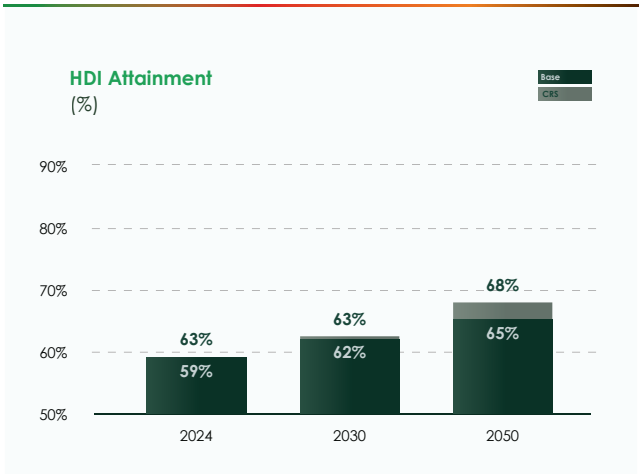


Figure 3.1: HDI attainment (%) in 2024, 2030 and 2050. Dark shading represents the baseline results, while light shading represents the additional attainment from the CRS scenario

Overall, the HDI shows a 9% incremental attainment in 2050, compared to the baseline year (2024), with the corresponding figure for the 2030 timeline being 4%, underscoring the long-term developmental benefits of the CRS pathway. The corresponding improvements under the baseline scenario are 6% and 3%, respectively. This shows significant impact, given that the education and health indicators underlying the HDI are inherently slow in achieving progress and underscores the importance of integrating climate resilience measures to enhance human development outcomes, particularly in areas such as education, health, and economic well-being.

3.2.1 Life Expectancy and Schooling

Historical data (where available) are compared with projections under the two scenario pathways presenting trends in the absolute values of the sub-indicators for the HDI, in terms of life expectancy, years of schooling and income per capita. From 2000 to 2024, life expectancy shows a steady increase, reaching 65 years in 2024. Under the baseline scenario, life expectancy is projected to plateau around 72 years by 2050, reflecting limited health improvements. In contrast, the CRS pathway shows a marginal gain of 1 year by 2050. **See Figure 3.2**.

In terms of schooling, historical trends indicate consistent progress, with the average number of years of schooling increasing from 6 years in 2000 to 8 years by 2024. Under the base scenario, this upward trend continues, reaching 10 years by 2050. The CRS scenario, however, does not lead to significant increase in average years of schooling by 2050. The additional progress highlights the positive but marginal impact of targeted investments in education under climate-resilient pathways. **See Figure 3.3**.

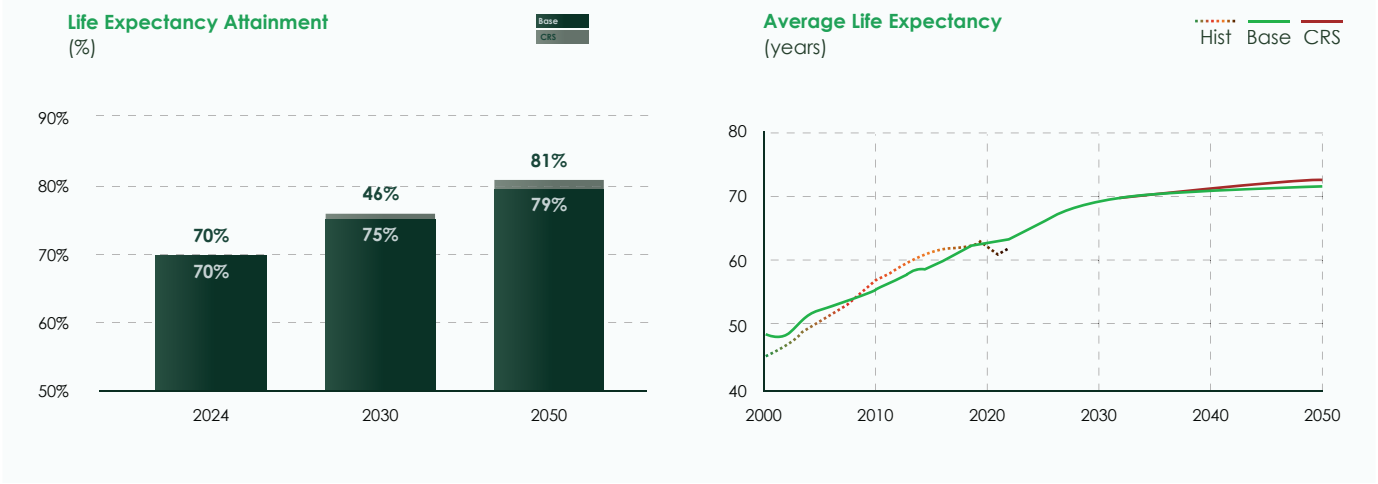


***Figure 3.2**: Life Expectancy index attainment (%) under modelled scenarios, measured in terms of average life expectancy (years)*

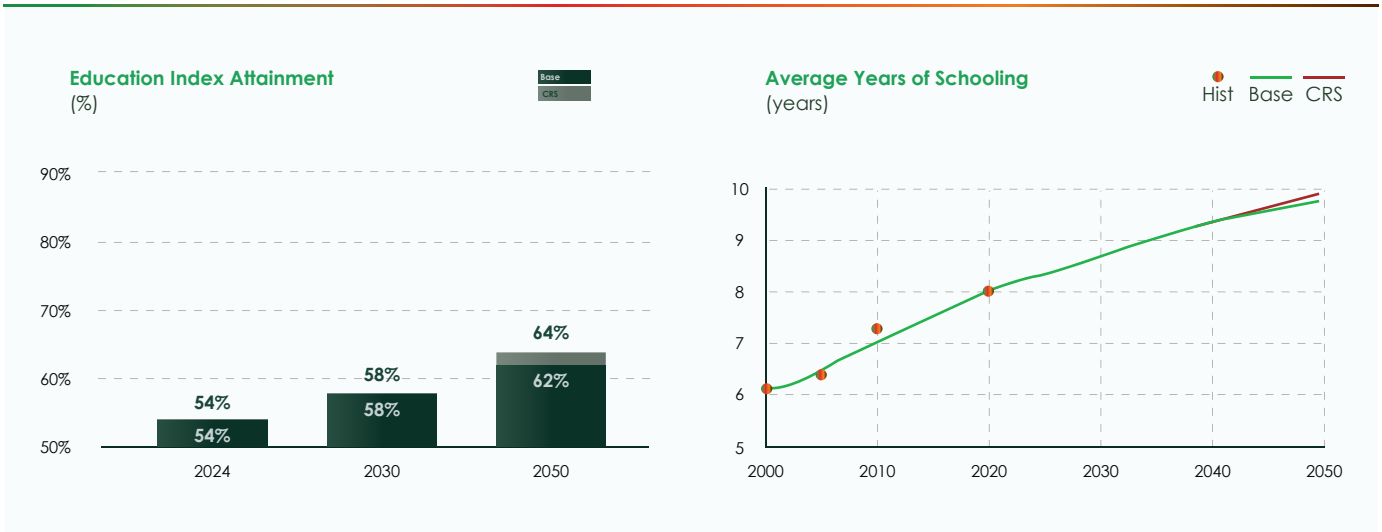


***Figure 3.3**: Education Index attainment (%) measured in terms of average years of schooling (years)*

Lastly, per capita GNI has grown steadily since 2000 (**Figure 3.4**), albeit with fluctuations around 2020, where values approached USD 3600 (PPP) in 2024. By 2050, the baseline scenario projects GNI to increase gradually to about USD 4100. The CRS pathway, however, demonstrates substantial improvements, with GNI reaching 5400 USD, driven by enhanced economic resilience and growth.

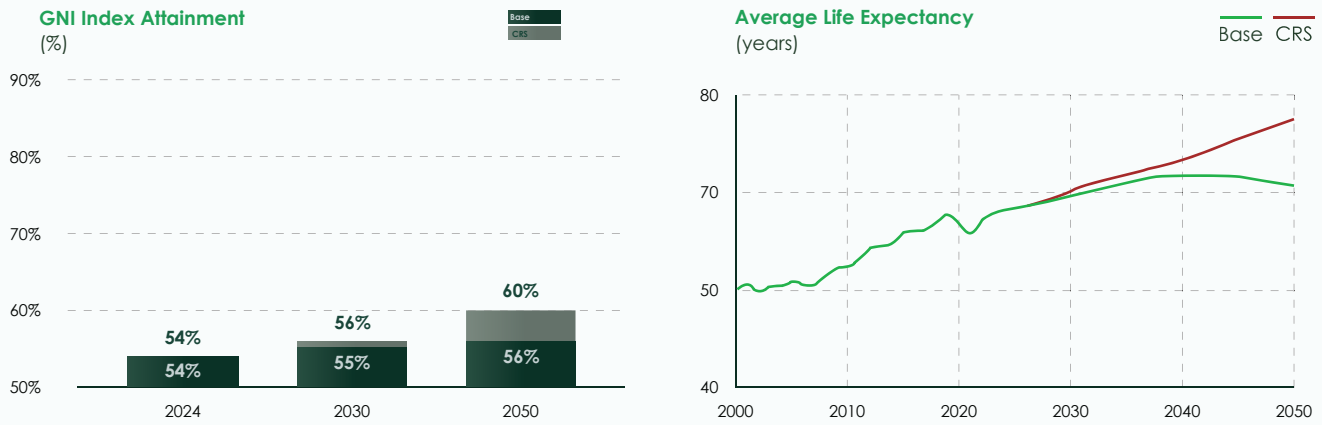


***Figure 3.4**: Attainment in the Gross National Income Index (%), measured in terms of per capita gross national income (USD PPP 2017)*

3.2.2 Policy triggers for improved HDI attainment

To investigate the cause of HDI attainment, **Figure 3.5** illustrates the return on investment (ROI) for the interventions, with the largest effects measured in terms of percentage HDI attainment per billion ZMW for 2030 and 2050. In other words, HDI attainments and the improvements seen are the direct consequence of the impact of policy (i.e. CRS -base) divided by the expenditure dedicated to the specific intervention over the implementation period. Interventions in health (0.015%/billion ZMW) and education (0.01%/billion ZMW) have the largest impact on HDI attainment in the short-term 2030, whereas expenditure in climate adaptation results in even larger gains in the HDI in the long-term (2050) by 0.03%/billion ZMW (**Figure 3.5**).

Other interventions with impacts on HDI include expenditure on solar electricity generation, access to water and sanitation and roads, with other expenditure (see Table 2.1) having larger combined impacts on HDI in the short-term. Though the results suggest that HDI attainment per billion is considered relatively small, they highlight the key interventions with the potential for the highest impact. To put this into perspective, an additional expenditure of 33 billion ZMW on climate adaptation by 2050 would result in a 1% gain in HDI, surpassing the HDI attainment from the baseline expenditure. Similarly, an additional 66.67 billion ZMW expenditure in healthcare by 2030 would be required to achieve an additional 1% gain in HDI, surpassing the HDI attainment from the baseline expenditure. Similarly, an additional 66.67 billion ZMW expenditure in healthcare by 2030 would be required to achieve an additional 1% gain in HDI.

Assuming the government spends an additional 22 billion ZMW on healthcare per annum and the ROI on healthcare remains 0.015%/billion ZMW until 2050, the government can achieve approximately 8% attainment in HDI by 2050 from healthcare spending alone, above the gains obtained from the baseline expenditure. This suggests that this can increase HDI attainment from 59% in 2024 to 67% in 2050. Additional expenditure on interventions including education, social protection, WASH (water and sanitation) and roads further contributes to HDI attainment indirectly (**Figure 3.5**).

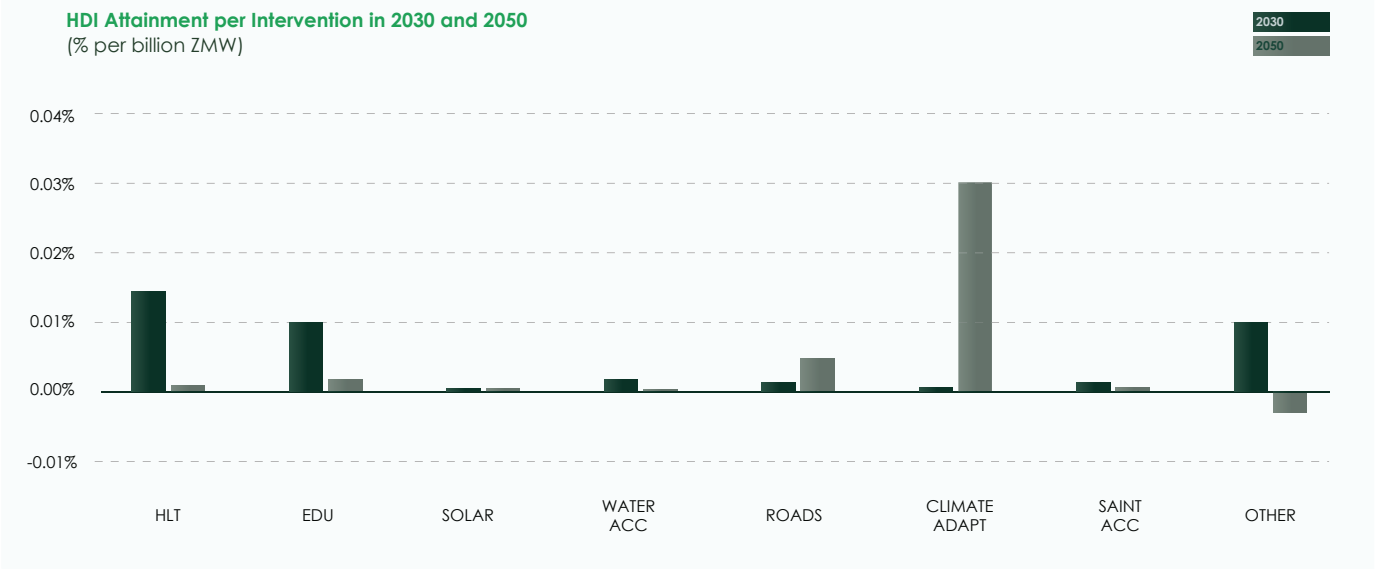


***Figure 3.5**: Policy interventions contributing to HDI attainment, measured per billion ZMW expenditure*

3.3 Effects on Social Development

Social outcomes encompass a diverse range of human development indicators such as trends in population growth, improvements in health, opportunities for education and the economic welfare of communities-among others. **Figure 3.6** illustrates trends in population growth, and in poverty and income inequality under the baseline and CRS development pathways. Population growth shows a steady increase from approximately 10 million people in 2000 to over 20 million by 2024. Both scenarios project continued growth, with Zambia's population expected to surpass 40 million by 2050.

Under the CRS pathway, the population is lower by approximately 500,000 persons, due to improved access to education, healthcare, and family planning, which subsequently reduces fertility rates and slows population growth. The proportion of the population below the international poverty line (USD 700/person/year/ 2500 RLCU/person/year) has remained high, peaking around 2010 at over 65%. Under the baseline scenario, poverty gradually declines to 49% by 2050, reflecting slow but insufficient progress. On the other hand, the CRS scenario accelerates poverty reduction, reducing it by a further 13%, emphasizing the role of climate resilience strategies, but more specifically due to interventions directed to access to basic facilities and transfers through farmer household support programs. The Gini coefficient, a measure of income inequality, increases significantly until 2010, stabilizing around 0.65 thereafter. Under the baseline scenario, inequality decreases only slightly by 2050, while the CRS scenario achieves a modest improvement, lowering the Gini coefficient by a further 2.3% owing to a modest improvement in household income for the lower percentiles.

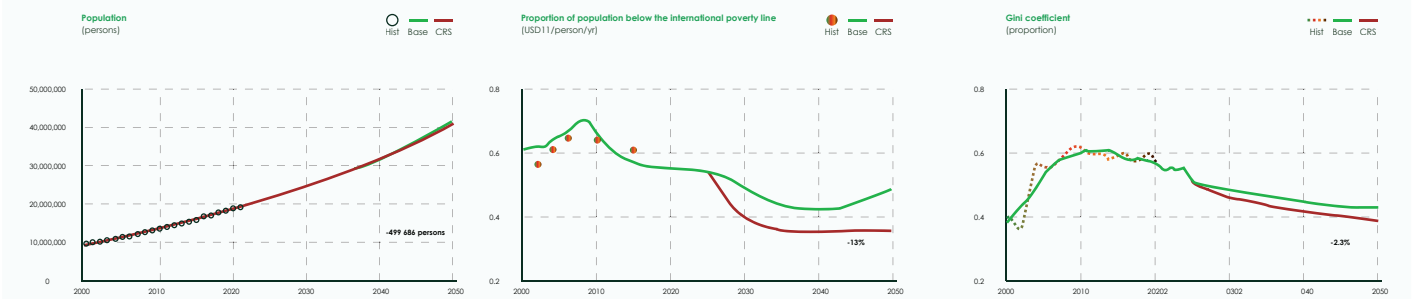


Figure 3.6: Zambia's population and poverty indicators measured in terms of the proportion of

3.4 Economic Indices and Attendant Dynamics

Like social indices and outcomes, the economic dynamics cover a wide range of human development indices, including trends in Gross Domestic Product (GDP); annual national economic growth, labour and employment trends, among others. **Figure 3.7** illustrates the projected economic trends in terms of real GDP growth rate and GDP per capita. The left panel shows real GDP growth at market prices against the historical data. Results show that the model follows usual GDP growth trends, though it underestimates growth in the first decade of simulation and slightly overestimates growth in the second. Specifically, the model estimates, rather accurately, GDP growth in 2024 at 4.8% and not the earlier estimate of 2.3% due to the impacts of the drought (ZIPAR, 2024).[6] By 2050, the baseline projects a growth at an average rate of 2% per year, however, in the CRS scenario this increases growth by 1.8%, resulting in an average growth rate of 4% per year. This suggests that climate interventions can boost economic productivity, particularly from resilient, productive outputs from the agriculture and mining sectors.

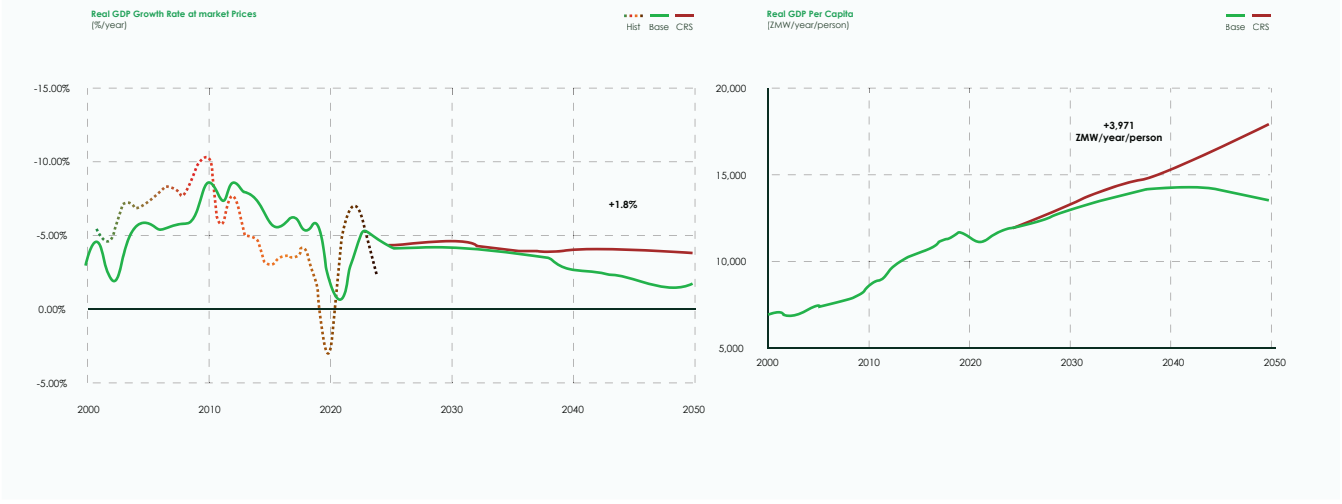


Figure 3.7: Economic outcomes: GDP growth rate (%/year) and GDP per capita (ZMW/year/person) Real GDP per capita shows modest growth between 2000 and 2020. Post-2020, both scenarios project upward trends, though the CRS pathway accelerates progress, reaching nearly 17,500 ZMW/person/year by 2050. In contrast, the baseline scenario shows slower growth, plateauing closer to 13,600 ZMW/person/yearpopulation below the international poverty line and a measure of inequality (Gini coefficient

[6] *According to the recently released Annual Economic Report 2024, published by the Ministry of Finance and national Planning, real GDP growth was recorded at 4.0 percent on account of good performance in the mining sector. This was supported by positive growth in the construction, information and communications technology, accommodation and food services, as well as the financial and insurance sectors. This attests to the country's underlying strengths and resilience of the economy to external shocks, particularly the extreme drought experienced in 2024.*

In terms of total employment, there is significant growth over time, with 875, 000 additional persons employed across sectors by 2050, under the CRS scenario (**Figure 3.8**), with the services sector emerging as the dominant employer. While agriculture initially holds a large share of employment, particularly in the short term, its contribution declines over time, reflecting a structural shift toward higher-value sectors. As a result, the CRS scenario similarly reflects a 5% reduction in unemployment by 2050 (absolute value = 18%), whereas unemployment in the baseline scenario continues to increase, reaching 23% in 2050. This highlights the CRS pathway's role in supporting economic transformation and labour market resilience.

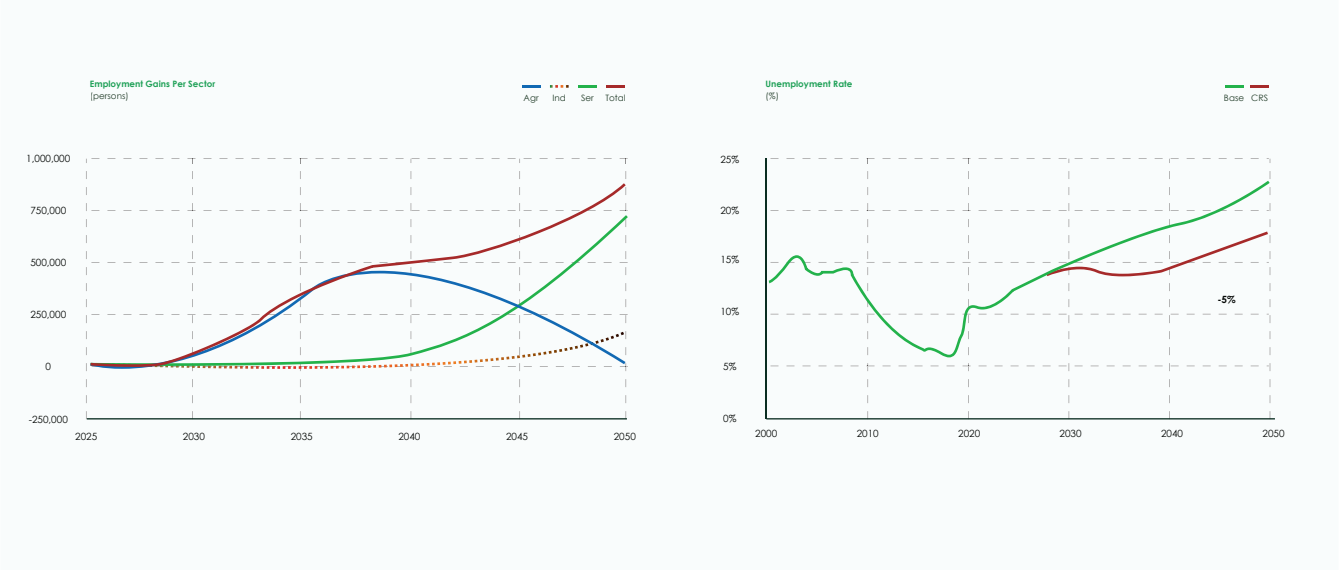


***Figure 3.8**: Employment and unemployment outcomes. Gains in employment by sector in the CRS scenario (left)*

3.4.1 Projections Regarding Public Domestic Debt

Public debt remains a major challenge in many African countries, primarily because huge public debt constrains the government's capacity to deliver on essential services that are critical to national development. **Figure 3.9** presents trends in Zambia's public domestic debt, in terms of government spending in relation to GDP and the Debt-to-GDP ratio under the model scenarios. The analysis highlights the important fact that targeted debt restructuring interventions are required, the absence of which would result in the government deficit remaining constant at a level of approximately 5% of GDP until 2050. Instructively, under the CRS scenario, the government deficit would narrow by -0.5% over time, suggesting modest improvements in revenue generation or expenditure control.

Domestic debt as a share of GDP rises in both scenarios, though it remains lower under the CRS pathway. By 2050, the CRS scenario achieves an 8 percentage point reduction in the debt-to-GDP ratio compared to the baseline, indicating a more sustainable fiscal trajectory. This trend highlights Zambia's reliance on borrowing for development, although climate financing plays a minor role in supporting development and addressing the broader debt challenge.

***Figure 3.9**: Government spending in proportion to GDP (%) and public domestic debt to GDP (%)*

3.4.2 Effects on mining: backbone of the economy

The Zambian economy is highly dependent on mining, particularly copper, which accounts for a significant portion of GDP (~10-15% depending on global market conditions), exports (70% of total export earnings and government revenue (Republic of Zambia, 2022a). Climate adaptation and mitigation are crucial in improving the resilience of the mining sector, particularly from arising impacts due to electricity shortages that disrupt mining operations (Republic of Zambia, 2022b). In this context, the CRS scenario results in a 4 billion ZMW increase in gross value added in the mining sector by 2050 (**Figure 3.10**). This is because of increased metal ore extraction, with a projected increase of 102 million tonnes/year as a result of combined positive effects from additional expenditure in electricity generation (predominantly solar), industry innovation and gross capital formation in the mining sector.

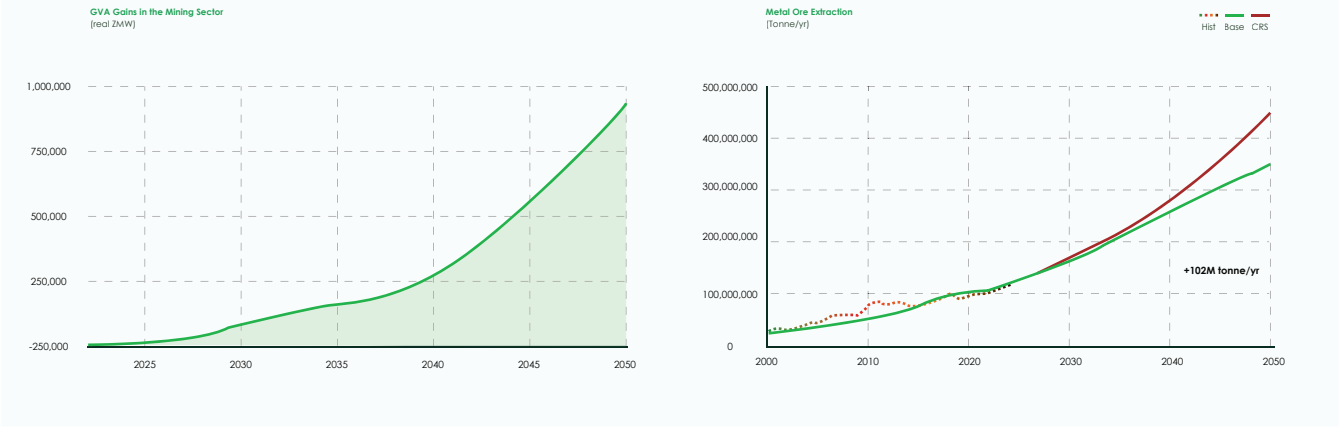


***Figure 3.10**: Gross value added in the mining sector in the CRS scenario (left) and change in metal ores*

3.4.3 Effects on agriculture and food security

Agriculture provides livelihoods for much of the population in Zambia, and it is central to food security and economic stability. Nevertheless, the sector remains highly exposed to climate variability and shocks, including the more indirect impacts. **Figure 3.11** highlights agricultural Gross Value Added (GVA) by sector. The crops and livestock sub-sector (A01) dominates GVA gains under the CRS scenario, suggesting it is the primary driver of agricultural growth, while A02 and A03 make smaller but increasing contributions.

The overall upward trend indicates a steady expansion in agricultural output, reflecting improvements in productivity resulting from additional expenditure on key agricultural interventions in the CRS scenarios; including agricultural training, agricultural investment, fertilizer subsidies, and access to water efficiency solutions. The CRS thereby increases the GVA by a total of 3.5 billion ZMW by 2050 (**Figure 3.11**).

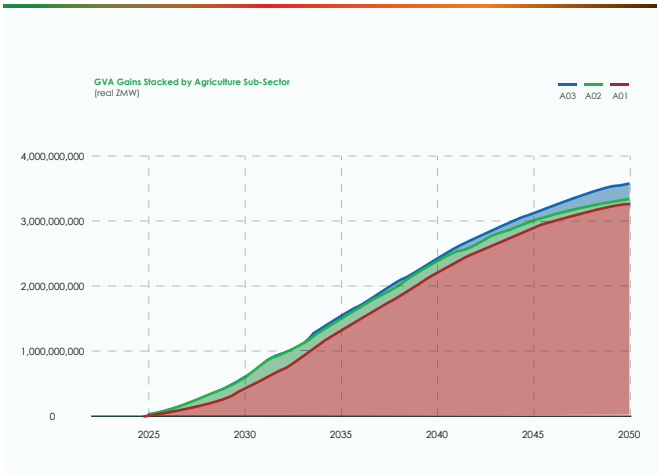


***Figure 3.11**: Gross value added by agriculture economic category under the CRS scenario. A01- crops and livestock, A02 – forestry and A03 – fish capture and harvest*

Increased value creation in the crops and livestock sub-sector under the CRS scenario is additionally attributed to increased production from cereal and non-cereal crops, showing an increase of 9.6 million tonnes/year for non-cereal crops and 1.3 million tonnes/year for cereal crops (**Figure 3.12**). This is because interventions through the CRS scenario enhance the resilience of crop yields against unfavourable climate conditions. Though these long-term trends fail to project impacts from future climate shocks; they highlight the role of climate adaptation in boosting long-term productivity in the agricultural sector.

***Figure 3.12**: Crop production in tonne/year for non-cereal (left) and cereal crops (right)*

3.4.4 Effects on the Energy Sector

Zambia's energy supply is largely dependent on hydropower, which generates over 80% of the country's electricity. However, the sector faces significant challenges from prolonged droughts that lower water levels and constrain generation capacity. Additionally, rising electricity demand from industries such as mining and agriculture, along with shifting access patterns between rural and urban areas is driving increased electricity consumption. This is evident in trends in electricity generation and consumption, as shown in the baseline projection (**Figure 3.13**).

Investments in the energy sector are shown to result in an additional ~14 TwH/yr by 2050 under the CRS scenario (**Figure 3.14**), remaining the above-required consumption patterns. This increase is due to increased electricity generation from both centralized and decentralized investments in solar photovoltaic, in addition to continual expenditure on hydropower sources, followed by smaller generation shares in coal, oil and gas, resulting in a total generation of 60 Twh/year (**Figure3.14**). This result highlights the importance of renewables in the CRS pathway, supporting higher electricity generation and energy diversification in providing long-term energy resilience. While the investment in solar power capacity simulated in the CRS reflects conventional systems, the characteristics of the energy sector in Zambia suggest that floating solar systems, deployed on large water reservoirs, could reduce evaporation and thus simultaneously increase hydropower output (Sanchez et al., 2021).

***Figure 3.13**: Zambia's baseline total electricity generation and consumption (left) and change in electricity generation in the CRS (right) in TWh/year.*

***Figure 3.14**: Electricity generation by source in the CRS scenario (left) and net electricity imports in Twh/yr, a positive representing import and negative corresponding to exports*

Scaling Solar Energy Project

The World Bank Zambia Scaling Solar Energy Project (P157943, P163958) is an example of a cost-effective climate intervention that aims to diversify Zambia's energy mix, reduce greenhouse gas (GHG) emissions, and enhance resilience against climate variability.
At its commissioning, the project resulted in competitive tariffs of 6.02 US cents/kWh (Bangweulu Solar Plant) and 7.84 US cents/kWh (Ngonye Solar Plant), among the lowest for solar PV projects in Sub-Saharan Africa (SSA). These tariffs were achieved through a competitive bidding process under the Scaling Solar Initiative, showcasing effective use of public and private resources to lower costs. Consequently, the lower tariffs reduce the financial burden on the Zambia Electricity Supply Corporation (ZESCO) and end-users, leading to significant savings in energy costs over the project's lifetime. The avoided cost of emergency diesel generation during periods of drought-induced hydropower shortages further highlights the economic efficiency of the project.

For every 100 MW of installed capacity, the project reduces 25,000–30,000 tons of CO_2 equivalent annually. Estimates suggest the cost per ton of CO_2 equivalent avoided is competitive compared to other renewable energy projects globally. Unlike fossil fuel-based projects such as mining and emissions from coal or diesel plants, the project avoided significant environmental degradation. Efficient resource use also ensured minimal disruption to local ecosystems. Solar energy, therefore, holds a competitive advantage in climate mitigation compared to diesel generators and fossil fuel-based energy sources. The project mobilised public and private financing, leveraging concessional loans, guarantees, and private capital. The International Development Association (IDA) guarantees reduced financial risk for private investors, optimising resource allocation and attracting significant foreign direct investment.

To maximise resource use and avoid conflicts over prime agricultural or urban land, Solar PV plants like the Bangweulu and Ngonye solar parks were developed on underutilised land with minimal environmental impact. The project fostered institutional capacity in Zambia by providing technical assistance to government agencies, improving regulatory frameworks, and establishing a transparent procurement model. These efforts have spillover benefits, enabling Zambia to replicate similar projects efficiently. By utilising abundant solar resources, the project diversified Zambia's energy mix, reducing over-reliance on hydropower, which is vulnerable to droughts and climate variability.
Nonetheless, there were challenges in implementing this project. Limited capacity in Zambia's national grid constrained the full utilisation of solar generation potential, necessitating further investments in transmission infrastructure. This and other structural barriers, like market reforms, further impaired the project's scalability and maximum resource utilisation across the energy sector. Additionally, some regulatory delays slowed the pace of financial closure and project commissioning, temporarily underutilising financial and technical resources.

In summary, the World Bank Zambia Scaling Solar Energy Project is a highly cost-effective climate intervention. It has maximised resource utilisation by leveraging competitive procurement, mobilising diverse financing sources, and efficiently utilising Zambia's solar potential. However, addressing grid and regulatory challenges will be crucial to further optimizing resource use and scaling up the program. The project demonstrates how well-designed interventions can deliver substantial climate, economic, and social benefits in a resource-efficient manner.

Historically, Zambia experienced periods of net electricity exports up to 2020, reflecting its reliance on hydropower for domestic needs and surplus for trade (**Figure 3.14**) (ERB, 2023). The high reliance on hydropower further makes the electricity market highly vulnerable to droughts and future climate impacts. Post-2020, the baseline scenario shows a long-term shift towards electricity imports driven by exceeding electricity consumption relative to generation.

Under the baseline, imports steadily increase to 9.5 Twh/year by 2050 (**Figure 3.14**). In contrast, the CRS scenario shows a lower reliance on electricity imports, but rather potential for exports, peaking in 2038 at 4.8Twh/year, but slowly returning to reliance on imports, though much lower than in the baseline scenario (4.4Twh/year) by 2050.

Lastly, historical trends in access to electricity are closely aligned with data observations from the ZAMSTAT, which reports that 53.6% of total households at a national level has access to electricity, comprised of 34% of households in rural areas compared to 80.3% in urban areas (ZAMSTAT, 2023). Future trends suggest a continual increase under the baseline scenario such that total national access to electricity in 2050 reaches 71% (**Figure 3.15**). The CRS scenario further increases overall access by 4%, resulting in 75% access to electricity by 2050.

***Figure 3.15**: Electricity generation by source in the CRS scenario (left) and net electricity imports in Twh/yr, a positive representing import and negative corresponding to exports*

3.5 Environmental Indices and Attendant Dynamics

Environmental governance has progressively emerged as one of the most pressing concerns in the era of climate change. At the heart of the matter is the demand for development and industrialisation, which is often pitted against the ideal of a clean and healthy environment that is largely underpinned by dependence on the less toxic renewable energy sources. The trends in Zambia show that from 2000 to 2020, the total GHG emissions in CO2eqv rose steadily, surpassing 34 million tonnes/year in 2024. Under the BaU scenario, emissions continue to rise, reaching 65 million tonnes/year by 2050, while the CRS scenario reduces total emissions in the long term by 9.6 million tonnes/year by 2050 (**Figure 3.16**). Nevertheless, even under the CRS there is an increasing trend, driven by development across economic sectors. These results highlight the challenge of decoupling economic growth from carbon emissions, underscoring the need for stronger low-carbon policies and increased renewable energy investments to curb emissions, in line with Zambia's NDCs.

A decline in forest land in Zambia is evident, as supported by the model results (**Figure 3.16**). From 2000 to 2024, forest cover steadily decreased from just under 50 million hectares to approximately 45 million hectares, primarily due to deforestation and land-use changes.

Projections under the baseline scenario indicate a continued decline, with forest land falling to around 37 million hectares by 2050. The CRS scenario, while also showing a decline, moderates this loss, maintaining forest cover at around 41 million hectares by mid-century.

These results highlight the ongoing pressure on Zambia's forests, driven by agricultural expansion, energy needs, and unsustainable land use practices (Republic of Zambia, 2014). The CRS pathway demonstrates the potential for better forest conservation through climate resilience strategies, emphasizing the importance of implementing sustainable land management and reforestation initiatives to slow deforestation and protect ecosystems.

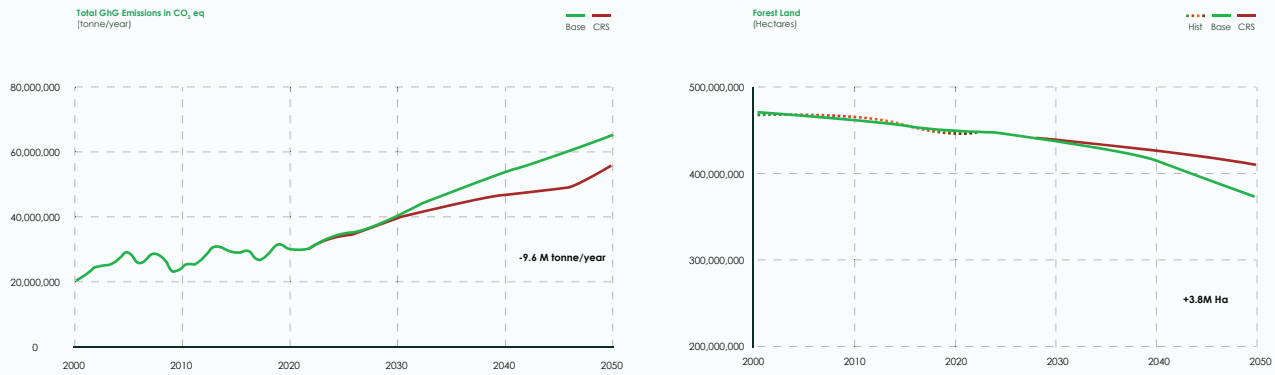


***Figure 3.16**: Total GhG emissions in CO2eq (tonne/yr) and change in forest land under the modelled scenarios*

GET FiT Zambia Solar Tender-a model for cost-effective, renewable energy

The GET FiT Zambia Solar Tender is a prominent climate intervention aimed at diversifying Zambia's energy mix and reducing GHG emissions through competitively priced solar photovoltaic (PV) power generation. Like the scaling solar project, the tender achieved lower tariffs, recording a low average tariff of 3.99 US cents/kWh, the first sub-4 US cents tariff in Sub-Saharan Africa (SSA). This competitive pricing underscores the program's cost efficiency and its ability to secure affordable renewable energy. The program significantly reduced Zambia's reliance on more expensive energy sources, such as emergency diesel generation, by delivering solar power at such low costs. Moreover, competitive tendering minimised costs while attracting high-quality developers. This ensured optimal allocation of resources for maximum energy output. Low tariffs translate into reduced financial burdens for the Zambia Electricity Supply Corporation (ZESCO) and consumers, yielding substantial savings over the projects' lifetimes.

The tender effectively capitalized on Zambia's high solar irradiation levels to generate affordable and clean energy, aligning resource availability with energy needs. Six projects were selected under the tender, with a combined capacity of 120 MW, and are projected to offset 40,000–50,000 tons of CO_2 equivalent annually by displacing fossil fuel-based power generation. The cost per ton of CO_2 mitigated is highly competitive, making the intervention a cost-effective tool for climate action.

The project mobilized substantial private-sector investment, supplemented by technical and financial support from the German Development Bank (KfW) and development partners. Additionally, public funds were utilized for transaction advisory and capacity-building efforts, ensuring minimal public expenditure relative to project outcomes.

Like the SCRALA project, they were sited on underutilised or degraded land, minimising conflicts with agriculture or urban development and maximising resource efficiency. Modular solar PV technology also allowed for flexible scaling and efficient land usage. The transparent and competitive procurement framework is also a replicable model for future projects, enhancing long-term resource efficiency in Zambia's energy sector.

The tender process provided technical assistance to Zambian institutions, improving their capacity to manage large-scale renewable energy projects, energy resilience and diversification. By adding 120 MW of solar capacity, the tender reduced reliance on climate-sensitive hydropower, improving the resilience of Zambia's energy system to droughts and climate variability. Solar energy integration strengthened the country's overall energy mix, promoting stability and sustainability.

While the tender was successful, the scale of implementation remains modest relative to Zambia's renewable energy potential. Limited transmission and distribution infrastructure constrains the full utilisation of solar energy and necessitates further investments to maximise the project's potential. Delays in financial closure and grid connectivity affected the timely deployment of some projects, temporarily underutilising available resources. Therefore, overcoming policy and infrastructure barriers will be key to scaling such interventions.

The GET FiT Zambia Solar Tender significantly improves cost-effectiveness compared to traditional fossil fuel generation and prior renewable energy projects. The intervention's emphasis on competitive bidding, private-sector participation, and technical assistance ensures optimal resource utilisation while achieving climate and economic goals. Moreover, it is a highly cost-effective and resource-efficient climate intervention that achieved record-low tariffs, reduced GHG emissions, and improved energy access while optimising financial, institutional, and natural resources. However, to fully capitalize on its benefits, Zambia must address grid infrastructure constraints and expand the scale of future projects. The program serves as a model for cost-effective, renewable energy procurement in developing economies.

In terms of freshwater resources, **Figure 3.17** shows the water vulnerability index (%), which measures the ratio of total water withdrawal relative to total water supply. Initially, both scenarios exhibit stable trends, but post-2024 water vulnerability experiences an increase above the baseline scenario. By 2050, water vulnerability is 14% higher under CRS, suggesting that despite resilience measures, pressures on water resources continue to grow due to increased water withdrawal from the agriculture and industry sectors, despite interventions in water efficiency. This trend highlights the increasing risks of water scarcity, likely driven by climate change, rising demand, or reduced water availability, emphasizing the need for stronger water management strategies in an increasingly warmer and drier climate.

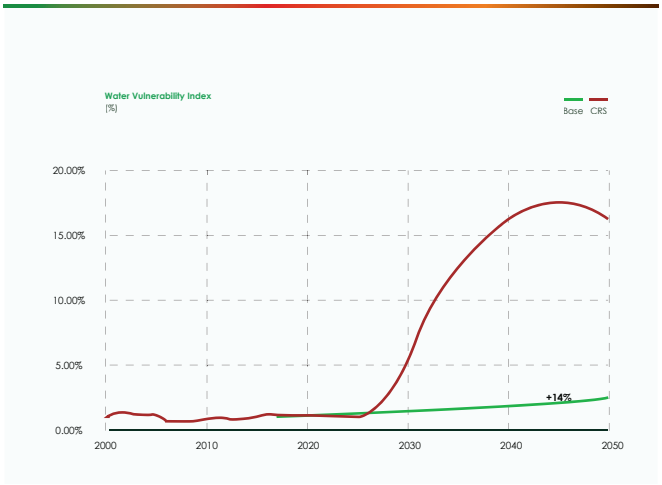


***Figure 3.17**: Change in the water vulnerability index measured as the ratio of total water withdrawal relative to total water supply*

3.6 Climate Resilience and the Sustainable Development Goals

This section highlights the effects of climate change policies on Zambia's developmental indices in the context of the Sustainable Development Goals (SDGs), not only because they are a globally agreed minimum for all countries but, more importantly, because of their direct bearing on all the known Human Development Indices and indicators. **Figures 3.18 and 3.19** compare the projected attainment of the SDGs by 2030 under the two scenarios. The results highlight significant variability in the attainment of SDGs, with some goals demonstrating notable progress. Under the baseline scenario, goals including SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities) show relatively high attainment, reaching close to or above 75% by 2030. In contrast, SDG 2 (Zero Hunger), SDG 8 (Economic growth), SDG 10 (Reduced Inequalities), and SDG 14 (Life below Water) show relatively poor attainment under the baseline scenario.

For some goals, the CRS further improves these outcomes, particularly in SDG 1 – No Poverty (15%); SDG 2- Zero Hunger (13%); SDG 6 – Clean Water and Sanitation (6%), and; SDG 11 –Sustainable Cities and Communities (17%). Environmental SDGs, including SDG 13 – Climate Action and SDG 15 – Life on land, achieve a 2% and 1% gain, respectively, by 2030. Lastly, SDG 17: Partnership of the goals achieves a 16% reduction in attainment by 2030, though this is because of the assumptions in financing interventions in the CRS scenario, which assumes 100% external financing, and hence negative attainment for SDG sub-indicator 17.1.2 ('proportion of domestic budget funded by taxes'). If this indicator was removed from the calculation of SDG 17, the SDG attainment would show a positive attainment of 1%. The CRS scenario further delivers marginal improvements for the other SDGs, reflecting the systemic inertia and remaining challenges in achieving these goals without targeted interventions.

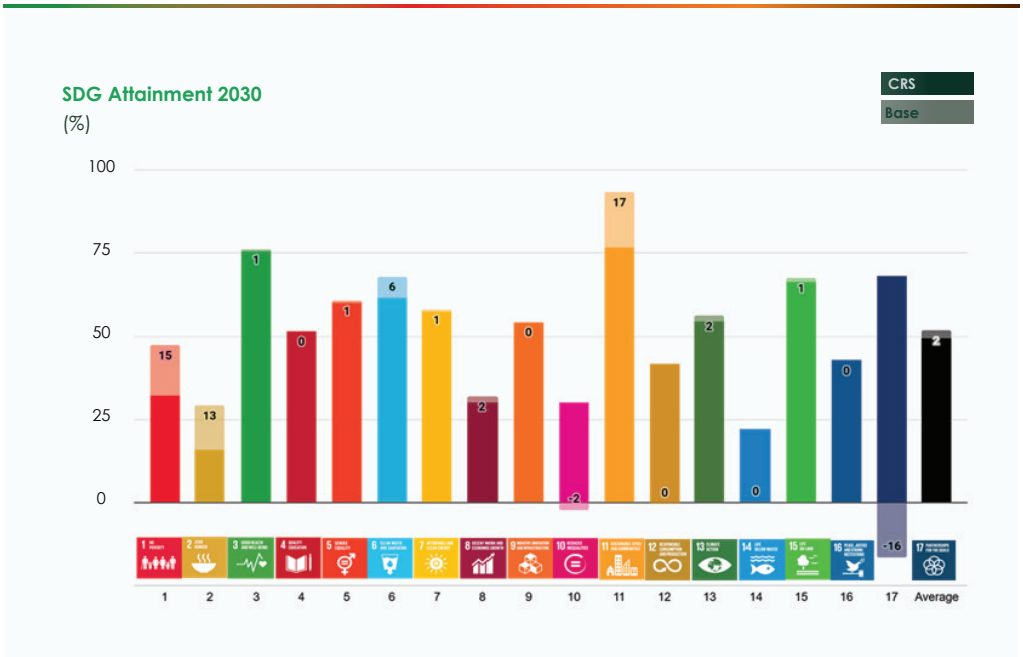


***Figure 3.18**: SDG attainment by 2030. Positive CRS gains shown in lighter shading are additive to the BAU result.*

Evaluating the SDG attainment over the short-term, as shown above, with only 5 years remaining, points to major challenges facing the country in her pursuit of the goals. It also demonstrates that development inherently has delays and that more progress would be observed in the long term to enable favourable trajectories. Evaluating the SDG attainment over a longer term (**Figure 3.19** below), allows more time for CRS to achieve more desirable outcomes for certain goals. Additional progress in attainment is particularly relevant for SDG 1 (no poverty) by 23%, 2 (zero hunger) by 31%, 7 (Clean energy) by 9%, 8 (Decent work and economic growth) by 13%, 9 (industry, innovation and infrastructure) by 16%, 13 (climate action) by 6%, 15 (life on land) by 5%. It shows a positive result for SDG 17 (partnership of the goals) in the long-term increasing by 2% by 2050.

Overall, the baseline scenario suggests that Zambia is halfway (50%) to achieving the SDG on average, with some goals performing better than others and implementing the CRS increases the average attainment by 2%, thus highlighting the benefits of integrating climate resilience strategies into development planning.

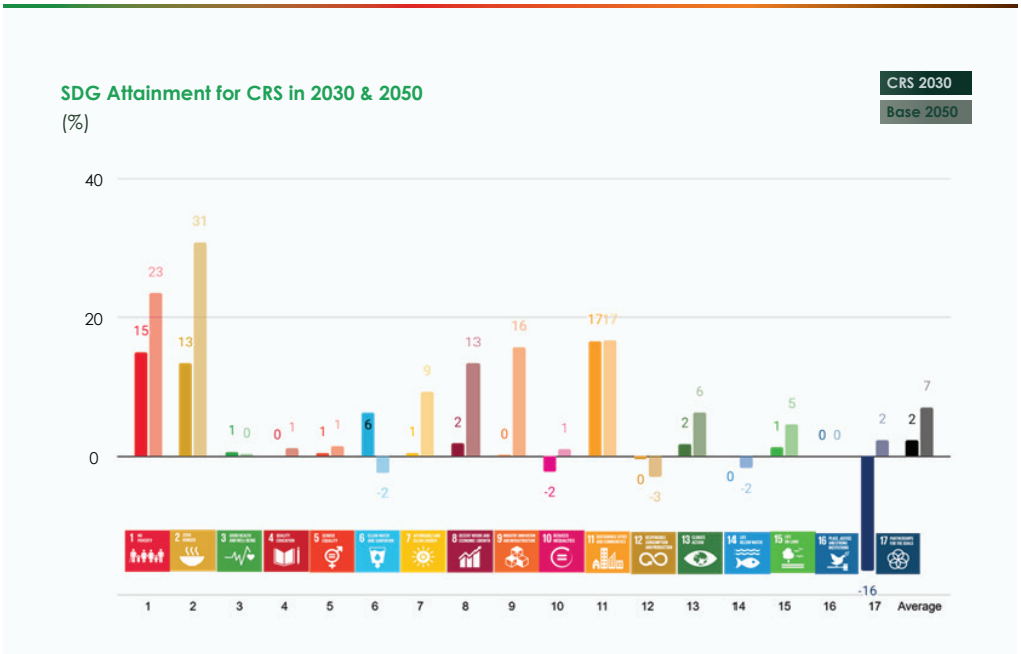


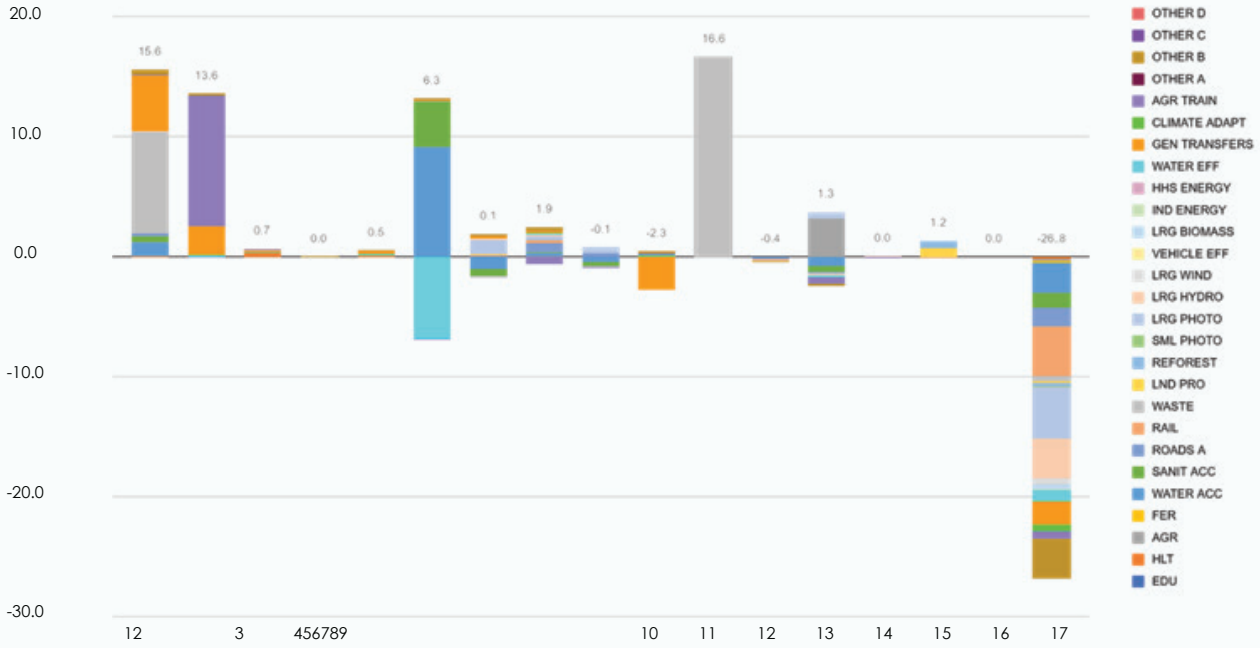
***Figure 3.19**: Net attainment in SDGs (i.e. CRS – base in 2030 and 2050).*

3.6.1 Decomposing the effects of policy interventions

Figure 3.20 also illustrates the policy interventions that impact SDG attainment by 2030. For this report's analysis, each policy intervention was run separately (see right column of **Figure 3.20**), as opposed to being combined as a general CRS policy, which can also result in trade-offs across goals. The analyses of each intervention further demonstrate the direct pathways through which interventions affect SDG results. Of the goals with the largest attainment, the attainment of SDG 1 (Zero poverty) can be directly apportioned to expenditure in 'general transfers' and 'waste', the latter related to the outcomes of the sub-indicator, 'proportion of households with access to basic services'. The attainment of SDG 2 (No Hunger) is largely attributed to expenditure in 'agricultural training' while for SDG 6 (clean water and sanitation) is positively impacted by water and sanitation access but negatively impacted by expenditure in 'water efficiency', resulting in an unintended increase in water use, particularly related to increase in crop production, under an increasingly sparse water supply.

The attainment of SDG 11 ('sustainable cities and communities) is attributed to expenditure on waste, which has a large impact on solid waste collection services. Finally, the negative attainment of SDG 17 ('partnerships for the goals') is similarly attributed to the lower 'proportion of domestic budget funded by tax' since the expenditure for all policies is funded through external financing sources. Notably, certain SDGs benefit most from interventions, whereas other interventions result in policy trade-offs.

SDG Attainment Per Intervention in 2030 (i.e. scenario-base)
(%)



Chapter 4

In Search of Good Practices and Policy Options for Overcoming Threat Multipliers of Climate Change

4.1 The National Climate Change Policy Landscape

As part of the preparatory process for this report, a review and analysis of policy responses to the increasing threat of climate change was undertaken. The broad aim of the review was to determine how climate change has been incorporated into national development policies and plans, including within the relevant legal/ regulatory instruments. The policy reviews have proffered some practical suggestions and recommendations aimed at enhancing national capacity and preparedness to deal with the threat multipliers of climate change while also ensuring the country's continued commitment to sustainable development.

A review of Zambia's policy response landscape reveals that the country has developed a suite of policies in an attempt to entrench adaptation, resilience building and mitigation as part of the response to climate change. In this regard, the notable policy frameworks already in place include, the Climate Policy Act; the national Climate Change Response Strategy (CCRS) (Republic of Zambia, 2010); the National Green Growth Strategy (GGS) (Republic of Zambia, 2024); the National Adaptation Plan (NAP), and; the upcoming 2025 Nationally Determined Contribution (NDC) for Zambia. The upcoming 2025 NDC, in particular, aims to build on the commitments outlined in the earlier NDC of 2021 (Republic of Zambia, 2021).

Additionally, Zambia has prepared her Eighth National Development Plan (8NDP) (Republic of Zambia, 2022a); a National Policy on Climate Change (NPCC) (Republic of Zambia, 2016); a National Adaptation Programme of Action (NAPA) (Republic of Zambia, 2023) and a Biennial Update Report (BUR) (Republic of Zambia, 2022c). The country has further submitted its Third National Communication to the UNFCCC in 2020 (Republic of Zambia, 2020). The NPCC and the NDCs also serve as unifying frameworks, fostering collaboration across sectors, while the NAP emphasizes multisectoral coordination, particularly in agriculture, water, and energy. The creation of the Ministry of Green Economy and Environment appears to have improved policy alignment and coordination among various ministries, even though challenges still remain.

4.1.1 Sector-specific policies that address climate change

Beyond the specific climate-related policies mentioned above, the country has developed a number of sector-specific policies that further strengthen the policy response to the threat of climate change in the specific sectors. For instance, the Energy Policy focuses on the adoption of renewable energy and improving energy efficiency, while the Agriculture Policy promotes climate-smart agricultural practices and sustainable land use. On the other hand, the Forestry Policy addresses reforestation, sustainable forest management, and carbon sequestration, while the Water Resources Management Policy aims to balance sustainable water use with disaster risk reduction strategies.

It can thus be said, in broad terms, that Zambia is on track by putting in place the basic policy measures that are expected to contribute to the reduction of emissions, thereby fulfilling, in part, Zambia's NDCs. Nevertheless, as this chapter discusses further below, it is also recognised that additional investments are required to put the country on a longer-term environmental and socio-economic resilience pathway.

4.1.2 Domestication of global climate change frameworks

Zambia has made strides in domesticating the main global frameworks and instruments designed to undergird climate change responses. This is in recognition of the fact that climate change is a global problem which requires global cooperation for it to be meaningfully addressed. In this respect, the key global instruments that have informed the country's national policies on climate change include the UN Framework Convention on Climate Change (UNFCCC) and its various protocols, primarily , the Paris Agreement (UNFCCC, 2015). The country has also aligned its policies to the Sustainable Development Goals (SDGs) as was agreed and adopted by UN member states in September 2015 and further, the Sendai Framework for Disaster Risk Reduction (United Nations, 2015) and the Convention on Biodiversity (CBD) (CBD, 2016) - among others (see **Table 4.1**).

The Nationally Determined Contribution (NDC) as premised on the Paris Agreement (UNFCCC, 2015) demonstrates a strong commitment to mitigating greenhouse gas emissions and adapting to climate change impacts. Article 4, paragraph 2 of the Paris Agreement requires each state party "to prepare, communicate and maintain successive NDCs that it intends to achieve..." Hence, countries are expected to pursue domestic measures that ultimately aggregate to the stated NDC. The NDC targets sectors like energy, agriculture, forestry, and waste management, with the country having defined its target of a 47% conditional reduction in emissions by 2030. Zambia's NPCC presents a comprehensive approach to developing climate resilience and embracing low-carbon development and is also consistent with the Paris Agreement's other objectives, such as increasing adaptation capabilities, increasing the ability to withstand impacts of climate change and reducing vulnerabilities to climate-related risks.

Additionally, and in line with the Cancún Adaptation Framework (UNFCCC, 2011), Zambia's NAP integrates climate resilience into medium and long-term planning of various sectors. Thus, it contributes to the Paris Agreement's objectives through enhancing the focus on building institutional capacities, enhancing access to climate finance and inclusive stakeholder engagement. The NPCC and NAP prioritize disaster risk management and resilience in accordance with the Sendai Framework, which aims at achieving the overall goal to reduce disaster risks and enhance Early Warning Systems (EWSs). The country's efforts in forest conservation and sustainable management of ecosystems align with its commitments under the Convention on Biological Diversity (CBD).

***Table 4.1**: Alignment between Zambia's national policies and global climate goals*

Global Policy Framework	National Policy Framework	Assessment of Alignment
UNFCCC and the Paris Agreement	• Nationally Determined Contributions (NDCs): Targets 47% conditional reduction in GHG emissions by 2030, focusing on energy, agriculture, forestry, and waste management. • Zambia's National Policy on Climate Change (NPCC): Provides a framework for low-carbon development and climate resilience.	• Paris Agreement Goal: Limit global temperature rise to 1.5–2°C above pre-industrial levels. • Emphasises nationally appropriate measures to reduce emissions and enhance resilience.
Sustainable Development Goals (SDGs)	• SDG 13 (Climate Action): Integrated in NDCs, NPCC, and National Adaptation Plan (NAP), prioritizing mitigation and adaptation efforts. • SDG 7 (Affordable and Clean Energy): Promotes renewable energy through projects like solar energy. • SDG 2 (Zero Hunger): Advances climate smart agriculture to ensure food security. • SDG 15 (Life on Land): Focuses on forest management and biodiversity conservation. • SDG 6 (Clean Water and Sanitation): Integrates water resource management into climate resilience strategies.	• SDG 13: Take urgent action to combat climate change. • SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy. • SDG 2: End hunger and ensure food security. • SDG 15: Protect, restore, and promote sustainable use of terrestrial ecosystems. • SDG 6: Ensure availability and • sustainable management of water and sanitation.

Global Policy Framework	National Policy Framework	Assessment of Alignment
Zambia's National Adaptation Plan (NAP)	• Integrates climate resilience into medium- and long-term sectoral planning. • Builds institutional capacity and enhances access to climate finance. • Promotes inclusive stakeholder engagement for effective adaptation strategies.	• Cancún Adaptation Framework: • Strengthen resilience, reduce vulnerabilities, and build capacity to adapt to climate change. • Paris Agreement: Support for long-term resilience goals.
Sendai Framework for Disaster Risk Reduction	• Prioritises disaster risk management through the NPCC and NAP. • Enhances early warning systems and builds community resilience to natural disasters.	• Sendai Framework Goal: Reduce disaster risk and enhance • Preparedness, resilience, and recovery mechanisms.
Convention on Biological Diversity (CBD)	• Commits to sustainable forest management, biodiversity conservation, and ecosystem protection under NPCC and NDCs.	• CBD Goal: Protect and sustainably manage biodiversity and natural ecosystems.

4.2 A Brisk Assessment of the Impact of Climate Change Policies

A proper assessment of the broader environmental, social, and economic outcomes attributable to national climate policies would involve a thorough examination of how these initiatives are transforming the various sectors. A brisk assessment, however, suggests that with a focus on renewable energy, conservation programs, and sustainable agricultural practices, Zambia is making strides toward enhancing resilience to climate change, reducing emissions and fostering sustainable development. In terms of reducing emissions, renewable energy projects such as the Scaling Solar Project (SSP) and the GET FiT Zambia Solar Tender are leading the way in reducing Zambia's reliance on fossil fuels. The SSP cuts emissions by approximately 25,000–30,000 tons of CO_2 annually per 100 MW, while the GET FiT program offsets around 40,000–50,000 tons of CO_2 annually, thereby contributing to the reduction of GHG emissions.

The implementation of REDD+ as a conservation initiative has significantly contributed to lowering deforestation rates, thereby preserving crucial carbon sinks. For environmental outcomes, the investments in reforestation and afforestation have boosted biodiversity and helped combat land degradation. Initiatives such as the protection of National Parks and Wildlife Conservancies (Lower Zambezi and Kafue) are crucial in supporting endangered species and maintaining ecological balance. In building climate resilience, the ongoing diversification of the energy mix with solar and wind reduces vulnerability to hydropower shortages during droughts. Additionally, sustainable land and water management practices have enhanced soil fertility and preserved watersheds, thereby mitigating desertification and erosion.

One of the tangible social outcomes of the climate policies is improved energy access. In recent years, there has been an increase in the number of solar projects, making electricity accessible to rural communities and improving living conditions by providing access to modern services such as healthcare, education, and

services such as healthcare, education, and clean water. The more affordable tariffs, achieved through programs like GET FiT, help reduce the financial burden on households and businesses. Renewable energy and conservation projects create employment opportunities during both the construction and operational phases. For instance, solar PV installations under the GET FiT program have generated jobs in construction and maintenance. The conservation programs have offered social benefits such as community-based tourism and revenue-sharing mechanisms, leading to the funding of local schools, clinics, and infrastructure development. The inbuilt training initiatives have equipped people with skills in renewable energy, sustainable farming, and natural resource management. In the healthcare sector, cleaner energy sources reduce air pollution and lower incidences of respiratory diseases, especially in urban areas previously dependent on diesel generators. Improved access to clean energy is also reducing reliance on harmful cooking fuels like kerosene and biomass, thereby improving indoor air quality (Matandirotya & Burger, 2022).

The promotion of renewable energy has reduced dependence on expensive diesel imports and emergency power during hydropower shortfalls. This has direct savings on energy costs. Moreover, private sector investment has been triggered, with competitive tenders like Scaling Solar and GET FiT having attracted substantial FDI. This has boosted economic growth in the renewable energy sector. The other impact is evident in the agriculture sector, where climate-smart agricultural practices such as conservation farming and drought-resistant crops are stabilizing food production, improving food security, and enhancing farmer incomes.

Furthermore, renewable energy-driven irrigation is reducing vulnerability to unpredictable rainfall patterns. The conservation initiatives have further spurred eco-tourism, especially in iconic locations like the Victoria Falls, Lower Zambezi, and Kafue national parks, thereby generating foreign exchange and local economic opportunities. . Additionally, significant cost savings have been achieved through resilience-building measures, including mitigating economic losses from natural disasters such as floods and droughts and preserving infrastructure and agricultural productivity through improved water management.

4.3 Indigenous Knowledge Systems and Climate Resilience

Indigenous knowledge systems have proven invaluable in promoting climate resilience.[7] The systems are deeply anchored in local ecosystems and provide adaptable solutions that meet community requirements while promoting sustainability. Local communities rely on indigenous techniques to forecast weather and changes in environmental conditions. Natural indicators, such as observing water levels, animal behaviour, and landscape shifts, allow communities to predict floods and droughts. These insights guide agricultural planning and inform disaster risk reduction strategies. The integration of indigenous knowledge not only improves the cultural acceptability of climate resilience efforts but also enhances their effectiveness. Grounding strategies in familiar and culturally significant practices ensures better community buy-in and long-term sustainability. Moreover, partnerships between scientific and indigenous communities can enrich adaptation efforts, blending empirical research with traditional wisdom.

4.3.1 Climate change adaptation: A case study of the Lozi people of Western Province

The Lozi people, an ethnic group predominantly residing in the Western Province of Zambia, occupy the Barotse floodplain, locally known as the Bulozi plain. This region is characterized by seasonal flooding of the Zambezi River, which significantly influences the socio-economic and cultural practices of the local people. The floodplain serves as a vital ecological zone, supporting livelihoods through fishing,

[7] See, for some references: (1.) Chileshe, B., Milupi, I., Sakala, E., Kabaghe, W., Mwendapole, J., & Membele, G. M. The Role of Local and Indigenous Knowledge in Climate Change Adaptation and Mitigation in the Barotse Floodplain of Western Province-Zambia; (2.) Mapedza, E., Rashirayi, T., Xueliang, C., Haile, A. T., van Koppen, B., Ndiyoi, M., & Sellamuttu, S. S. (2022). Indigenous Knowledge Systems for the management of the Barotse Flood Plain in Zambia and their implications for policy and practice in the developing world. In Current Directions in Water Scarcity Research (Vol. 4, pp. 209-225). Elsevier.

[8] https://www.adaptation-undp.org/projects/strengthening-climate-information-and-early-warning-systems-zambia
Mbewe, M. (2019). Indigenous knowledge systems for local weather predictions: A case of Mukonchi Chiefdom in Zambia.

farming, and livestock rearing. However, the Lozi's dependence on the floodplain also makes them particularly vulnerable to the effects of climate change, such as erratic rainfall patterns, prolonged droughts, and intensified flooding.

In response to these challenges, the Lozi people have developed ingenious methods of managing seasonal flooding. They use cultivation techniques tailored to varying soil types and moisture levels, ensuring year-round farming. Additionally, centuries-old canal systems are used for irrigation, navigation, and drainage, sustaining livelihoods in a region prone to flooding. Traditional fishing practices and seasonal resource-use restrictions demonstrate a profound understanding of ecological cycles. These practices enhance resilience by preserving biodiversity and ensuring sustainable resource use.

Indigenous Knowledge is also deeply embedded in land and resource management strategies. Farmers grow drought-resistant Indigenous crops and use intercropping to maintain soil fertility. They employ conservation methods through controlled burns, rotational grazing, and planting of native species, which help sustain biodiversity while reducing vulnerability to climate shocks.[9, 10]

4.3.2 Case of Adaptation and resilience building in Luapula Province

Luapula Province in northern Zambia, is rich in natural resources and boasts an impressive array of rivers like the Luapula, expansive lakes such as Bangweulu and Mweru, lush wetlands, and diverse forest ecosystems. The local economy is primarily driven by subsistence farming, fishing, and small-scale trade, providing livelihoods for a majority of the population. Despite its natural wealth, Luapula faces many climate-related challenges. Erratic rainfall, frequent floods, recurring droughts, and worsening land degradation places immense pressure on food security, livelihoods, and the region's unique biodiversity.

In the face of these challenges, Indigenous Knowledge Systems have emerged as a cornerstone of the region's climate adaptation strategies. Deeply rooted in cultural traditions and a long-standing connection to the environment, these systems offer practical, locally tailored solutions for building climate resilience. Over generations, local communities have developed indigenous practices that showcase remarkable adaptability and resilience to the impacts of climate change, including the long-practised reliance on innovative agricultural practices to ensure food production, even in the face of challenging conditions. One such approach is dimba farming, where crops like vegetables, millet, and maize are cultivated on nutrient-rich floodplains exposed when water levels recede. Additionally, farmers prioritise crop diversity, growing a mix of staples like cassava, sweet potatoes, millet, and groundnuts. By incorporating drought-resistant indigenous varieties, they create a buffer against unpredictable weather and bolster food security.

Cultural and spiritual values also play a significant role in conserving Luapula's ecosystems. Forests, sacred groves, and wetlands are actively preserved, which helps maintain biodiversity and ecological balance. For example, mushitu, or evergreen swamp forests, are often protected because of their spiritual significance, indirectly safeguarding vital habitats and promoting ecological resilience.

Traditional knowledge has been instrumental in helping communities adapt to changing environmental conditions. Practices like seasonal fishing bans prevent overfishing and allow aquatic populations to replenish, while natural early warning indicators, such as changes in animal behaviour or plant cycles, guide decision-making. Preservation methods like smoking and sun-drying fish enable communities to store food without refrigeration, ensuring a reliable food supply during lean periods. These time-tested practices demonstrate the importance of integrating indigenous knowledge into modern climate resilience strategies, offering sustainable solutions rooted in local expertise and traditions.

[9] *Kaczan, D., Arslan, A., & Lipper, L. (2013). Climate-smart agriculture? A review of current practice of agroforestry and conservation agriculture in Malawi and Zambia.*

[10] *Swennenhuis, J. (2015). Food security strategies in the Kazungula and Zambezi heartlands, and their link with conservation impact and climate change.*

4.3.3 Factors Limiting the use of traditional knowledge systems

Despite its potential, several challenges hinder the full utilisation of the afore-highlighted traditional knowledge systems. Modernisation and urbanisation are steadily eroding traditional practices as younger generations move away from such knowledge systems in favour of modern lifestyles. While indigenous knowledge systems hold valuable insights, integrating them with modern scientific approaches could significantly enhance their effectiveness. The intensifying effects of climate change, such as prolonged droughts and more frequent floods, often surpass the adaptive capacity of these traditional systems, leaving communities increasingly vulnerable. Addressing these challenges, therefore, requires deliberate efforts to preserve Indigenous knowledge, foster collaboration between traditional wisdom and modern science, and ultimately strengthen adaptive capacities to withstand escalating climate threats.

4.4 Aligning Policies with Financing Mechanisms

To bring sectoral policies in line with climate resilience goals, it is important to ensure that these policies are well funded and are in harmony with one another to avoid policy conflicts and encourage cross-sectoral collaboration. Whereas there has been some progress, there are still gaps and challenges that require improvements across the board.

4.4.1 Limited budgetary allocation in the face of constrained fiscal space

In 2024, Zambia allocated approximately ZMW1.4 billion ($54 million) to environmental sustainability, representing 0.8% of the national budget. This marked a 36% increase from the ZMW1 billion allocated in 2023. An additional ZMW1.5 billion was earmarked for environmental protection and climate resilience initiatives with four priorities, including:

Expanding renewable energy capacity;

Promoting climate-smart agriculture;

Strengthening disaster preparedness and mitigation programs and;

Supporting afforestation and reforestation efforts.

There is, however, a lack of clarity around how the government re-allocates climate resilience funds across sectors and balances resources between mitigation and adaptation efforts. It has been noted that each sector operates with its own annual mandate and budget plan aligned to specific priorities. For instance, the energy sector's budget focuses on renewable energy initiatives, such as solar, hydro, and wind projects. These programs aim to reduce dependence on fossil fuels while promoting sustainable energy solutions. Similarly, the agriculture sector allocates its funds toward climate-smart practices, including sustainable farming techniques, soil conservation, and irrigation systems. In turn, the water sector prioritizes improved water management, infrastructure for water harvesting, and sanitation projects. While increased budget allocation underscores Zambia's commitment to addressing climate challenges, the national capacity to implement large-scale projects remains constrained. Debt repayment obligations and broader macroeconomic challenges continue to pose significant barriers, limiting the scope and impact of these efforts. It is apparent that the total climate-related funding allocated for 2024 falls far short of addressing the scale of the challenges Zambia faces. To address these issues, a recommendation has been made to increase the share of the national budget dedicated to climate resilience to at least 2%. Additionally, the need for greater transparency has been emphasized, especially in documenting private sector contributions to climate resilience. This would help track progress more effectively and ensure accountability.

4.4.2 Over-reliance on donor contributions

Development and cooperating partners are critical in supporting national climate mitigation efforts by providing grants, concessional loans, and technical assistance. A significant portion of climate-related projects relies on international donors and partnerships. This reliance highlights the need for increased domestic funding to ensure program sustainability. Historically, the major donors for climate change-related interventions have been the following:

Green Climate Fund (GCF), which supports projects like Zambia's Integrated Forest Landscape Project (ZIP), targeting deforestation and emissions reductions (GCF Zambia, 2019);

Global Environment Facility (GEF), which funds initiatives in biodiversity conservation, sustainable land management and climate change mitigation (GEF, 2023);

World Bank and African Development Bank (AfDB), both of which back projects such as strengthening climate resilience in the Pilot Programme for Climate Resilience (PPCR), which focuses on community adaptation (AFDB, 2019);

UNDP, which implements projects like SCRALA, which enhances smallholder farmers' resilience to climate impacts;

Bilateral donors, such as Germany, Norway and the UK, who fund renewable energy, water management, and forest conservation programs, including the UK-backed Climate Resilient Infrastructure Development Facility (CRIDF).

While donor financial support is critical, relying entirely on it poses significant threats. The problem is that donors' priorities may change, or they may experience delays in providing the funds necessary for project implementation. Additionally, accessing donor funding is typically preceded by a complex application process, which can also hinder progress and delay implementation. The domestic financial architecture is partially aligned with its national climate targets, which include supporting renewable energy, climate-smart agriculture, reforestation and other adaptation and mitigation interventions. However, some of the important areas identified in the NAP, such as urban climate resilience and water resource management, have not received sufficient funding over time. Limited government allocations also hinder the implementation of Zambia's NDCs, which aim to reduce emissions and enhance adaptive capacity. Whereas donor-supported projects, such as SCRALA-7, demonstrate alignment with important global and national policy goals, the available funding does not meet the scope of the transitions envisioned in these policy frameworks. Specifically, the financing for mitigating greenhouse gas emissions in the energy and transport sectors lacks sufficient financial backing, indicating the need for stronger financing mechanisms.

The SCRALA Project

The Strengthening Climate Resilience of Agricultural Livelihoods in Agro-Ecological Regions I and II (SCRALA) project in Zambia is a flagship initiative funded by the Green Climate Fund (GCF) and implemented by the UNDP in collaboration with the Zambia's Ministry of Agriculture. The SCRALA project received a substantial allocation of $137 million, with significant contributions from the GCF and international partners. These funds targeted interventions such as irrigation infrastructure, conservation agriculture training, and alternative livelihoods, including livestock and beekeeping, benefiting over 940,000 smallholder farmers directly (UNDP, 2021). The project funds were strategically allocated to high-impact areas, such as irrigation systems in drought-prone districts and capacity-building initiatives for farmers, ensuring optimal resource use. It fostered collaborations with local governments and community organisations, reducing administrative costs and expanding program outreach. Training programs in conservation agriculture and sustainable practices were conducted to equip farmers with skills and those who adopted climate-smart agricultural practices reported increased crop yields and better incomes. Conservation farming, for instance, boosted productivity with minimal added costs. Early warning systems and training on climate adaptation were used during the project to reduce vulnerability to droughts and other shocks hence fostering long-term economic resilience. These programs contributed to the project's sustainability, yielding benefits long after the project's active phase.

The project, which was composed of diversified livelihood programs, like the pass-on livestock mechanism, proved highly effective in enhancing income streams. Subsequently, participants used proceeds from animal husbandry to improve housing and other living conditions. The project's integrated approach lowered dependency on emergency aid, empowering communities to become self-sustaining and thus more cost-efficient over time. The project also experienced some challenges, including the bureaucratic delays given the scale of infrastructure projects which occasionally slowed timely fund disbursement. The limited Monitoring and Evaluation (M&E) systems made it difficult to measure the full economic and environmental benefits against the expenditures.

Overall, the SCRALA project exemplifies effective resource use and cost-efficiency through its well- targeted interventions, benefiting vulnerable communities and building resilience. However, scaling its impact and implementing stronger monitoring systems are essential ij seeking to fully maximize its economic and social benefits.

Box 4-1

4.4.3 Enhancing the role of the private sector

The private sector is increasingly stepping up, particularly in renewable energy and sustainable agriculture, to narrow the financing gaps through various means and instruments such as:

Public-private partnerships (PPPs) play a significant role in facilitating infrastructure development in Zambia, particularly in areas such as irrigation systems and clean energy solutions. A notable example is Zambia's Scaling Solar Initiative, implemented under the International Finance Corporation (IFC), which aims to expand solar energy capacity through private sector investment. In addition to PPPs, corporate initiatives are contributing to climate resilience, with companies like SNV and Simahala Incubator Farm Company adopting climate-resilient practices in agriculture and forestry. Independent Power Producers (IPPs) also play a crucial role by investing in solar and hydropower projects, supported by enabling policies such

are increasingly integrating sustainable practices, adopting climate-smart approaches, and funding conservation efforts to promote environmental sustainability and resilience to climate change.

Despite these efforts, the private sector's contribution to climate finance in Zambia is still low due to perceived investment risks, which deters broader involvement. Green bonds and PPPs show promise but are yet to be explored.

4.5 Policy Harmonization Challenges

Zambia continues to encounter several challenges in its efforts to achieve a proper alignment of policies with climate change resilience goals. One major issue is the existence of policy overlaps and gaps, particularly between Forestry and Agriculture Policies. Conflicts arise around land use priorities, where deforestation for agricultural expansion creates tension and policy inconsistencies. Similarly, there is a misalignment between Energy and Water policies, which negatively affects both hydropower development and the sustainability of water resources. Another challenge is weak cross-sectoral collaboration, as ministries and agencies often work in isolation, leading to fragmented implementation of climate-related initiatives. Additionally, there is a lack of effective stakeholder engagement platforms, which limits inclusive and participatory planning processes. Resource constraints, especially in terms of financial and human capital, further hinder the effective implementation and integration of climate policies. Finally, data and information gaps—particularly the absence of shared data systems across sectors—undermine evidence-based decision-making and obstruct coordinated planning efforts.

4.5.1 Areas that require policy action for improvement

In spite of the promise inherent in the climate policies highlighted in this chapter, several outstanding challenges remain that require collaborative action from all stakeholders. Coordinated policy responses are essential to effectively address these issues. One of the primary challenges is the persistent funding gap, which is exacerbated by limited domestic financing sources, leading to a heavy reliance on international donors. Additionally, policy implementation is often delayed due to coordination challenges, which hinder the timely execution of climate strategies. Inequality also poses a significant concern, as some rural and vulnerable populations are excluded from the benefits of large-scale renewable energy projects. Furthermore, infrastructure bottlenecks, particularly the insufficient grid infrastructure, continue to restrict the integration of renewable energy and impede efforts to expand rural electrification. Addressing these challenges requires a concerted and inclusive approach to ensure the successful realization of climate resilience goals.

4.6 Towards Improved Climate Action and Policy Effectiveness

The foregoing analysis highlights significant strides that have been made in aligning domestic climate change policies with intended objectives; including securing funding and executing impactful projects. However, there are many areas that still require improvement, particularly in cross-sectoral coordination and scalability. These include strengthening integrated and cross-sectoral planning; diversifying funding sources and exploring innovative funding mechanisms; regular review and audit of project and programme performance; upscaling implementation of successful projects and programmes; documentation, integration and preservation of proven successful indigenous knowledge systems; facilitation of knowledge sharing, and; capacity building of local communities for enhanced natural resource management and climate resilience.

Annexes

Annex 1: Human Development Indices -2024

Human Development Index (HDI) and its Components by Province - 2024

	Life Expectancy at birth (years)	Expected years of schooling (years)	Mean years of schooling (years)	Gross national income (GNI) per capita (2017	Life expectancy index	Education index	GNI index	Human development index (HDI) value
Zambia	56.9	14.3	7.2	4,097	0.568	0.637	0.561	0.588
Central	56.6	13.9	7.1	3,244	0.563	0.622	0.526	0.569
Copperbelt	55.4	17.2	8.8	5,809	0.545	0.771	0.614	0.636
Eastern	53.4	9.3	5.2	1,614	0.514	0.432	0.420	0.453
Luapula	52.9	12.1	6.1	2,007	0.506	0.538	0.453	0.498
Lusaka	57.5	19.0	9.1	6,165	0.577	0.803	0.623	0.661
Muchinga	59.3	10.7	5.8	1,396	0.605	0.489	0.398	0.490
Northern	59.2	10.9	5.7	1,683	0.603	0.492	0.426	0.502
North Western	59.6	17.8	7.1	9,244	0.609	0.732	0.684	0.673
Southern	61.6	14.2	7.3	3,004	0.640	0.638	0.514	0.594
Western	53.2	15.0	5.6	2,271	0.511	0.604	0.472	0.526

***Source**: Calculated based on the 2022 Census of Population and Housing; 2024 Zambia Demographic and Health Survey; Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023*

GDP is largely influenced by dominant sectors such as mining, agriculture, manufacturing, and tourism, with the mining sector often being the largest contributor. Since the Human Development Index (HDI) incorporates income often proxied by GDP, regions with strong economic performance in these sectors tend to show higher HDI values. Some regions with higher HDI could likely reflect the area's robust mining activity and its positive impact on income and overall human development.

Trends in Human Development Index by Province, 2008-2024

	2008	Rank	2010	Rank	2012	Rank	2014	Rank	2024	Rank
Zambia	0.514		0.524		0.547		0.551		0.588	
Central	0.464	5	0.457	5	0.495	5	0.501	5	0.569	5
Copperbelt	0.601	1	0.565	2	0.590	3	0.598	3	0.636	3
Eastern	0.374	7	0.372	7	0.392	7	0.398	7	0.453	10
Luapula	0.411	6	0.408	6	0.440	6	0.447	6	0.498	8
Lusaka	0.567	2	0.577	1	0.598	1	0.603	1	0.661	2
Muchinga			0.357	8	0.381	8	0.383	8	0.490	9
Northern	0.221	9	0.314	10	0.342	10	0.347	10	0.502	7
North Western	0.546	3	0.557	3	0.598	2	0.601	2	0.673	1
Southern	0.503	4	0.550	4	0.579	4	0.580	4	0.594	4
Western	0.302	8	0.315	9	0.344	9	0.353	9	0.526	6

***Source**: Calculated based on the 2022 Census of Population and Housing; 2024 Zambia Demographic and Health Survey; Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023*

Trends in Inequality-Adjusted Human Development Index, Zambia, 2008-2024

Year	Human Development Index (HDI) value	Inequality- Adjusted HDI	Loss due to inequality (%)	Coefficient of human inequality (%)
2006	0.511	0.335	34.4	28.6
2008	0.514	0.301	41.4	31.2
2010	0.524	0.374	28.5	24.6
2012	0.547	0.408	25.4	22.6
2014	0.551	0.411	25.4	22.6
2024	0.618	0.510	17.5	17.2

***Source**: Calculated based on the 2022 Census of Population and Housing; 2024 Zambia Demographic and Health Survey; Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023*

Gender Inequality Index -2024

Health		Empowerment				Labour Market		Gender Inequality Index
Maternal Mortality Ratio	Adolescent Birth Rate	Parliamentary Representation		Attainment of Secondary/Higher Education		Labour Market Participation Rate % ages 15 and older)		
Deaths per 100,000 live births	Births per 1,000 women ages 15-19	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	
187	118.0	14.0	86.0	35.5	54.8	31.0	47.3	0.566

***Source**: Calculated based on the 2022 Census of Population and Housing; 2024 Zambia Demographic and Health Survey; Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023*

Gender Development Index by Province, Zambia, 2024

Region	Sex	Life Expectancy	Expected Yrs of Schooling	Mean Yrs of Schooling	GNI per Capita (PPP$)	Life Exp Index	Education Index	GNI Index	HDI Value	GDI Value
Zambia	Female	59.5	15.0	6.3	3,063	0.569	0.627	0.517	0.569	0.942
	Male	54.5	13.5	8.3	5,152	0.569	0.651	0.595	0.604	
Central	Female	58.9	13.2	6.2	2,749	0.560	0.575	0.501	0.544	0.920
	Male	54.24	14.4	8.1	3,749	0.565	0.669	0.547	0.592	
Copperbelt	Female	57.5	16.7	7.9	3,678	0.538	0.727	0.545	0.597	0.897
	Male	53.45	17.1	9.9	7,954	0.553	0.807	0.661	0.666	
Eastern	Female	57.9	10.7	4.3	1,202	0.544	0.442	0.376	0.449	0.957
	Male	52.48	7.7	6.2	2,031	0.538	0.420	0.455	0.469	
Luapula	Female	55.8	11.6	5.1	1,729	0.512	0.492	0.431	0.477	0.913
	Male	50.03	12.8	7.4	2,296	0.500	0.602	0.473	0.523	
Lusaka	Female	59.8	19.3	8.3	4,965	0.573	0.775	0.590	0.640	0.939
	Male	55.28	18.6	10.1	7,396	0.581	0.838	0.650	0.682	
Muchinga	Female	62.9	10.3	4.6	1,069	0.622	0.439	0.358	0.461	0.974
	Male	55.82	11.3	3.1	1,734	0.590	0.417	0.431	0.473	
Northern	Female	62.2	10.7	4.5	1,239	0.611	0.448	0.380	0.470	0.895
	Male	56.3	10.5	7.0	2,135	0.597	0.526	0.462	0.526	
North-Western	Female	61.3	19.1	5.8	6,012	0.597	0.695	0.619	0.636	0.908
	Male	57.94	16.9	8.6	12,476	0.622	0.756	0.729	0.700	
Southern	Female	64.2	16.2	6.7	2,649	0.641	0.674	0.495	0.598	1.023
	Male	58.02	12.1	8.0	3,364	0.623	0.604	0.531	0.585	
Western	Female	50.2	17.6	5.1	1,606	0.426	0.659	0.419	0.490	0.885
	Male	56.38	12.3	6.3	2,981	0.598	0.553	0.513	0.553	

***Source**: Calculated based on the 2022 Census of Population and Housing; 2024 Zambia Demographic and Health Survey; Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023*

Annex 2: Technical Notes

Technical Note 1. Human Development Index

The Human Development Index (HDI) is a summary measure of achievements in three key dimensions of human development: a long and healthy life, access to knowledge, and a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. This technical note describes the data sources, steps to calculating the HDI, and the methodology used to estimate missing values.

Data sources

Life expectancy at birth: Population Projections based on 2010 census data), Maternal Mortality Rate and Adolescent Birth rate (2022 ZDHS)

Expected years of schooling: the Living Conditions Monitoring Survey (2022)

Mean years of schooling: Labour Force Survey Report 2023 Zambia Demographic Health Survey (2022)

GNI per capita: World Bank data (constant, 2017 International)

Steps to calculate the Human Development Index

Step 1. Creating the dimension indices

The health dimension is measured by life expectancy at birth, with a normalized value using a minimum of 20 years and a maximum of 85 years. The education dimension combines two indicators: expected years of schooling and mean years of schooling, both normalized (expected from 0 to 18 years and mean from 0 to 15 years), and then averaged to form the education dimension. The standard of living is assessed using Gross National Income (GNI) per capita, adjusted by a logarithmic transformation and normalized between $100 and $75,000. Finally, the HDI is computed as the geometric mean of the three dimensions (health, education, and income), offering a balanced assessment of development that reflects improvements across all areas.

Dimension	Indicator	Minimum	Maximum
Health	Life expectancy (years)	20	85
Education	Expected years of schooling (years)	0	18
	Mean years of schooling (years)	0	15
Standard of living	GNI per capita (2011 PPP$)	$100	$75,000

Having defined the minimum and maximum values, the dimension indices are calculated as:

$$\text{Dimension Index} = \frac{\textit{actual value-minimum value}}{\textit{maximum value-minimum value}}$$

Technical Note 2. Inequality-adjusted Human Development Index

The Inequality-adjusted Human Development Index (IHDI) adjusts the Human Development Index (HDI) for inequality in the distribution of each dimension across the population. It is based on a distribution- sensitive class of composite indices proposed by Foster, Lopez-Calva and Szekely (2005), which draws on the Atkinson (1970) family of inequality measures. It is computed as a geometric mean of inequality-adjusted dimensional indices.

The IHDI accounts for inequalities in HDI dimensions by "discounting" each dimension's average value according to its level of inequality. The IHDI equals the HDI when there is no inequality across people but falls below the HDI as inequality rises. In this sense, the IHDI measures the level of human development when inequality is accounted for.

Data Sources

Since the HDI relies on country-level aggregates such as national accounts for income, the IHDI must draw on additional sources of data to obtain insights into the distribution. The distributions are observed over different units—life expectancy is distributed across a hypothetical cohort, while years of schooling and income are distributed across individuals.

Inequality in the distribution of HDI dimensions is estimated for:

Life expectancy at birth: Population Projections based on 2010 census data), Maternal Mortality Rate and Adolescent Birth rate (2022 ZDHS)

Expected years of schooling: the Living Conditions Monitoring Survey (2022)

Mean years of schooling: Labour Force Survey Report 2023 Zambia Demographic Health Survey (2022)

Steps to calculate the Inequality-adjusted Human Development Index

There are three steps to calculating the IHDI:

Step 1. Estimating inequality in the dimensions of the Human Development Index

The IHDI draws on the Atkinson (1970) family of inequality measures and sets the aversion parameter ε equal to 1.1 In this case the inequality measure is A = 1– g/μ, where g is the geometric mean and μ is the arithmetic mean of the distribution. This can be written as:

$$A_x = 1 - \frac{\sqrt[n]{X_1 \dots x_n}}{\overline{X}}$$

where {X1, … , Xn} denotes the underlying distribution in the dimension of interest. Ax is obtained for each variable (life expectancy, mean years of schooling and disposable income or consumption per capita).

The geometric mean in equation 1 does not allow zero values. For mean years of schooling one year is added to all valid observations to compute the inequality. Income per capita outliers extremely high incomes as well as negative and zero incomes were dealt with by truncating the top 0.5 percentile of the distribution to reduce the influence of extremely high incomes and by replacing the negative and zero incomes with the minimum value of the bottom 0.5 percentile of the distribution of positive incomes. Sensitivity analysis of the IHDI is given in Kovacevic (2010).

Step 2. Adjusting the dimension indices for inequality

The inequality-adjusted dimension indices are obtained from the HDI dimension indices, I_x, by multiplying them by (1 – Ax), where Ax, defined by equation 1, is the corresponding Atkinson measure:

$$I^*_x = (1 - A_x) \cdot I_x$$

The inequality-adjusted income index, I^*_{income}, is based on the index of logged income values, I_{inc}* and inequality in income distribution computed using income in levels. This enables the IHDI to account for the full effect of income inequality.

Step 3. Combining the dimension indices to calculate the Inequality-adjusted Human Development Index

The IHDI is the geometric mean of the three-dimensional indices adjusted for inequality:

$$IHDI = (I_{Health} \cdot I_{Education} \cdot I_{Income})^{1/3} = \{(1-A_{Health}) \cdot (1-A_{Health}) \cdot (1-A_{Health})\}^{1/3} \cdot HDI$$

The loss in the Human Development Index due to inequality is:

$$Loss = 1 - \{(1-A_{Health}) \cdot (1-A_{Health}) \cdot (1-A_{Health})\}^{1/3}$$

Technical Note 3: Gender Inequality Index

The Gender Inequality Index (GII) reflects gender-based disadvantage in three dimensions reproductive health, empowerment and the labour market for as many countries as data of reasonable quality allow. It shows the loss in potential human development due to inequality between female and male achievements in these dimensions. It ranges between 0, where women and men fare equally, and 1, where one gender fares as poorly as possible in all measured dimensions.

The GII is computed using the association-sensitive inequality measure suggested by Seth (2009), which implies that the index is based on the general mean of general means of different orders the first aggregation is by a geometric mean across dimensions; these means, calculated separately for women and men, are then aggregated using a harmonic mean across genders.

Data Sources

Life expectancy at birth: Population Projections based on 2010 census data), Maternal Mortality Rate and Adolescent Birth rate (2022 ZDHS)

Expected years of schooling: the Living Conditions Monitoring Survey (2022)

Mean years of schooling: Labour Force Survey Report 2023 Zambia Demographic Health Survey (2022)

Estimated earned income: Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023

Steps to calculate the Gender Inequality Index

There are five steps to calculating the GII.

Step 1: Treating zeroes and extreme values

Because a geometric mean cannot be computed from zero values, a minimum value of 0.1 percent is set for all component indicators. Further, as higher maternal mortality suggests poorer maternal health, for the maternal mortality ratio the maximum value is truncated at 1,000 deaths per 100,000 births and the minimum value at 10. The rationale is that countries where maternal mortality ratios exceed 1,000 do not differ in their inability to create conditions and support for maternal health and that countries with 10 or fewer deaths per 100,000 births are performing at essentially the same level and that small differences are random. Sensitivity analysis of the GII is given in Gaye et al. (2010).

Step 2. Aggregating across dimensions within each gender group, using geometric means

Aggregating across dimensions for each gender group by the geometric mean makes the GII association- sensitive (see Seth 2009). For women and girls, the aggregation formula is:

$$G_F = \sqrt[3]{\left(\frac{10}{MMR}\ \frac{1}{ARF}\right)^{1/2} \cdot (PR_F \cdot SE_F)^{1/2} \cdot LFPR_F},$$

and for men and boys, the formula is

$$G_M = \sqrt[3]{1 \cdot (PR_M \cdot SE_M)^{1/2} \cdot LFPR_M}$$

The rescaling by 0.1 of the maternal mortality ratio in equation (1) is needed to account for the truncation of the maternal mortality ratio at 10.

Step 3: Aggregating across gender groups, using a harmonic mean

The female and male indices are aggregated by the harmonic mean to create the equally distributed gender index.

$$\text{HARM} = (G_F, G_M) = \left[\frac{(G_F)^{-1} + (G_M)^{-1}}{2}\right]^{-1}$$

Using the harmonic mean of within groups geometric means captures the inequality between women and men and adjusts for association between dimensions that is, it accounts for the overlapping inequalities in dimensions.

Health should not be interpreted as an average of corresponding female and male indices but rather as half the distance from the norms established for the reproductive health indicators fewer maternal deaths and fewer adolescent pregnancies.

Step 4. Calculating the geometric mean of the arithmetic means for each indicato

The reference standard for computing inequality is obtained by aggregating female and male indices using equal weights (thus treating the genders equally) and then aggregating the indices across dimensions:

$$G_{\overline{F,M}} = \sqrt[3]{\overline{Health} \cdot \overline{Empowerment} \cdot \overline{LFPR}}$$

where

$$\overline{Health} == \left(\sqrt{\frac{10}{MMR} \frac{1}{ARF}} + 1/ \right) 2, \quad \overline{Empowerment} \quad \sqrt{PR_F . SE_F} + \sqrt{PR_M . SE_M} /2, \text{ and}$$

Step 5. Calculating the Gender Inequality Index

Comparing the equally distributed gender index to the reference standard yields the GII,

$$1 — \frac{HARM\,(G_F, G_M)}{G_{\overline{F,M}}}$$

Technical Note 4: Gender Development Index

The Gender Development Index (GDI) measures gender inequalities in achievement in three basic dimensions of human development: health, measured by female and male life expectancy at birth; education, measured by female and male expected years of schooling for children and female and male mean years of schooling for adults aged 25 years and older; and command over economic resources, measured by female and male estimated earned income.

Data Sources

Life expectancy at birth: Population Projections based on 2010 census data), Maternal Mortality Rate and Adolescent Birth rate (2022 ZDHS)

Expected years of schooling: the Living Conditions Monitoring Survey (2022)

Mean years of schooling: Labour Force Survey Report 2023 Zambia Demographic Health Survey (2022)

Estimated earned income: Living Conditions Monitoring Survey 2022; and the Labour Force Survey Report 2023

Steps to calculate the Gender Development Index

There are four steps to calculating the GDI.

Step 1: Estimating the female and male earned incomes

To calculate estimated incomes, the share of the wage bill is calculated for each gender. The female share of the wage bill (Sf) is calculated as follows:

$$S_f = \frac{W_f/W_m \,.\, EA_f}{\frac{W_f \,.}{EA_m} EA_f + EA_m}$$

where *Wf/Wm* is the ratio of female to male wage, EA_f and EA_m are respective female and male share of the economically active population.

The male share of the wage bill is calculated as:

$$S_m = 1 - S_f$$

Estimated female earned income per capita $(GNI_{pc}f)$ is obtained from GNI per capita (GNI_{pc}), first by multiplying it by the female share of the wage bill, S_f, and then rescaling it by the female share of the population, $P_f = N_f/N$:

$$GNI_{pc,f} = GNI_{pc} \,.\, S_f / P_f$$

Estimated male earned income per capita is obtained in the same way:

$$GNI_{pc,f} = GNI_{pc} \,.\, S_m / P_m$$

where $P_m = 1 - P_f$ is the male share of population

Steps to calculate the Gender Development Index

There are four steps to calculating the GDI.

Step 2: Normalizing the indicators

To construct the female and male HDI values, first the indicators, which are in different units are transformed into indices and then dimension indices for each sex are aggregated by taking the geometric mean.

The indicators are transformed into a scale of 0 to 1 using the same goalposts as for the HDI, except life expectancy at birth, which is adjusted for the average of five years biological advantage that women have over men.

Goalposts for the Gender Development Index in this Report

Indicator	Minimum	Maximum
Expected years of schooling (years)	0	18
Mean years of schooling (years)	0	15
Estimated earned income (2011 PPP$)	100	75,000
Life expectancy at birth (years)		
Female	22.5	87.5
Male	17.5	82.5

***Note**: For rationale on choice of minimum and maximum values, see Technical note 1.*

Having defined the minimum and maximum values, the subindices are calculated as follows:

$$\text{Dimension Index} = \frac{\text{actual value-minimum value}}{\text{maximum value-minimum value}}$$

For education, the dimension index is first obtained for each of the two subcomponents, and then the unweighted arithmetic mean of the two resulting indices is taken.

Step 3: Calculating the female and male Human Development Index values

The female and male HDI values are the geometric means of the three dimensional indices for each gender:

$$HDI_f = (I_{Health_f} \cdot I_{Education_f} \cdot I_{Income_f})^{1/3}$$

$$HDI_m = (I_{Health_m} \cdot I_{Education_m} \cdot I_{Income_m})^{1/3}$$

Step 4: Calculating the Gender Development Index Normalizing the indicators

The GDI is simply the ratio of female HDI to male HDI:

$$GDI = \frac{HDI_f}{HDI_m}$$

References

2022 living conditions monitoring survey report

2023 LABOUR FORCE SURVEY (LFS)

AFDB. (2019, July 16). Zambia and the AfDB [Text]. African Development Bank Group; African Development Bank Group. https://www.afdb.org/en/countries/southern-africa/zambia/zambia-and-the-afdb

African Center for Biodiversity. (2024, July 18). Is Zambia's Food System Collapsing? African Centre for Biodiversity. https://acbio.org.za/corporate-expansion/is-zambias-food-system-collapsing/

Baumann, F. (2021). The Next Frontier—Human Development and the Anthropocene: UNDP Human Development Report 2020. Environment: Science and Policy for Sustainable Development, 63(3), 34–40. https://doi.org/10.1080/00139157.2021.1898908

Carioli, A., Schiavina, M., Melchiorri, M., & Kemper, T. (2024). GHSL Country Statistics by Degree of Urbanization. JRC Publications Repository. https://doi.org/10.2760/0075418

CBD, B. (2016, May 13). Text of the Convention. Secretariat of the Convention on Biological Diversity. https://www.cbd.int/convention/text

ERB. (2023). Energy Regulation Board Zambia, 2023. Energy Regulation Board Annual Report

Foster, J.L., Lopez-Calva, and M. Szekely. 2005. Measuring the distribution of Human Development: Methodology and an application in Mexico. Journal of Human Development and Capabilities. 6(1):5-25

GCF Zambia. (2019, June 10). Zambia [Text]. Green Climate Fund; Green Climate Fund. https://www.greenclimate.fund/countries/zambia

GEF. (2023, June 29). Zambia. Global Environment Facility. https://www.thegef.org/projects-operations/country-profiles/zambia

Haq, K. (2008). Amartya Sen and Mahbub ul Haq: A Friendship that Continues beyond Life. Journal of Human Development, 9(3), 329–330. https://doi.org/10.1080/14649880802236524

Gaye, A., J. Klugman, M. Kovacevic, S. Twigg, and E. Zambrano. 2010. Measuring key disparities in human development: The gender inequality index. Human Development Research Paper. UNDP-HDRO, New York http://hdr.undp.org/sites/default/files/hdrp_2010_46.pdf

Goodman, S., & Baudu, P. (2023). Climate change as a "threat multiplier": History, uses and future of the concept. Center for Climate and Security, 38. https://councilonstrategicrisks.org/wp-content/uploads/2023/01/38-CCThreatMultiplier.pdf

Haq, K. (2008). Amartya Sen and Mahbub ul Haq: A Friendship that Continues beyond Life. Journal of Human Development, 9(3), 329–330. https://doi.org/10.1080/14649880802236524

Matandirotya, N. R., & Burger, R. P. (2022). The Nexus Between Biomass Burning, Black Carbon Air Pollution and Planetary Health in Africa. In W. Leal Filho (Ed.), Handbook of Human and Planetary Health (pp. 335–348). Springer International Publishing. https://doi.org/10.1007/978-3-031-09879-6_19

Muñoz-Sabater, J., Dutra, E., Agustí-Panareda, A., Albergel, C., Arduini, G., Balsamo, G., Boussetta, S., Choulga, M., Harrigan, S., & Hersbach, H. (2021). ERA5-Land: A state-of-the-art global reanalysis dataset for land applications. Earth System Science Data, 13(9), 4349–4383.

Nanja, D. H. (2017). Indigenous knowledge in weather and seasonal rainfall prediction in Zambia. Indigenous Knowledge Systems and Climate Change Management in Africa, 295.

Republic of Zambia. (2006). Zambia's Vision 2030. https://www.mofnp.gov.zm/?wpdmpro=the-vision-2030

Republic of Zambia. (2010). National Climate Change Response Strategy. https://www4.unfccc.int/sites/NAPC/Documents/Zambia%20Climate%20Change%20Response%20Strategy.pdf

Republic of Zambia. (2014). Zambia, Ministry of Lands, Natural Resources and Environmental Protection. 2014. Second National Communication to the United Nations Framework Convention on Climate Change 2000–2004. Lusaka. https://unfccc.int/sites/default/files/resource/zmbnc2.pdf

Republic of Zambia. (2016). National Policy on Climate Change—Climate Change Laws of the World. https://climate-laws.org/documents/national-policy-on-climate-change_c348

Republic of Zambia. (2020). Third National Communication to United Nations Framework Convention on Climate Change. Lusaka. https://unfccc.int/sites/default/files/resource/Third%20National%20Communication%20-%20Zambia.pdf

Republic of Zambia. (2021). Zambia's 2021 Nationally Determined Contribution (NDC) framework. https://unfccc.int/sites/default/files/NDC/2022-06/Final%20Zambia_Revised%20and%20Updated_NDC_2021_.pdf

Republic of Zambia. (2022a). Eighth National Development Plan (8NDP) 2022-2026 | Embassy of the Republic of Zambia in Washington, D.C. https://zambiaembassy.org/document/eighth-national-development-plan-8ndp-2022-2026

Republic of Zambia. (2022b). Zambia Renewable Energy Strategy And Action Plan. https://www.moe.gov.zm/irp/?wpdmpro=zambia-renewable-energy-strategy-and-action-plan-rar

Republic of Zambia. (2022c). Zambia's Biennial Update Report. https://unfccc.int/documents/267111

Republic of Zambia. (2023). The national adaptation programme of action (NAPA) by Zambia. Ministry of Tourism, Environment, and Natural Resources | Open Library. https://openlibrary.org/books/OL24034440M/The_national_adaptation_programme_of_action_(NAPA)

Republic of Zambia. (2024). Zambias national Green Growth Strategy (GGS 2024-2030). https://www.cabinet.gov.zm/newsite/wp-content/uploads/2024/04/2NATIONAL-GREEN-GROWTH-STRATEGY-2024-2030-6.pdf#:~:text=In%20this%20regard%2C%20the%20National%20Green%20Growth%20Strategy,efficient%2C%20resilient%20and%20socially%20inclusive%20economy%20by%202030.

Ridder, N. N., Ukkola, A. M., Pitman, A. J., & Perkins-Kirkpatrick, S. E. (2022). Increased occurrence of high impact compound events under climate change. Npj Climate and Atmospheric Science, 5(1), 3.

Sanchez, R. G., Kougias, I., Moner-Girona, M., Fahl, F., & Jäger-Waldau, A. (2021). Assessment of floating solar photovoltaics potential in existing hydropower reservoirs in Africa. Renewable Energy, 169, 687–699.

SIPRI. (2022). Environment of Peace: Security in a New Era of Risk. SIPRI. https://www.sipri.org/publications/2022/policy-reports/environment-peace-security-new-era-risk

Stanton, E. A. (2007). The Human Development Index: A History. https://hdl.handle.net/20.500.14394/40243

The CNA Coperation. (2007). National Security and the Threat of Climate Change. https://www.cna.org/reports/2007/national-security-and-the-threat-of-climate-change

Thrasher, B., Wang, W., Michaelis, A., Melton, F., Lee, T., & Nemani, R. (2022). NASA global daily downscaled projections, CMIP6. Scientific Data, 9(1), 262.

UNDP. (2001). Zambia human development report, 1999/2000: Employment and sustainable livelihood. https://digitallibrary.un.org/record/458045

UNFCCC. (2011). UNFCCC : Cancun Agreements: Adaptation. https://unfccc.int/tools/cancun/adaptation/index.html

UNFCCC. (2015). The Paris Agreement | UNFCCC. https://unfccc.int/process-and-meetings/the-paris-agreement

United Nations. (1997). General Human Development Report Zambia—1997. In Human Development Reports. United Nations. https://hdr.undp.org/content/general-human-development-report-zambia-1997

United Nations. (1998). Human Development Report 1998. In Human Development Reports. United Nations. https://hdr.undp.org/content/human-development-report-1998

United Nations. (2003). The Reduction of Poverty and Hunger in Zambia: An Agenda for Enhancing the Achievement of the Millennium Development Goals. In Human Development Reports. United Nations. https://hdr.undp.org/content/reduction-poverty-and-hunger-zambia-agenda-enhancing-achievement-millennium-development

United Nations. (2007). 2007 Zambia human development report: Enhancing household capacity to respond to HIV and AIDS: youth-friendly version. United Nations Development Programme. https://openlibrary.org/books/OL20638197M/2007_Zambia_human_development_report

United Nations. (2011). Service Delivery for Sustainable Human Development. In Human Development Reports. United Nations. https://hdr.undp.org/content/service-delivery-sustainable-human-development

United Nations. (2015). Sendai Framework for Disaster Risk Reduction 2015—2030.

United Nations. (2016). National Human Development Report: Zambia. In Human Development Reports. United Nations. https://hdr.undp.org/content/national-human-development-report-zambia

United Nations. (2019). Climate change recognized as 'threat multiplier', UN Security Council debates its impact on peace | UN News. https://news.un.org/en/story/2019/01/1031322

University of Notre Dame. (2025). Rankings // Notre Dame Global Adaptation Initiative // University of Notre Dame. Notre Dame Global Adaptation Initiative. https://gain.nd.edu/our-work/country-index/rankings/

Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: The standardized precipitation evapotranspiration index. Journal of Climate, 23(7), 1696–1718.

WMO. (2025). World Meteorological Day 2025. World Meteorological Organization. https://wmo.int/site/world-meteorological-day-2025

Zambia Demographic and Health Survey (2024), Zambia Statistics Agency *Demographic and Health Survey Report*

ZAMSTAT. (2023). ZAMSTAT, 2023 (244). zamstats.gov.zm

ZIPAR. (2024). 2024 – Zambia Institute for Policy Analysis and Research. https://www.zipar.org.zm/2024/

United Nations Development Programme
United Nations House, Alick Nkhata Rd
Longacres, Lusaka

undp.org/zambia/publications/NHDR-2025