The cost to Africa

drastic economic damage from climate change

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christian aid

Contents

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1. Executive summary

African countries are set to lose out on realising potential economic growth due to the growing impacts of climate change across the continent. As a continent, Africa accounts for a negligible proportion of global historic carbon emissions; yet to develop many of its people need to consume more energy as they increase their income and overcome poverty. Yet this will happen too slowly for many and not at all for some as climate change directly affects lives and livelihoods, including by reducing the economic growth of countries across the continent in years and decades to come.

As world leaders meet in Sharm el-Sheikh, Egypt for COP27, it is imperative that negotiators including government leaders recognise that climate change is already causing Loss and Damage as limits to adaptation are surpassed, and the terrible inequity of those most often on the frontlines of these climate impacts being both those who bear the least responsibility for causing climate change and those who lackthe means to deal with the impacts due to low incomes, unsustainable debt, limited assets and lack of effective public services. Much more ambitious climate finance is needed to address climate impacts across adaptation and Loss and Damage. And rich, polluting countries – not only the historic polluters but including more recent carbon contributors such as high income Gulf countries and middle income countries like India and China must drastically cut their carbon emissions to prevent run-away climate change which would bring exponentially higher levels of climate impacts affecting more people more quickly than what we are witnessing across the world now.

This report highlights the major economic impacts of climate change on 50 of the 54 countries across Africa, covering over 99 per cent of the continent's economy.[1] Our data analysis uses an internationally recognised methodology[2] to assess how far different levels of global warming are likely to reduce economic growth rates of countries (see Appendix 2 for more details). The shocking estimates reveal that all of these low and lower-middle income countries face massive cuts to their economic growth rates because of climate change in the years and decades to come. These growth rates are already under huge short-term pressure due to the impacts of Covid, deepening debt crises, rising dollar interest rates and austerity becoming a condition of more donor funding, including more loans. Even if governments across the world live up to the commitment made in 2015 at the Paris COP23 to limit global heating to 1.5C above pre-industrial levels, the average hit to GDP per capita across African countries will be 14% up to 2050, growing to 34% by the end of the century. But even these substantial reductions are dwarfed by the impact of current climate policies – which are likely to see global heating reach average temperatures around 2.7C higher than pre-industrial times – which would lead to a 20% reduction in economic growth rates by 2050 and a huge 64% on average by 2100.

Our data draws on the methodology used in a 2019 study by Diffenbaugh and Burke,[3] which showed that GDP per capita is 13.6% lower across Africa than it would have been without warming from 1991-2010. In its comprehensive report on economic losses due to climate change, the Vulnerable Group of 20 countries cites the work of Baarsch et al which estimated that African countries have experienced losses ranging from -15 to -10 percent of their GDP per capita growth, which depending on the growth baseline amount to 5 to 15 percent reduction in GDP over a 30-year period starting in 1986.[4] Were countries in the Horn of Africa richer now than they are, it is likely that far fewer people would be facing severe hunger, and that governments in the region could afford more support to those in crisis,[5] rather than having to make invidious choices about whether to pay off burdensome debts or tackle shorter term crises such as hunger , or longer-term ones including climate change.

COP27 presents an opportunity for richer countries to demonstrate they can make up for lost GDP and time by committing and delivering as a start the $100bn a year from 2020-2025 target initially agreed over a decade ago and extended to 2025 in the Paris Agreement – retrospectively making up shortfalls to the target. Investing more in mitigation now will reduce the costs of adaptation and eventually reduce claims from countries experiencing Loss and Damage. But even with increased financing for mitigation and adaptation, COP27 negotiators from rich, polluting countries need to accept that new, ambitious, additional and need based funding is required to address Loss and Damage since climate change is already creating impacts that cannot be prevented through adaptation. A disproportionate number of those experiencing Loss and damage live in African countries. They are experiencing extreme weather events which span cyclones, flooding and drought, and slow onset events such as desertification and sea level rise. The continuing economic impacts of climate change will create a negative feedback loop whereby climate impacts lower future economic growth rates - slowing poverty reduction - meaning climate impacts will hit more people more significantly in future. It is already beyond the time for agreement on how polluting countries should pay to address climate impacts, the negotiations need to move on to questions of how much and when.

Recommendations

Our data and analysis underscore the need for action to avert, minimise and address Loss and Damage since we can see the greater and hugely unequal impacts on economic growth in low and lower-middle income countries across the African continent.

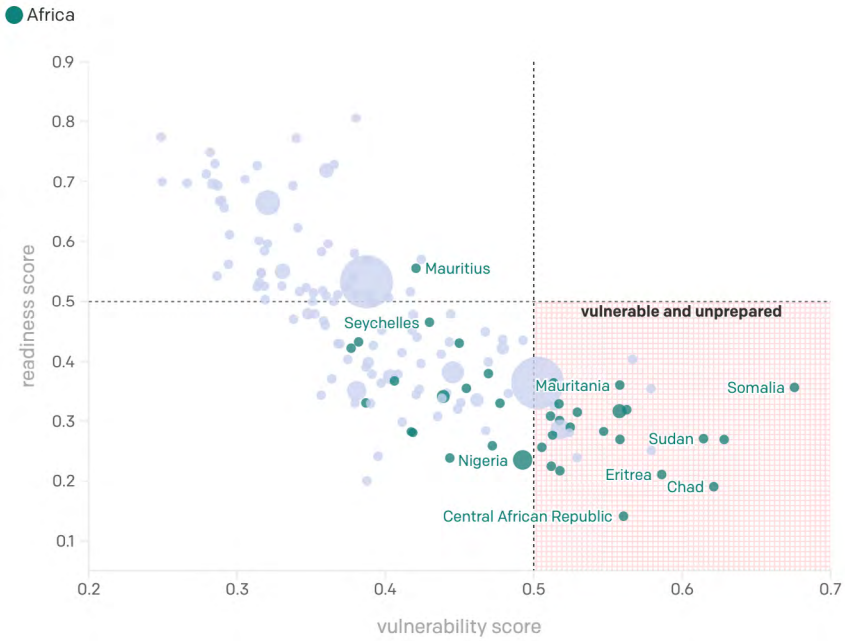
- Countries need to focus on averting, minimising and addressing Loss and Damage. Negotiators at COP27 need to build political will to enable the breakthroughs to address key issues at COP27.
- Avert – Parties must take action in this decade to close emissions reduction gaps to stay within Paris limits 1.5C to prevent escalating Loss and Damage.
- Minimise – Parties should redouble efforts for climate finance to flow to countries most vulnerable to climate change to withstand existing and future climate shocks and risks. This includes fragile and conflict affected countries, not least the Sahel region. The existing adaptation funding gap needs to be closed.
- Address – Parties should address the finance gap to address Loss and Damage, drawing on principles to put in place new and additional funding for Loss and Damage such as a Loss and Damage Finance Facility to respond to the needs of those affected by Loss and Damage.
- Loss and Damage should be a permanent agenda item at COPs and at meetings of subsidiary bodies so that Loss and Damage can be tracked and addressed.
- A COP decision should establish how the Santiago Network on Loss and Damage is to be operationalised to catalyse reliable action and support to countries and communities most at risk of Loss and Damage.

2. Loss and Damage at COP27

It is fitting that COP27 is hosted by an African government. Africa's collective responsibility for creating climate change is much smaller than almost all other continents – yet it hosts around 1 in 6 people in the world, and contributes on an annual basis around only 1 in 20 of global emissions.[6] At the same time, many African countries are disproportionately vulnerable to the growing climate change impacts wrought by global heating. ONE's data show that the ten most vulnerable countries, home to a combined 125 million people, are all in Africa. It is highly probable that increasing numbers of people from African countries will be affected by climate change impacts since most countries across the continent are not 'ready' to deal with impacts from rapid weather events to slow-onset crises. This deficit of 'readiness' is to a large extent determined by scarce economic resources available to adapt to climate change, and support people who are already being affected.

Climate change vulnerability and readiness

African countries are particularly susceptible to climate change. The world's 10 most climate vulnerable countries are in Africa, accounting for over 150 million people. Most African countries are also unprepared to tackle the impacts of climate change.



Source: Notre Dame Global Adaptation Initiative (ND-GAIN)
This chart shows country climate vulnerability index scores against readiness index scores. Dots are sized by population. Index values vary from 0 - 1; higher values indicate higher vulnerability or readiness.

Source: Data Dive: How Africa can help drive global climate change solutions - ONE Data & Analysis

Country Index // Notre Dame Global Adaptation Initiative // University of Notre Dame

The human impacts of Cyclone Ana in Malawi

Malawi is highly vulnerable to the impacts of climate change. Its economy is dependent on climate sensitive sectors such as agriculture, water, tourism, wildlife, and energy. Increased frequency and severity of extreme weather events which include floods and droughts have greatly increased climate risks.

Despite decent economic growth in recent years, Malawi remains a low income country. Most Malawians cannot afford to invest in adapting to the changing climate; neither does the government have sufficient resources to reduce the increased risks associated with rapid population growth and urbanization. The impacts of climate change have eroded development gains which had been realised, driving vulnerable populations back into poverty. Over the past five decades, Malawi has experienced more than 19 major floods and 7 droughts, with these events increasing in frequency and severity over the years. In late January 2022,

Tropical Storm Ana[7] caused heavy flooding in several districts, especially in the Southern Region, due to a lot of heavy rainfall and strong winds. Sixteen districts and two cities were impacted, affecting a population of 995,072. Those affected included 32,935 households of 190,429 people who were displaced and sheltering in IDP sites as a result. Widespread Loss and Damage were experienced, with close to a million people affected by the destruction of property and crops during the storm. These disastrous events have had a significant impact on people's lives, livelihoods, and on infrastructure. Cyclone Ana was found to have been made significantly more likely because of climate change, with heavier rainfalls than would be expected even for a similar event.[8] As the World Bank notes 'Malawi's pathway to economic growth is persistently halted by climate shocks, leaving many millions trapped in poverty for many decades.'[9]

'Our family was one of the affected families because of Cyclone Ana. Because of overcrowding, life was very tough at the evacuation camp. Women and children were separated from men and boys, which affected our marriage rights. This affected family and cultural values.'

Bijana Tenesani
26 years old, Mwandikoya village,
Nsanje district in the southern part of Malawi

The small business Bilana's family was running was completely destroyed, wrecking their livelihoods. To avoid future Loss and Damage from flooding the family has moved to higher land where they are constructing a new home. 'We have completely moved out from the place where the house collapsed due to Cyclone Ana.'

These economic and non-economic losses and damages in the affected areas have pushed many people further into poverty and food insecurity. Cyclone Ana worsened the already dwindling livelihoods of the people of Chikwawa, who have faced multiple years of climate related disasters, including erratic rainfall, floods, and drought, resulting in deepened poverty and a prolonged dependence on humanitarian assistance. Losses and damage include deaths, collapsed houses, destroyed infrastructure such as roads, bridges, schools and health centres and lost crops and livestock for many households. Over the long-term, the extreme weather shock has reduced resilience and has exacerbated poverty through impacts such as reduced agricultural productivity leading to food and nutrition insecurity, low-income and limited surpluses for sale, and increased food prices. It has also eroded gains from investments made through previous development programmes. Furthermore, those affected have depleted already limited assets. The destruction of agricultural farms by the cyclone resulted in limited employment for agricultural labour, which serves as a source of livelihood for many households.

Despite many years of resilience work and emergency response being undertaken by agencies such as Christian Aid and other external agencies to alleviate the immediate humanitarian needs of the communities, there has not yet been the investment needed to address the identified wide-ranging economic and non-economic Loss and Damage.

Bijana, her family and community continue to experience the Loss and Damage impacts long after Storm Ana. Road networks in the region have been extensively damaged, cutting off access between the district and the rest of the country. This has affected the district economically as most businesses have struggled to restock their shops and get supplies. The district did not have electricity for almost two months resulting in essential services such as health providers finding it difficult to operate.

Horn of African drought

The impacts of climate change are being witnessed in different African countries in multiple ways. Rapid onset events are more frequent and acute in many parts of Africa, affecting more people and leading to greater economic losses. Slow onset events can be harder to identify but can also be acute and affect many people. The current hunger crisis in the Horn of Africa is driven in large part by five consecutive failed rainy seasons across much of the region, a climatic event not seen in the last forty years, the UN notes.[10]

Impact of drought in northern Kenya

The Horn of Africa is experiencing the worst drought in 40 years. Communities are experiencing catastrophic impacts of four, heading into the fifth, lost rainy season in the past two and a half years.[11] The March-May 2022 rainy season was the driest on record in the last 70 years—making the 2020-2022 dry spell surpass the horrific droughts in both 2010-2011 and 2016-2017 in duration and severity.[12] Over 36 million people have now been affected by the drought which began in October 2020, including more than 24 million in Ethiopia, almost 8 million in Somalia and more than 4 million in Kenya.[13] At least 21 million people are already waking each day to high levels of acute food insecurity and rising malnutrition across Ethiopia, Kenya and Somalia, and this figure could increase to between 23 and 26 million by February 2023.[14]

'We are badly affected by the drought, it has gotten worse. We have no meat or milk to sell. We can't water our vegetables because there is not enough water. The weather has changed over the last 10 years. Now we have prolonged drought, there have been no rains for the last 4-5 seasons and we are losing a lot of animals.

No one has cattle anymore. And this area was also invaded by locusts last year too.'

The Loss and Damage is on an enormous scale, both economic and non-economic. The economic losses include almost 9 million livestock—which pastoralist families rely upon for sustenance and livelihoods—dead across the region.[15] More than 16 million people cannot access enough water for drinking, cooking and cleaning across the Horn of Africa, including 8 million in Ethiopia, almost 4 million in Somalia and 4 million in Kenya, according to UNICEF.[16] Many water points have dried up or diminished in quality, heightening the risk of water-borne diseases and increasing the risk of skin and eye infections as families are forced to ration their water use and prioritise drinking and cooking over hygiene.

Due to the scale of economic losses, families are taking desperate measures to survive, with over 1.3 million people across the region abandoning their homes in search of food, water and pasture for livestock, triggering further displacement in the region.[17] Women and girls are most affected, for example, because girls tend to be the first to be forced out of school. When food is scarce, they eat last and least. Women and girls are having to walk longer distances to access water, increasing potential exposure to gender-based violence. In Kenya, women report having to walk three times further for water. In Ethiopia and Kenya, child marriage has skyrocketed, increasing by 199% and 98%.[18]

3. Projecting economic growth losses from climate impacts

Impacts of climate change on economic performance (here measured by country-level GDP per capita) were estimated using a two-step modelling procedure proposed by Burke et al. (2015, 2018). The first step estimates a historical relationship between GDP growth and climatic variables, and in the second step this relationship is extended to different temperature pathways over the 21st century to estimate how GDP growth might be affected by climate change (See Appendix 2 for a full methodology). Our estimates are modelled projections which naturally have some limitations. The data assume countries undertake no adaptation, so adaptation where this happens, we would expect a reduction in the economic damage estimates; however, neither do the data predict the impacts of individual extreme events of which we are seeing an increasing number with more acute events and corresponding impacts happening in different African countries in recent years. Recent research shows that extreme weather events are already reducing economic growth in many countries, and that lower income countries tend to experience greater reductions in GDP, widening global inequalities.[19] Therefore, even our drastic projections could be an underestimate given the impact of more frequent and acute weather events which themselves are likely driven at least partly by climate change.

The boxplots shown in Figure 1 capture the range of impacts on GDP for 50 out of 54 countries in the African continent. Countries vary in terms of the effects of climate change on their national GDP per capita, but are all negatively affected, even if in the temperature pathway compatible with the limits set by the Paris Agreement, with a median of -14% in a 1.5°C scenario, -17% in a 2°C scenario and -20% on a "current policy" scenario in 2050. The effect of limiting the GMT increase to the goals of the Paris Agreement becomes more pronounced at the end of the century where the median damage on the current policy pathway is 65% vs 34% in 1.5°C pathway, implying that damages can be almost halved in a 1.5°C world, though they remain drastic.

There are eight countries (Sudan, Mauritania, Mali, Niger, Burkina Faso, Chad, Djibouti and Nigeria) which each face the prospect of seeing their economic growth reduced by at least 25% by 2050 if climate change impacts eventuate in line with current policies – which are likely to see around 2.7C of warming. The combined population of these eight countries is around 336 million people, or one in four of all people living across the African continent. All eight countries are either low income or lower-middle income countries according to the World Bank's classification.[20] This means that the average income per person in these countries is under $4,255 a year. Six of these eight countries predicted to experience the most severe economic growth impacts from climate change are in the Sahel region (Mauritania, Mali, Niger, Burkina Faso, Chad and Nigeria) with Sudan and Djibouti further east on a similar latitude.

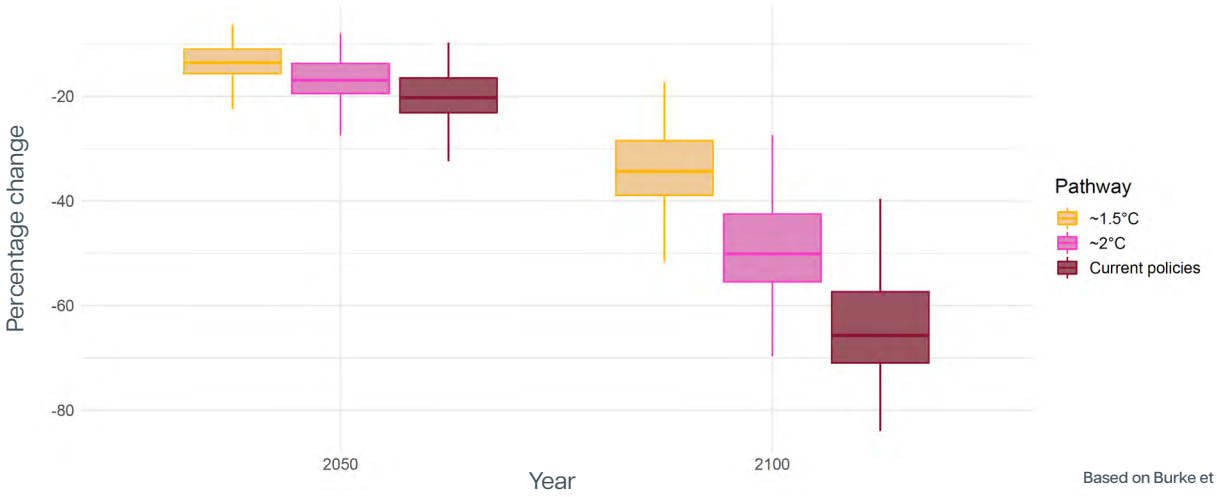
Country	Year	Scenario	GDP change	C02 per capita 2020
Sudan	2050	~1.5°C	-22.38	0.43
Sudan	2050	~2°C	-27.45	
Sudan	2050	Current policies	-32.39	
Sudan	2100	~1.5°C	-51.58	
Sudan	2100	~2°C	-69.65	
Sudan	2100	Current policies	-83.95	
Mauritania	2050	~1.5°C	-22.25	0.73
Mauritania	2050	~2°C	-27.29	
Mauritania	2050	Current policies	-32.22	
Mauritania	2100	~1.5°C	-51.45	
Mauritania	2100	~2°C	-69.54	
Mauritania	2100	Current policies	-83.84	
Mali	2050	~1.5°C	-22.10	0.17
Mali	2050	~2°C	-27.12	
Mali	2050	Current policies	-32.01	
Mali	2100	~1.5°C	-51.12	
Mali	2100	~2°C	-69.18	
Mali	2100	Current policies	-83.57	

Country	Year	Scenario	GDP change	C02 per capita 2020
Niger	2050	~1.5°C	-22.00	0.7
Niger	2050	~2°C	-27.01	
Niger	2050	Current policies	-31.89	
Niger	2100	~1.5°C	-50.66	
Niger	2100	~2°C	-68.72	
Niger	2100	Current policies	-83.12	
Burkina Faso	2050	~1.5°C	-21.03	0.19
Burkina Faso	2050	~2°C	-25.85	
Burkina Faso	2050	Current policies	-30.58	
Burkina Faso	2100	~1.5°C	-49.17	
Burkina Faso	2100	~2°C	-67.16	
Burkina Faso	2100	Current policies	-81.82	
Chad	2050	~1.5°C	-20.65	0.06
Chad	2050	~2°C	-25.39	
Chad	2050	Current policies	-30.04	
Chad	2100	~1.5°C	-48.41	
Chad	2100	~2°C	-66.27	
Chad	2100	Current policies	-81.07	
Djibouti	2050	~1.5°C	-19.03	0.36
Djibouti	2050	~2°C	-23.45	
Djibouti	2050	Current policies	-27.81	
Djibouti	2100	~1.5°C	-45.65	
Djibouti	2100	~2°C	-63.25	
Djibouti	2100	Current policies	-78.33	
Nigeria	2050	~1.5°C	-17.64	0.61
Nigeria	2050	~2°C	-21.78	
Nigeria	2050	Current policies	-25.88	
Nigeria	2100	~1.5°C	-42.63	
Nigeria	2100	~2°C	-59.83	
Nigeria	2100	Current policies	-75.26	

The countries expected to endure the most severe economic impacts of climate change in Africa are already dealing with extremely difficult weather and climate conditions. Much of the Sahel region is desert, with opportunities for agricultural livelihoods more restricted than in many other parts of the continent. It is notable that most of these countries are also contributing less than the already very low greenhouse gas emissions for Africa as a whole. Whilst the continental average is around 1 tonne of CO2 per person per year, the annual individual average is lower in these eight countries (Chad 0.06; Niger 0.07, Mali 0.17, Burkina Faso 0.19, Guinea 0.26, Djibouti 0.36, Nigeria 0.71, Mauritania 0.73). [21]

Yet despite their need for faster economic growth to help overcome income poverty, the vulnerability to further climate change impacts and the lack of contribution to overall emissions these countries are not being sufficiently supported to adapt to climate change or deal with its lasting effects. Rich, polluting countries have failed to provide even the inadequate $100bn a year of climate finance promised annually for 2020-2025. Looking at available data for how much low and lower-middle income countries receive in climate finance, the amounts of the biggest fund. the Green Climate Fund (GCF) – accounting for over half of reported climate finance – shows that the eight countries due to be most affected by climate change are receiving only a few dollars per person from this fund. Djibouti is somewhat of an outlier, receiving around $23 per person from the GCF, with the next most per person going to Mauritania at just over $10 each. Most countries have received only a few dollars per person, with Sudan not even receiving $1 per person from the GCF.[22] Sudan is the country projected to be worst hit economically by climate change impacts yet is receiving even less than other countries in Africa to deal with climate change.

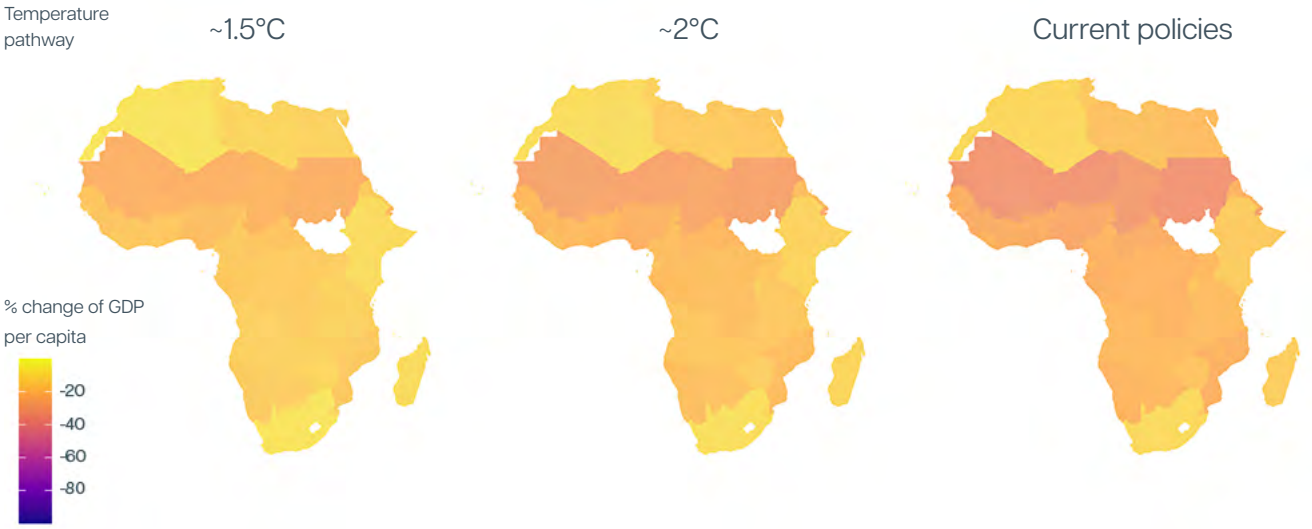
Impact of climate change on GDP per capita for countries in the African continent



Based on Burke et al. (2015, 2018).

Figure 1: Boxplots of economic damages expressed as a decrease in GDP per capita for 50 countries in the African continent, in three scenarios of global mean temperature increase. The lower and upper hinges correspond to the first and third quartiles (the 25th and 75th percentiles). The upper whisker extends from the hinge to the highest value that is within 1.5 * interquartile range of the hinge.

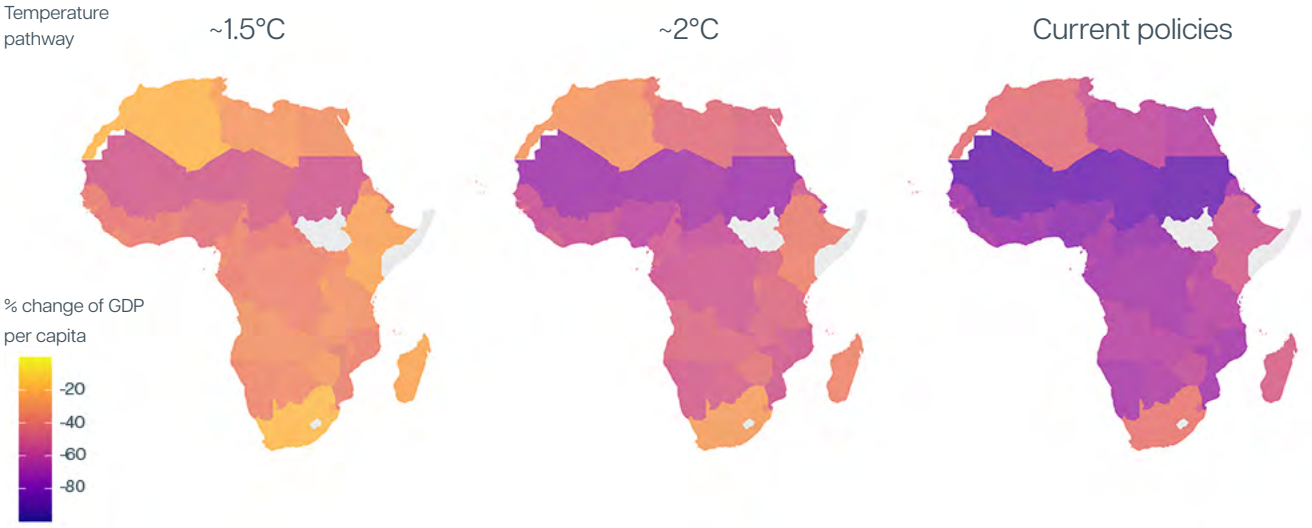
Impact of climate change on GDP for countries in the African continent in 2050



Based on Burke et al. (2015, 2018).

Figure 2: Maps of economic damages expressed as a decrease in GDP per capita (2050)

Impact of climate change on GDP for countries in the African continent in 2100



Based on Burke et al. (2015, 2018).

Figure 3: Maps of economic damages expressed as a decrease in GDP per capita (2100)

4. Implications of climate impacts in Africa

a) temperature scenarios matter

In all of the projections, the negative economic impacts for countries across Africa are significant. The hit to growth rates of countries which need to increase average incomes to overcome high levels of income poverty is alarming. The long-run estimates show that impacts on growth compound over time, meaning that the higher the temperature scenario, the deeper and deeper the cut to growth over time. But it is also clear that the impacts are more drastic in the estimates of higher global heating overall: the hit to growth rates by 2100 will be roughly double under estimates associated with current policies to limit global heating (to around 2.7C) compared to hitting the Paris Agreement target of 1.5C. It is thus very important that all countries work to limit total global emissions so that temperatures do not rise more than 1.5C above pre-industrial levels. Even meeting the apparently ambitious Paris Agreement target 'locks in' substantial climate change impacts. Given global temperatures are already 1.1C above that benchmark, the plans for rich countries to get to net zero need to be implemented, and in many cases ambitions need to be increased and action accelerated.

b) green transition

In the current context of fraught supply chains across the globe, volatile energy supplies and high inflation, governments have particularly important choices to make about how to ensure their citizens have access to affordable basics such as food and fuel. Even in rich countries, many governments are backtracking on commitments to end reliance on fossil fuels, with some increasing production and purchase of coal as well as increasing subsidies for oil and gas production and consumption. These are retrograde actions which increase carbon emissions – and thus global heating – and postpone and make harder the necessary transition to sustainable renewable energy. Whilst most countries in Africa have very negligible impacts on overall global emissions, it is still in these countries' interests to plan for clean renewable energy, 'leapfrogging' major emitters and becoming less dependent on volatile fossil fuels in the process. Civil society groups across the continent mobilised to call for leaders to not 'gas Africa'.[23]

Governments in Africa should resist pressure from some European countries and others to invest their minimal resources in fossil fuel assets which will become 'stranded assets' in the near future. Much of this pressure is based on changing energy demands in European countries as a result of attempts to end dependence on Russian gas and oil.[24] Instead, civil society groups across Africa have called for investment instead to be directed to renewable energy which could serve the continent's energy and wider social needs.[25]

c) impacts on growth, poverty and inequality

Even in the better case scenarios of limiting global heating to 1.5C in line with the Paris Agreement, the prognosis for economic growth across African countries is not good. Around one third of households across the continent live in extreme income poverty ($2.15), with the current trend increasing as a result of the Covid-19 pandemic, plus inflation, expenditure and revenue shocks- much as a result of the Ukraine war.[26] Whilst the thirty years prior to the Covid-19 pandemic saw most countries in Africa grow steadily, and largely corresponding reductions in extreme income poverty, this trend has stopped. Lower economic growth projections now mean that making progress in reducing the numbers living in extreme income poverty will be slower than previously envisaged – a trend that will be worsened by the lower growth rates we estimate due to climate change impacts – even before taking into account the already unequalising effects of extreme weather events on GDP.[27] As well as high and sustained income poverty rates in many African countries, income inequality is set to increase. This has dangerous economic, social and climate implications. Richer people consume more, tending to increase overall carbon emissions but without necessarily having a direct positive impact on those in poverty. If the increased wealth of the richer parts of populations are not effectively taxed, governments with already low tax/GDP ratios will find it difficult to allocate more resources to adapt to climate change alongside other priorities such as education, health, social protection and paying off debts.

d) lack of adaptation finance

In a time of multiple demands on already stretched budgets, one casualty of only being able to plan based on short-term financing needs is investment in adaptation. Rich polluting countries have failed to fulfil their pledge made at last year's COP26 to double the amount they provide to fund adaptation.[28] Meanwhile many governments in Africa are experiencing severe fiscal challenges, with some in debt distress, leaving little scope to increase investment in agriculture, even though the case for doing so is compelling in terms of improvements for those affected by climate change and the 'return on investment'.[29] It is even more important, therefore, that COP27 galvanises and delivers new commitments to adaptation financing, recognising the additional costs of dealing with climate impacts ex post. Even with a 45 per cent increase in adaptation financing to Africa in recent years, adaptation finance specifically and climate finance overall is far below needed levels – at around just $25bn for the whole continent.[30] Despite experiencing severe climate impacts already and hosting mostly lower income economies, Africa as a whole received barely a quarter of climate finance from richer countries between 2016 and 2020.[31]

A large majority of climate finance is provided as loans so that rich countries (which have largely caused climate change) are asking lower income countries (which haven't) to repay them for the privilege of protecting themselves and the wider world against climate change! There are already multiple examples of the higher costs of dealing with climate-related impacts in comparison to the more efficient and effective investments in adaptation – whether in response to rapid crises such as Storm Ana or slow onset crises such as the drought in eastern Africa. So far, climate finance has tended not to seek to prevent countries at risk of conflict from dealing with climate impacts and thus helping stave off deeper impacts. Those communities and countries at risk of escalating conflict may particularly benefit from smart climate finance but are often overlooked. [32]

e) already experiencing L&D- an exponential increase?

Already it is clear that adaptation will not be enough. Even the most ready and resilient can experience Loss and Damage. Such is the impact of global heating through more acute and frequent extreme weather and other climatic changes that many more will endure loss and damage. This is more likely for those whose readiness is lower due to their having fewer household assets or options to change livelihoods and where public services – including social protection – and private insurance are patchy. Such circumstances are more likely to be the case for many lower income households across most African countries. Women are more likely to work in informal sectors including agriculture – or where their work is formal it is likely to be in the public sector where donor funding is again attached to 'austerity conditions' – and thus be more vulnerable to Loss and Damage impacts. In addition, men are more likely to have migrated in advance of climate impacts to work elsewhere. Current reckonings of Loss and Damage tend to prioritise countable 'economic' costs, overlooking vital non-economic costs such as lost schoolyears or the difficulty of caring for household members in an emergency context. Governments need to work out how to address these different kinds of losses and damages in ways that do not exacerbate gender inequalities.

f) need for LDFF

Rising temperatures, greater climatic volatility and increased extreme weather events are already taking their toll on many in different parts of Africa. In the absence of formal funding to address the Loss and Damage experienced by many, governments are the de facto insurer of last resort, providing support to those whose lives have been upended; sometimes with resources and inputs from humanitarian or other agencies. But the case for dedicated finance to address Loss and Damage grows with each person experiencing it, particularly for those who have not contributed to climate change, have less wherewithal to withstand its impacts and whose governments have not received the support to adapt to climate change so far. Christian Aid and our partners have therefore proposed the UNFCCC negotiators agree to establish a Loss and Damage Finance Facility (LDFF). The LDFF should be established based on six principles:

1. International cooperation and solidarity, historical responsibility and the polluter pays principle;
2. New and additional;
3. Needs-based, adequate, predictable and precautionary;
4. Locally driven with subsidiarity – enveloping gender responsiveness and equitable representation;
5. Public and grant-based;
6. Balanced and comprehensive

Appendix 1: Data by country

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Sudan	2050	~1.5°C	-22.38	0.43
Sudan	2050	~2°C	-27.45	
Sudan	2050	Current policies	-32.39	
Sudan	2100	~1.5°C	-51.58	
Sudan	2100	~2°C	-69.65	
Sudan	2100	Current policies	-83.95	
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Mauritania	2050	~2°C	-27.29	
Mauritania	2050	Current policies	-32.22	
Mauritania	2100	~1.5°C	-51.45	
Mauritania	2100	~2°C	-69.54	
Mauritania	2100	Current policies	-83.84	
Mali	2050	~1.5°C	-22.10	0.17
Mali	2050	~2°C	-27.12	
Mali	2050	Current policies	-32.01	
Mali	2100	~1.5°C	-51.12	
Mali	2100	~2°C	-69.18	
Mali	2100	Current policies	-83.57	
Niger	2050	~1.5°C	-22.00	0.7
Niger	2050	~2°C	-27.01	
Niger	2050	Current policies	-31.89	
Niger	2100	~1.5°C	-50.66	
Niger	2100	~2°C	-68.72	
Niger	2100	Current policies	-83.12	
Burkina Faso	2050	~1.5°C	-21.03	0.19
Burkina Faso	2050	~2°C	-25.85	
Burkina Faso	2050	Current policies	-30.58	
Burkina Faso	2100	~1.5°C	-49.17	
Burkina Faso	2100	~2°C	-67.16	
Burkina Faso	2100	Current policies	-81.82	
Chad	2050	~1.5°C	-20.65	0.06
Chad	2050	~2°C	-25.39	
Chad	2050	Current policies	-30.04	
Chad	2100	~1.5°C	-48.41	
Chad	2100	~2°C	-66.27	
Chad	2100	Current policies	-81.07	
Djibouti	2050	~1.5°C	-19.03	0.36
Djibouti	2050	~2°C	-23.45	
Djibouti	2050	Current policies	-27.81	
Djibouti	2100	~1.5°C	-45.65	
Djibouti	2100	~2°C	-63.25	
Djibouti	2100	Current policies	-78.33	
Nigeria	2050	~1.5°C	-17.64	0.61
Nigeria	2050	~2°C	-21.78	
Nigeria	2050	Current policies	-25.88	
Nigeria	2100	~1.5°C	-42.63	
Nigeria	2100	~2°C	-59.83	
Nigeria	2100	Current policies	-75.26	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Sierra Leone	2050	~1.5°C	-16.13	0.11
Sierra Leone	2050	~2°C	-19.96	
Sierra Leone	2050	Current policies	-23.76	
Sierra Leone	2100	~1.5°C	-39.60	
Sierra Leone	2100	~2°C	-56.25	
Sierra Leone	2100	Current policies	-71.74	
Central African Republic	2050	~1.5°C	-16.09	0.04
Central African Republic	2050	~2°C	-19.94	
Central African Republic	2050	Current policies	-23.78	
Central African Republic	2100	~1.5°C	-39.50	
Central African Republic	2100	~2°C	-56.30	
Central African Republic	2100	Current policies	-71.97	
Benin	2050	~1.5°C	-16.03	0.55
Benin	2050	~2°C	-19.83	
Benin	2050	Current policies	-23.63	
Benin	2100	~1.5°C	-39.24	
Benin	2100	~2°C	-55.84	
Benin	2100	Current policies	-71.27	
Guinea	2050	~1.5°C	-15.94	0.26
Guinea	2050	~2°C	-19.75	
Guinea	2050	Current policies	-23.54	
Guinea	2100	~1.5°C	-39.73	
Guinea	2100	~2°C	-56.51	
Guinea	2100	Current policies	-72.09	
Ghana	2050	~1.5°C	-15.83	0.52
Ghana	2050	~2°C	-19.59	
Ghana	2050	Current policies	-23.34	
Ghana	2100	~1.5°C	-39.03	
Ghana	2100	~2°C	-55.58	
Ghana	2100	Current policies	-71.03	
Côte d'Ivoire	2050	~1.5°C	-15.52	0.38
Côte d'Ivoire	2050	~2°C	-19.23	
Côte d'Ivoire	2050	Current policies	-22.94	
Côte d'Ivoire	2100	~1.5°C	-38.79	
Côte d'Ivoire	2100	~2°C	-55.39	
Côte d'Ivoire	2100	Current policies	-70.84	
Senegal	2050	~1.5°C	-15.52	0.62
Senegal	2050	~2°C	-19.21	
Senegal	2050	Current policies	-22.89	
Senegal	2100	~1.5°C	-38.28	
Senegal	2100	~2°C	-54.65	
Senegal	2100	Current policies	-70.09	
Togo	2050	~1.5°C	-15.11	0.26
Togo	2050	~2°C	-18.71	
Togo	2050	Current policies	-22.31	
Togo	2100	~1.5°C	-37.27	
Togo	2100	~2°C	-53.41	
Togo	2100	Current policies	-68.84	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Gabon	2050	~1.5°C	-14.92	1.93
Gabon	2050	~2°C	-18.52	
Gabon	2050	Current policies	-22.12	
Gabon	2100	~1.5°C	-37.00	
Gabon	2100	~2°C	-53.22	
Gabon	2100	Current policies	-68.73	
Gambia	2050	~1.5°C	-14.72	0.21
Gambia	2050	~2°C	-18.26	
Gambia	2050	Current policies	-21.79	
Gambia	2100	~1.5°C	-36.69	
Gambia	2100	~2°C	-52.75	
Gambia	2100	Current policies	-68.23	
Mozambique	2050	~1.5°C	-14.51	0.21
Mozambique	2050	~2°C	-18.00	
Mozambique	2050	Current policies	-21.52	
Mozambique	2100	~1.5°C	-36.17	
Mozambique	2100	~2°C	-52.25	
Mozambique	2100	Current policies	-67.91	
Cameroon	2050	~1.5°C	-14.39	0.26
Cameroon	2050	~2°C	-17.85	
Cameroon	2050	Current policies	-21.35	
Cameroon	2100	~1.5°C	-35.99	
Cameroon	2100	~2°C	-52.03	
Cameroon	2100	Current policies	-67.67	
Republic of the Congo	2050	~1.5°C	-14.31	0.56
Republic of the Congo	2050	~2°C	-17.76	
Republic of the Congo	2050	Current policies	-21.24	
Republic of the Congo	2100	~1.5°C	-35.81	
Republic of the Congo	2100	~2°C	-51.83	
Republic of the Congo	2100	Current policies	-67.36	
Eritrea	2050	~1.5°C	-14.27	0.2
Eritrea	2050	~2°C	-17.73	
Eritrea	2050	Current policies	-21.23	
Eritrea	2100	~1.5°C	-35.29	
Eritrea	2100	~2°C	-51.32	
Eritrea	2100	Current policies	-67.04	
DRC	2050	~1.5°C	-14.04	0.03
DRC	2050	~2°C	-17.45	
DRC	2050	Current policies	-20.90	
DRC	2100	~1.5°C	-35.56	
DRC	2100	~2°C	-51.62	
DRC	2100	Current policies	-67.27	
Liberia	2050	~1.5°C	-13.90	0.2
Liberia	2050	~2°C	-17.25	
Liberia	2050	Current policies	-20.60	
Liberia	2100	~1.5°C	-35.01	
Liberia	2100	~2°C	-50.65	
Liberia	2100	Current policies	-65.99	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Namibia	2050	~1.5°C	-13.75	1.53
Namibia	2050	~2°C	-17.14	
Namibia	2050	Current policies	-20.56	
Namibia	2100	~1.5°C	-34.71	
Namibia	2100	~2°C	-50.72	
Namibia	2100	Current policies	-66.67	
Guinea-Bissau	2050	~1.5°C	-13.51	0.15
Guinea-Bissau	2050	~2°C	-16.77	
Guinea-Bissau	2050	Current policies	-20.03	
Guinea-Bissau	2100	~1.5°C	-34.13	
Guinea-Bissau	2100	~2°C	-49.49	
Guinea-Bissau	2100	Current policies	-64.67	
São Tomé & Príncipe	2050	~1.5°C	-13.25	0.51
São Tomé & Príncipe	2050	~2°C	-16.46	
São Tomé & Príncipe	2050	Current policies	-19.67	
São Tomé & Príncipe	2100	~1.5°C	-33.77	
São Tomé & Príncipe	2100	~2°C	-49.10	
São Tomé & Príncipe	2100	Current policies	-64.32	
Malawi	2050	~1.5°C	-13.12	0.07
Malawi	2050	~2°C	-16.33	
Malawi	2050	Current policies	-19.59	
Malawi	2100	~1.5°C	-33.11	
Malawi	2100	~2°C	-48.60	
Malawi	2100	Current policies	-64.20	
Botswana	2050	~1.5°C	-13.00	2.77
Botswana	2050	~2°C	-16.23	
Botswana	2050	Current policies	-19.52	
Botswana	2100	~1.5°C	-33.02	
Botswana	2100	~2°C	-48.74	
Botswana	2100	Current policies	-64.52	
Equatorial Guinea	2050	~1.5°C	-12.87	7.32
Equatorial Guinea	2050	~2°C	-16.01	
Equatorial Guinea	2050	Current policies	-19.16	
Equatorial Guinea	2100	~1.5°C	-32.50	
Equatorial Guinea	2100	~2°C	-47.53	
Equatorial Guinea	2100	Current policies	-62.75	
Uganda	2050	~1.5°C	-12.73	0.11
Uganda	2050	~2°C	-15.86	
Uganda	2050	Current policies	-19.01	
Uganda	2100	~1.5°C	-32.34	
Uganda	2100	~2°C	-47.60	
Uganda	2100	Current policies	-63.12	
Angola	2050	~1.5°C	-12.56	0.68
Angola	2050	~2°C	-15.66	
Angola	2050	Current policies	-18.81	
Angola	2100	~1.5°C	-31.33	
Angola	2100	~2°C	-46.31	
Angola	2100	Current policies	-61.79	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Zambia	2050	~1.5°C	-12.24	0.36
Zambia	2050	~2°C	-15.26	
Zambia	2050	Current policies	-18.34	
Zambia	2100	~1.5°C	-31.32	
Zambia	2100	~2°C	-46.35	
Zambia	2100	Current policies	-61.82	
Tanzania	2050	~1.5°C	-12.17	0.18
Tanzania	2050	~2°C	-15.19	
Tanzania	2050	Current policies	-18.26	
Tanzania	2100	~1.5°C	-31.20	
Tanzania	2100	~2°C	-46.11	
Tanzania	2100	Current policies	-61.46	
Egypt	2050	~1.5°C	-12.15	2.09
Egypt	2050	~2°C	-15.16	
Egypt	2050	Current policies	-18.21	
Egypt	2100	~1.5°C	-31.22	
Egypt	2100	~2°C	-46.16	
Egypt	2100	Current policies	-61.58	
Libya	2050	~1.5°C	-11.24	7.38
Libya	2050	~2°C	-14.06	
Libya	2050	Current policies	-16.91	
Libya	2100	~1.5°C	-28.95	
Libya	2100	~2°C	-43.26	
Libya	2100	Current policies	-58.45	
Comoros	2050	~1.5°C	-11.21	0.3
Comoros	2050	~2°C	-13.97	
Comoros	2050	Current policies	-16.76	
Comoros	2100	~1.5°C	-28.92	
Comoros	2100	~2°C	-42.85	
Comoros	2100	Current policies	-57.48	
Zimbabwe	2050	~1.5°C	-10.74	0.71
Zimbabwe	2050	~2°C	-13.46	
Zimbabwe	2050	Current policies	-16.22	
Zimbabwe	2100	~1.5°C	-28.07	
Zimbabwe	2100	~2°C	-42.14	
Zimbabwe	2100	Current policies	-57.24	
Burundi	2050	~1.5°C	-10.48	0.05
Burundi	2050	~2°C	-13.11	
Burundi	2050	Current policies	-15.81	
Burundi	2100	~1.5°C	-27.33	
Burundi	2100	~2°C	-41.10	
Burundi	2100	Current policies	-55.94	
Rwanda	2050	~1.5°C	-10.40	0.08
Rwanda	2050	~2°C	-13.02	
Rwanda	2050	Current policies	-15.69	
Rwanda	2100	~1.5°C	-27.10	
Rwanda	2100	~2°C	-40.82	
Rwanda	2100	Current policies	-55.63	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Mauritius	2050	~1.5°C	-9.87	3.13
Mauritius	2050	~2°C	-12.31	
Mauritius	2050	Current policies	-14.78	
Mauritius	2100	~1.5°C	-25.72	
Mauritius	2100	~2°C	-38.51	
Mauritius	2100	Current policies	-52.30	
Tunisia	2050	~1.5°C	-9.50	2.38
Tunisia	2050	~2°C	-11.94	
Tunisia	2050	Current policies	-14.44	
Tunisia	2100	~1.5°C	-25.18	
Tunisia	2100	~2°C	-38.44	
Tunisia	2100	Current policies	-53.04	
Ethiopia	2050	~1.5°C	-9.45	0.13
Ethiopia	2050	~2°C	-11.88	
Ethiopia	2050	Current policies	-14.37	
Ethiopia	2100	~1.5°C	-24.92	
Ethiopia	2100	~2°C	-37.98	
Ethiopia	2100	Current policies	-52.40	
Eswatini	2050	~1.5°C	-9.30	0.82
Eswatini	2050	~2°C	-11.65	
Eswatini	2050	Current policies	-14.08	
Eswatini	2100	~1.5°C	-24.40	
Eswatini	2100	~2°C	-37.18	
Eswatini	2100	Current policies	-51.35	
Kenya	2050	~1.5°C	-9.05	0.3
Kenya	2050	~2°C	-11.36	
Kenya	2050	Current policies	-13.71	
Kenya	2100	~1.5°C	-23.88	
Kenya	2100	~2°C	-36.39	
Kenya	2100	Current policies	-50.29	
Madagascar	2050	~1.5°C	-8.78	0.13
Madagascar	2050	~2°C	-10.99	
Madagascar	2050	Current policies	-13.26	
Madagascar	2100	~1.5°C	-23.18	
Madagascar	2100	~2°C	-35.26	
Madagascar	2100	Current policies	-48.81	
Cape Verde	2050	~1.5°C	-7.62	0.99
Cape Verde	2050	~2°C	-9.55	
Cape Verde	2050	Current policies	-11.53	
Cape Verde	2100	~1.5°C	-20.30	
Cape Verde	2100	~2°C	-31.16	
Cape Verde	2100	Current policies	-43.60	
Algeria	2050	~1.5°C	-7.06	3.53
Algeria	2050	~2°C	-8.93	
Algeria	2050	Current policies	-10.89	
Algeria	2100	~1.5°C	-18.95	
Algeria	2100	~2°C	-29.83	
Algeria	2100	Current policies	-42.95	

Country	Year	Scenario	GDP change	C02 per capita, tonnes, 2020
Morocco	2050	~1.5°C	-6.67	1.75
Morocco	2050	~2°C	-8.45	
Morocco	2050	Current policies	-10.29	
Morocco	2100	~1.5°C	-18.23	
Morocco	2100	~2°C	-28.81	
Morocco	2100	Current policies	-41.67	
South Africa	2050	~1.5°C	-6.35	7.62
South Africa	2050	~2°C	-8.03	
South Africa	2050	Current policies	-9.79	
South Africa	2100	~1.5°C	-17.28	
South Africa	2100	~2°C	-27.34	
South Africa	2100	Current policies	-39.59	

Appendix 2: Methodology

Impacts of climate change on economic performance (here measured by country-level GDP per capita) were estimated using a two-step modelling procedure proposed by Burke et al. (2015, 2018). The first step estimates a historical relationship between GDP growth and climatic variables, and in the second step this relationship is extended to different temperature pathways over the 21st century to estimate how GDP growth might be affected by climate change.

There is no consensus so far in economics and statistics on the "right" theoretical approach to estimate economic damages of climate change and the numbers vary widely depending on the initial specification and the modelling approach. One of the most prominent sources of differences stems from the choice between estimating damage to the level of output in an economy (i.e., impact on GDP in a single year or at a point in time) or whether it impacts economic growth (i.e., impact on GDP growth via damages to natural and human capital, under-investment, etc.). Resulting estimates from the two approaches vary primarily because the growth effects accumulate over time and are, by definition, substantially larger than level effects. Growth-based effects from prominent global assessments based on top-down econometrics vary between 7% (Kahn et al. 2019) and 23% (Burke et al. 2015) globally, while the level-based effects are centered around 1-2% of GDP reduction globally (Newell et al., 2021).

The analysis here is based on an econometric approach proposed in prominent papers of Marshall Burke and colleagues published in Nature magazine in 2015 and 2018.

Historical relationship between per capita GDP growth, temperature and precipitation is estimated using a fixed effects model with the following equation:

$$\Delta \ln(GDP_{i,t}) = \beta_1 T_{it} + \beta_2 T_{it}^2 + \beta_3 P_{it} + \beta_4 P_{it}^2 + \mu_i + \upsilon_t + \theta_{1i}\, t + \theta_{2i}\, t^2 + \varepsilon_{it}$$

where the dependent variable is GDP growth of country i in year t, T and P are the average temperature and precipitation in year t, μ_i represents country-fixed effects that control for heterogeneity between countries that do not vary over time (e.g. historical legacy, institutions or culture), υ_t are year-fixed effects that account for common global shocks in a given year (e.g. financial crisis), and θ_1i t + θ_2i t^2 are country-specific linear and quadratic time trends, which allow GDP and temperature to evolve flexibly (e.g. account for positive growth trends of both variables without confounding the relationship). Inclusion of the three types of fixed effects means that the estimated coefficients β_1 - β_4 can be interpreted as actual impacts of temperature and precipitation that are independent of non-climate related confounding factors. Only temperature variable (coefficients β_1 and β_2) is statistically significant in different specifications tested and this relationship holds robustly across alternative models. The non-linear (quadratic) relationship between GDP and climate variables allows the effect of warming to differ depending on the country's average temperature.

Several bootstrapping techniques (by country; by year; by five-year blocks) have been used to quantify uncertainty in coefficient estimates β_1 and β_2. Bootstrapping uses different sampling methods to derive improved estimates of standard errors and confidence intervals.

Coefficient estimates obtained from the historical regression model are used in the second step of the analysis in combination with climate model projections of temperature to obtain projected future per capita GDP growth. Here we present three scenarios of global warming:

A Paris Agreement-compatible pathway of the global mean temperature (GMT) increase limited to 1.5°C in 2100

A less ambitious Paris-compatible limit of 2°C in 2100

A "current policy" pathway that results in the increase of around 2.8°C (2°C – 3.6°C) in 2100 compared to the pre-industrial period based on the latest update of the Climate Action Tracker (CAT) from November 2021.

Future GDP growth in the climate change scenarios is compared to the "baseline" scenarios available from the socio-economic scenario framework – the Shared Socioeconomic Pathways (SSPs) (O'Neill et al. 2017) – which are the basis for climate impact assessments in the 6th Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC). The SSPs are meant to represent a range of plausible futures of socio-economic components in a hypothetical world without climate change. They are used as baselines in comparisons to scenarios with climate change. Here we use the SSP1 scenario which is meant to be most compatible with the 1.5°C-consistent pathway. Baseline SSP scenarios can also be explored here.

Caveats:

Estimates presented here are based on an econometric model that is based on the relationship between GDP growth and temperature, without accounting for the possible impacts of extreme events. Incorporating climate extremes such as droughts, floods or storms that could have a substantial impact on economic performance. Recent advances in damage estimates that include extreme events are significantly larger than the ones who do not,

implying that the optimal temperature pathways are the ones that limit global warming in line with the Paris Agreement (Piontek et al., 2021). Additionally, it is useful to keep in mind that adaptation measures which could potentially alleviate some of the damage are not incorporated here either.

Note that due to missing data, 4 countries are not included in this analysis: Lesotho, Seychelles, Somalia and South Sudan.

Endnotes

1 Data was not available for Lesotho, Seychelles, Somalia and South Sudan. Together, these four countries comprise around 0.5% of the total African' continent's economy (see List of African countries by GDP (nominal) - Wikipedia). South Sudan and Somalia are classified by the World Bank as low income countries, with per capita GDP of under $1000 a year; Lesotho is classified as a lower-middle income country with a GDP per capita of around $1,100 a year whilst Seychelles is the only high income country in Africa with a GDP per capita of around $13,000 year.

2 The Burke et al (2015) two step modelling procedure used in this briefing has also been used in similar studies, including the recent V20 (2022) Climate vulnerable economies loss report https://www.v-20.org/wp-content/uploads/2022/06/Climate-Vulnerable-Economies-Loss-Report_June-14_compressed-1.pdf

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