V20 | VULNERABLE TWENTY GROUP

# CLIMATE VULNERABLE ECONOMIES LOSS REPORT

## Economic losses attributable to climate change in V20 economies over the last two decades (2000-2019)

REPUBLIC OF GHANA · CLIMATE VULNERABLE FORUM · CVF V20 · VULNERABLE TWENTY GROUP · PRESIDENCY

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# I. PREFACE

***Economic impact of climate change in the past two decades in 55 of the world's most climate vulnerable nations***

Climate vulnerable countries are reeling from multiple crises – the debilitating impacts of Covid-19, significant debt distress, the prevailing fuel and food crisis driven by the Russia-Ukraine war, in addition to climate impacts. This report presents a unique study into the recent economic loss and damage suffered by the world's most climate vulnerable economies – the members of the Vulnerable Twenty (V20) Group and Climate Vulnerable Forum (CVF).

This report demonstrates how, over the last 20 years, the most at-risk economies of the V20 lost over half their economic growth potential due to the negative effects of human-induced climate change. On average a fifth of the GDP of our 55 economies has been eliminated – in other words, without climate change, our people would be 20% wealthier today. We are bearing this alarmingly high economic cost, despite having contributed the least to causing climate change, while also being least equipped to respond to its costly consequences. These enormous economic costs barely cover the significant and irreversible damage that would be done to ecosystems, social structures, and lives from extreme climate events. Losses and damage go well beyond what can be quantified in dollars and cents in the form of lost and destroyed lives, livelihoods, land, even threats to our culture. A breaching of the threshold temperature of 1.5ºC, would send the world into climate chaos - accelerating weather cycles, accentuating severe weather events like flooding, sea level rise, and heatwaves amongst others.

Although Africa contributes only about 3.8% of global greenhouse gas emissions, Africa bears alarmingly high economic cost due to climate change. According to the UNECA, responding to climate change vulnerabilities costs African countries 3-5 percent of GDP annually and, in some cases, more than 15 percent. With V20 countries representing some of the fastest -growing economies in the world, the future of the World Economy could be severely impaired with worsening issues of poverty, food and physical security if adaptation measures are not stepped up to protect these economies.

The failure of developed countries to deliver on the annual $100 billion climate finance from 2009 to 2022 has had dire effects on the implementation of mitigation and adaptation measures. Meeting and exceeding the COP26 agreed Delivery Plan to make-up for shortcomings on the delivery of the annual $100 billion financing and the doubling of adaptation finance by 2025 would be crucial to the world's economic well-being.

It is disconcerting to realise that even if international adaptation funding doubles, helping to make positive adjustments towards a climate resilient future, we will not always succeed in recovering what we are losing day-in-day-out, year-in, year-out because of climate change impacts.

V20 finance ministries and communities are already allocating alarmingly significant and growing proportions of their public budgets to cover rapidly growing loss and damage costs, which diminishes the already scarce resources intended to support critical economic and development strategies in education, public health, nutrition, energy access, and jobs creation.

The V20 Group of Finance Ministers representing 55 of the world's most climate-vulnerable economies reiterate our need for separate and dedicated international funding for loss and damage. Through the V20's role in co-chairing the InsuResilience Global Partnership and our engagement in further important financial protection mechanisms, including the Global Shield and the Insurance Development Forum, we must close the massive 98% financial protection gap against climate and disaster risks in the V20 as rapidly as possible.

In wealthy economies it is commonplace to have insurance against natural disasters for homes, buildings, and other assets, but in the V20 such financial protection is still considered a privilege. Yet, for as long as the protection gap prevails, there is the need to secure additional resources to support communities on the frontline - to rebuild their lives and livelihoods as they are, in too many cases, affected by recurring and constant climate incidents, due to worsening climate events and related impacts.

For this reason, at our V20 Ministerial Dialogue in April this year, the V20 resolved to pioneer its own loss and damage funding mechanism. We have allocated and mobilized funds from the philanthropic community through our own CVF & V20 Joint Multi-Donor Fund to channel resources directly into the worst affected communities of the V20 with small-scale grants. We are working with the Global Environment Facility's Small Grants Programme to develop our V20 loss and damage funding mechanism.

The GEF has managed billions of dollars in over 20,000 small grants in more than 130 countries including current projects in 41 Least Developed Countries and 37 Small Island Developing States. By COP27 we plan to demonstrate from this endeavour that loss and damage funding fills a vital gap in the climate finance landscape, that it can be financed effectively and efficiently, and that loss and damage funding is entirely possible at scale.

Still, what the V20 can do on our own is limited and only makes sense if the world's rich, powerful and climate change responsible nations can be inspired by our pathbreaking efforts and go beyond. It should fall on COP27 to decisively act on the void of finance for loss and damage. This will be a litmus test indicating the willingness of the Parties who fueled the current climate crisis to begin taking significant responsibility for their role in global warming and acknowledging the moral responsibility to reduce the impacts of their actions on the developing world's poor and vulnerable nations. As a matter of pragmatism and justice, the V20 and CVF are thereby calling on COP27 to establish an international financing mechanism for climate change loss and damage in solidarity with victims least responsible for, and least equipped to withstand, the increasingly extreme shocks driven by climate change.

In the words of Dr. Kwame Nkrumah, the first President of Ghana, "The forces that unite us are intrinsic and greater than the superimposed influences that keep us apart." Our President today, His Excellency Nana Addo Dankwa Akufo-Addo, took up the mantle of Chair of the CVF only last month and Ghana will be leading the work of the CVF and V20 for the next two years. We intend to play our role with a spirit of fierce urgency to ensure that global solidarity and action on the climate crisis is strengthened for the protection of the most climate vulnerable and for the rest of the world.

Hon. Kenneth Nana Yaw Ofori-Atta

**Hon. Kenneth Nana Yaw Ofori-Atta**
**Minister for Finance and Economic Planning of Ghana**
**Incoming V20 Chair**

# II. EXECUTIVE SUMMARY

- Building on two already published and peer-reviewed econometric models (Baarsch et al., 2020; Burke et al., 2015) that assess the consequences of climate variability and change on economic development, the study focuses on economic losses that occurred for the period ranging from 1980 to 2019. For the first time, the analysis aims at estimating climate change-attributable economic losses by comparing losses in the observed climate (S. Lange et al., 2021) against losses in a counterfactual climate in which climate change would not have occurred (Mengel et al., 2021). The model estimates are validated against a set of climate-related disasters that occurred in V20 economies.

- The majority of V20 economies are already affected by a changing climate far beyond their so-called (economically) optimum temperature. Due to the underlying micro-level mechanisms leading to the formation of the optimum temperature, moving it up, to adapt to increasing temperatures, will require unprecedented levels of investments. Limiting global mean temperature increase below 1.5°C would reduce the level of investments required to adapt.

- For all V20 economies for the 2000-2019 period, climate change attributable losses average 0.92% of a given level of annual economic growth and total to 20% of the GDP over the last two decades (2000-2019). Meaning the GDP of the V20 as a whole would have been 20% higher today had it not been for climate change. To contextualize these findings in a country example: in the specific case of Ghana, the loss to growth due to climate change in this period is estimated at 0.50% a year on average. Ghana's actual average growth of 4% for the period would have been 4.5% without climate change. When looking at the most at-risk V20 members (the tenth percentile of economies assessed) losses add up to an estimated average of 51 percent of the GDP over the twenty year period (2000-2019), or more than half of their economic potential since the year 2000.

- Due to anthropogenic climate change, historical temperatures across the majority of V20 economies have already exceeded their optimum temperatures. Hence, it is very likely that further warming will lead to an increase in losses at the macroeconomic level. Countries that were close to their optimum, but still below, will start experiencing this level being exceeded and could potentially face losses as a result of temperature stress on their economies.

- Looking specifically at the effects of changes in hydrometeorology, all V20 economies face reductions in their GDP per capita, due to a lack of adaptation to current precipitation patterns. As the consequences of climate change progressively affect precipitation patterns, more countries in V20 are exposed to an increased economic burden on the ability to develop. The losses - on average between -10 and 15% of the growth potential - estimated in all V20 economies are compelling and shed a light on the urgent and massive level of investments required to adapt to climate change.

- The results of modelling are compared with climate-related disasters that affected V20 economies. This comparison allows to highlight Tuvalu as a case where international finance has made a difference. For Tuvalu, the effect estimated by the model does not reflect the disaster year's GDP per capita dynamic. While the drought and its consequences were unfolding on the islands, the Government of Tuvalu received a significant increase in ODA (from US$ 13.9 million or 27% of GNI in 2010 to US$ 37.3 million or 64% of GNI in 2011), this increase in ODA contributed to totally offset the negative consequences of the drought at the macroeconomic level. The example of Tuvalu is an illustration of the benefits associated with a mechanism, at the national, regional or international level that would support countries in the aftermath of climate-related disasters - in line with the on-going negotiations on loss and damage at the UNFCCC - although such mechanisms can never compensate for lives lost.

# KEY FINDINGS

20% — Climate change has eliminated one fifth of the wealth of the V20 over the last two decades: initial evidence shows that the V20 would have been 20% wealthier today had it not been for climate change and the losses it incurred for poor and vulnerable economies.

US$ 525B — In aggregate dollar terms, V20 economies have lost approximately US$ 525 billion because of climate change's temperature and precipitation patterns affects (2000-2019).

51% — For the most at-risk countries (10% of worst affected V20 economies), economic losses due to climate change are estimated to exceed half (51%) of all growth since the year 2000 (2000-2019): the most at-risk of the world's most climate vulnerable nations would be twice as wealthy today were it not for climate change.

1% — Economic losses cut GDP growth in the V20 by one full percent each year on average (minus 0.9% to the percentage of growth which averaged 3.7% in 2019 across the V20).

The year-to-year reduction in GDP per capita growth attributable to climate change represents one quarter (25%) of the actual average annual economic growth of the V20 economies today (2019); for the 10% most at-risk V20 members the climate change attributable losses to annual growth already significantly exceed the total actual average GDP growth rate (of 0.38% per year, 2015-2019).

Nearly all V20 economies have already warmed to mean temperatures that are far beyond what would be optimal for generating economic growth, and thereby instead incur economic losses – additional warming will only carry V20 economies further from the optimum, greatly increasing the risks of losses in the future.

Given warming is set to progress to within 1.5°C in the next decade regardless of further mitigation action, even as adaptation accelerates economic losses would continue to increase. Adaptation needs to accelerate at a phenomenal rate both to prevent loss and damage at current levels, as well as to offset the growth in economic losses and damage that will be generated as temperatures continue to rise with hydro-meteorological extremes becoming more pronounced in parallel.

Because the estimated economic losses due to hydro-meteorological extreme events are higher in the last two decades than the previous two decades, the world's most vulnerable economies are also not adapting fast enough to cope with weather extremes of the changing climate as it currently stands.

Analysis presented in this report provides initial evidence that international aid support supplied to V20 economies affected by hydro-meteorological extremes can diminish the negative macro-economic effect that would otherwise have prevailed, underscoring the importance of funding for loss and damage.

V20

# KEY FINDINGS

**JUNE 2022 V20 REPORT ON ECONOMIC LOSS AND DAMAGE**

20%

**V20 would be 20% wealthier today**

Climate change eliminated 1/5th of wealth over the last 2 decades.

US$ 525B

**V20 economies have lost US$ 525 Billion**

In aggregate dollar terms because of climate change's effects (2000-2019).

51%

**The most at risk countries would be twice as wealthy today were it not for climate change**

Economic losses exceeded half (51%) of growth since 2000 for most at-risk countries.

1%

**Economic losses cut GDP growth by 1% per year**

On average.

**Year to year reduction in GDP per capita growth attributable to climate change is 25%**

Of the economic growth of the V20 economies.

**Temperatures are far beyond optimal for economic growth**

Most V20 economies instead incur economic losses - additional warming greatly increases risks of losses in the future.

**Warming is set to be 1.5°C in the next decade**

*Even if mitigation efforts continue to be made, losses will incur.*

Adaptation would need to accelerate at a phenomenal rate to offset growing losses.

**Economic losses are higher in the last 2 decades than previous decades**

The V20 economies are not adapting fast enough.

**International resources supplied to V20 economies can diminish the negative macro-economic effect**

Underscoring the importance of funding for loss and damage

# 1. INTRODUCTION

The IPCC Sixth Assessment Report (AR6) published in 2021 and 2022 are more alarms of the dire consequences of climate change. Above all, the IPCC clearly states that climate change's appropriate tense is not just the future, but the present, as its consequences are increasingly being felt by people and societies.

This note takes stock of the extent to which already observable changes in precipitation and temperature patterns have affected V20's economic performance over the last 40 years. In the context of on-going negotiations on loss and damage at the UNFCCC, three key aspects are explored: the speed of temperature warming across V20 economies, the distance between their optimum temperature and current temperature observed and the economic losses attributable to observed climate change, almost all caused by anthropogenic influences.

# 2. TEMPERATURE INCREASING - BEYOND ECONOMIC OPTIMUM

## 2.1 INCREASING TEMPERATURE

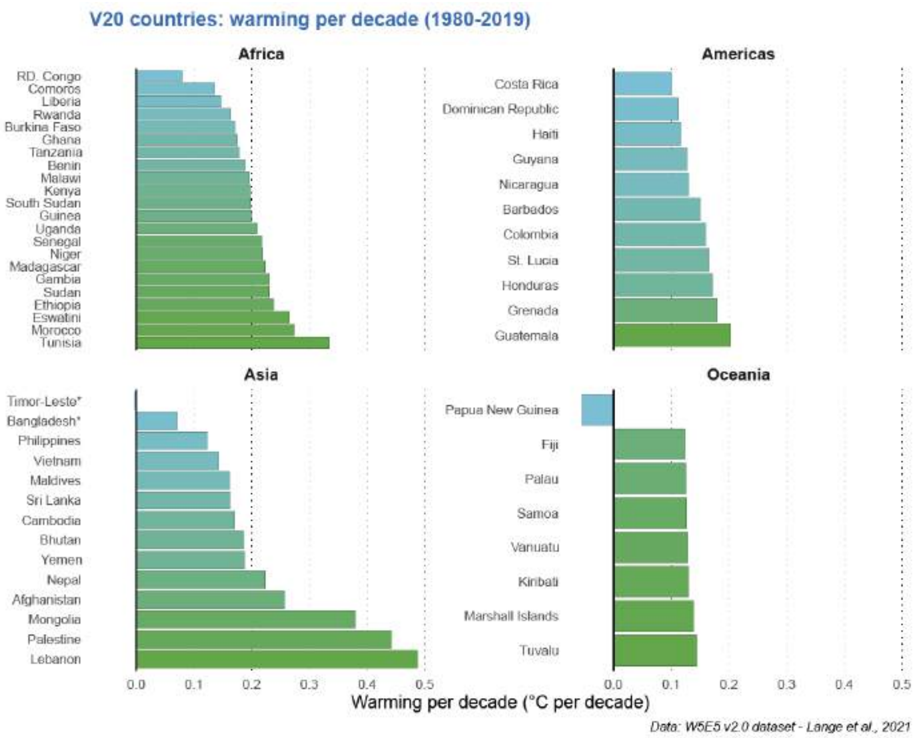


*Figure 1: Population-weighted warming per decade in the 1980-2019 period in V20 economies. The statistical significance of the trend is estimated using the Mann-Kendall test, an asterisk indicates that the trend is not statistically significant. Daily temperature from W5E5 v2.0 dataset (Lange et al., 2021) and population density data from CIESIN (CIESIN - Columbia University, 2016).*

The increased concentration of GHG in the atmosphere already influences today's climate. According to NOAA, over the last four decades (1981-2022), temperature has increased globally at a rate of about 0.18°C per decade - an accelerated warming, twice as fast as for the period starting in 1880 (0.08°C per decade). Beyond this global average, countries warm at a different pace depending on their characteristics, such as their location or their topography. Here, the analysis specifically focuses on warming over the last 40 years in V20 economies.

In recent decades, Lebanon was the V20 economy exposed to the fastest warming of its population-weighted temperature with 0.49°C per decade. On the other side, Bangladesh experienced the slower pace of warming at a rate of 0.07°C per decade. On the African continent, Morocco and Tunisia faced the fastest warming at 0.27 and 0.33°C. In the Pacific region, warming was rather homogeneous with the exception of Papua New Guinea.

The speed at which a country's mean temperature increases is an important indicator for the growing risk faced by V20 economies to be exposed to temperature under which their economies perform sub-optimally, and for the current and future level of investments required to adapt to these risks of negative consequences.

## 2.2 OPTIMUM TEMPERATURE

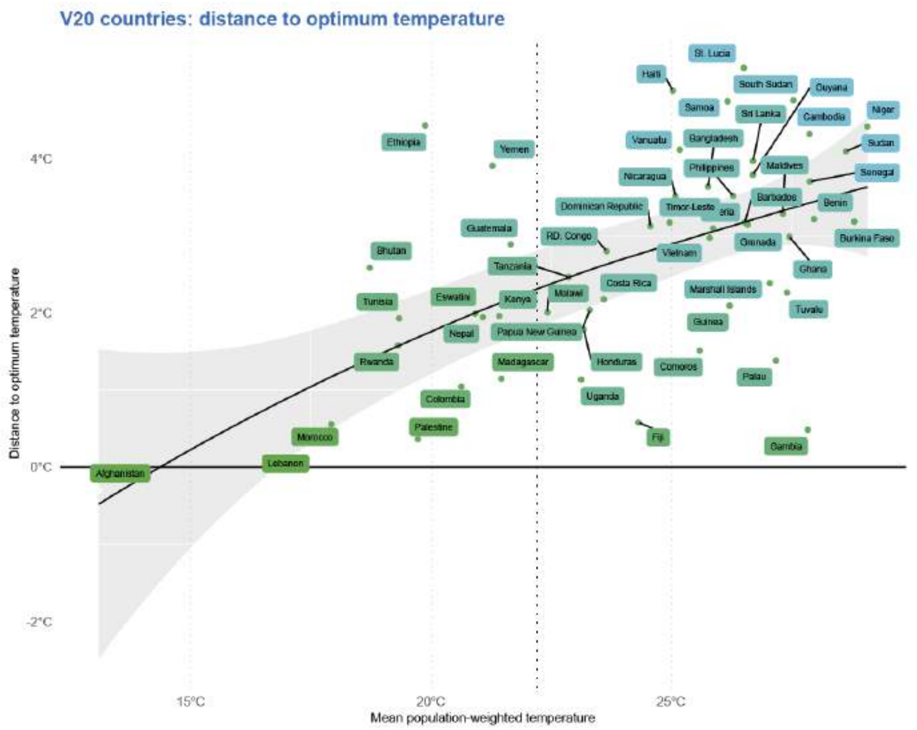


*Figure 2: Observed population-weighted median annual temperature from 2000 to 2019 and distance to median country-specific optimum temperature. A distance to optimum temperature above zero indicates that country's temperature has already exceeded optimum. The vertical dotted line is the optimum temperature resulting from the panel regression of all low- and middle-income countries.*

In 2015, in a Nature paper, Burke et al. introduced the idea that economies could have an optimum temperature level, below and beyond which economic performance reduces. This optimum temperature is the translation, even potentially the macroeconomic aggregation, of biophysical processes, with for example:

- a given crop finds its optimal temperature within a range of a few degrees.
- different types of construction materials and architecture can accommodate different minimum and maximum temperatures until heating or air conditioning is required to maintain decent livable or workable conditions.
- thermal power plants that require cooling for energy production function optimally within a certain range of temperature (the Carnot cycle).

Therefore, many micro-economic factors (crops, building, etc.) with their different optimal ranges could converge towards defining a country-level optimum temperature.

The above figure (Figure 2) provides the distance between the median temperature observed in the 2000-2019 period and the median optimum temperature[1] for all V20 economies.

First, the figure clearly shows that the higher the median temperature is, the longer the distance to optimum. A long distance to optimum indicates that the country's economy operates outside its optimal range leading to sub-optimal economic performance.

Second, V20 economies can be qualitatively clustered in three groups based on their distance to optimum and their current temperature level:

- Countries with annual temperature around 15°C, lower than the rest of the V20 economies, with optimum temperature below or very close to optimum. This is for example the case of Afghanistan and Lebanon.
- Countries with annual temperature close to 20°C, and a distance to optimum below 2°C, with as an illustration: Nepal, Tunisia or Fiji.
- Countries with annual temperature close and above 25°C that face further distances to optimum – a sign of potentially chronic sub-optimal performance, with for example Niger or South Sudan.

With a progressively warming climate, the distance to optimum will further increase. Because of the macro- and micro-economic nature of the optimum temperature, adapting to climate change, which entails moving up the optimum temperature to fill the gap and follow increasing temperature will require most likely unprecedented levels of investments in all infrastructures, such as buildings, energy production as well as practices in the agricultural sector if not cultural adaptation when temperature levels become unsuitable for some crops or animal breeds.

# 3. ECONOMIC LOSSES FROM CLIMATE CHANGE &

## 3.1 ATTRIBUTABLE ECONOMIC LOSSES FROM CLIMATE CHANGE

This analysis provides the first ever estimate of the economic losses attributable to anthropogenic climate change only. Hitherto, studies on the impacts of climate change on economic development relied on a more or less recent past reference period against which economic losses were estimated. This study leverages on a recently published dataset (Mengel et al., 2021) that provides a counter-factual climate for observations over the last 40 years. In other words, the counter-factual climate for observations provides precipitation and temperature data without the influence of anthropogenic climate change. Building on the macro-econometric model described in the annex, the analysis then compares the effect on GDP per capita growth in real climate observations (Lange et al., 2021) against the effect in the counter-factual climate estimates (Mengel et al., 2021).

In this study, we focus on the worst losses accounting for climate change, as exemplified by the 10% worst outcomes for GDP driven by climate extremes over the past decades.

As of 2022, it is estimated that global mean

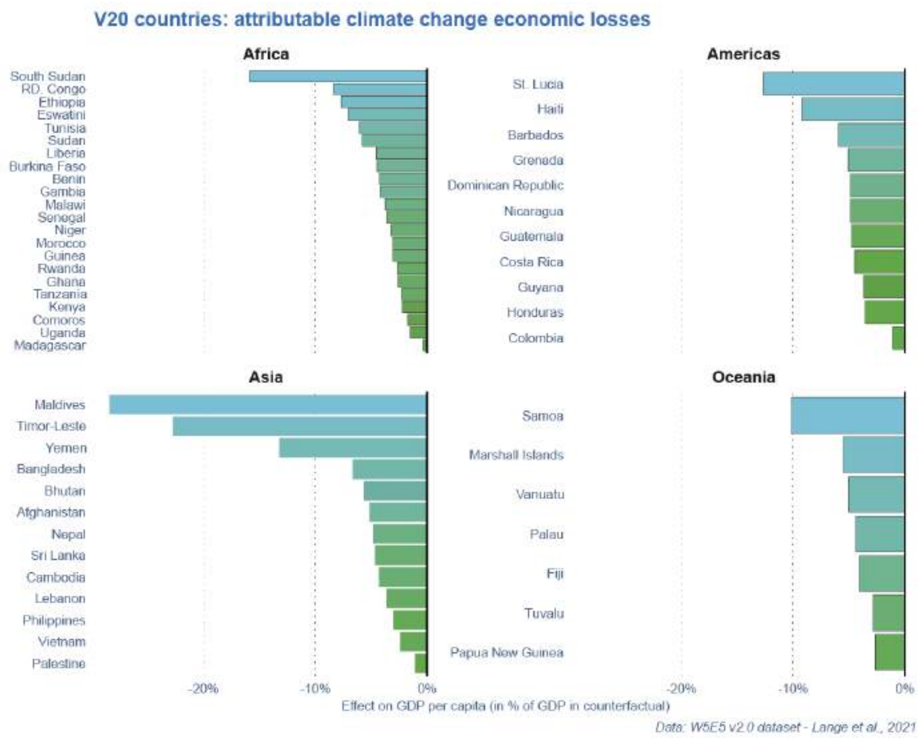


*Figure 3: Attributable economic losses from climate change in V20 economies (in the 10th percentile of the distribution). The analysis does not cover V20 economies for which insufficient data is available for a statistically robust analysis. Authors' calculations with daily temperature and precipitation from W5E5 v2.0 dataset (Lange et al., 2021) and counterfactual climate based on W5E5 2.0 dataset (Mengel et al. 2021).*

temperature has increased about 1°C compared to pre-industrial level (V. Masson-Delmotte et al., 2021). While this warming is limited in comparison to the projected warming by the end of the 21st century in scenarios estimating the future effects on greenhouse-gas emissions of current climate policies and actions (2.7°C, Climate Action Tracker[2]) or mitigation pledges and targets (2.1°C, Climate Action Tracker[3]), it already yields negative consequences across the majority of the V20 economies.

Across all continents where V20 economies are located, the reduction in GDP per capita attributable to climate change ranges from -4.6% in Asia to -3.1% in Africa (for the 10th percentile of the distribution). For individual countries on the same continent, reductions attributable to climate change can vary significantly. For example in Oceania, impacts range from -10.2% to -1.1%. Similar heterogeneity is apparent across African country members of the V20, with reductions ranging from -15.9% in South Sudan to -0.4% in Madagascar.

In aggregate dollar terms, over the 2000-2019 period, V20 countries have lost about US$ 525 billion because of climate change already affecting temperature and precipitation patterns. This loss amounts to 22 per cent of 2019 total GDP (in current $US). Due to their population size and level of economic development, three countries concentrate 44 percent of the total losses: Bangladesh (19% of total), the Philippines (16.6%) and Vietnam (8.4%). The unweighted mean loss over the period for V20 countries is estimated at about 20 percent of GDP for the 2000-2019 period – as a group V20 countries would have been 20 percent wealthier if it had not been for climate change.

For this group of countries, that gathers both low- and middle-income countries, both weighted and unweighted economic losses are in line with earlier estimates of the economic losses induced by climate variability and change. In Baarsch et al. (2020), it is 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 amounts to 5 to 15 percent reduction in GDP over a 30-year period starting in 1986. Two more studies estimated losses to about 8 percent in GDP for a period from 1970 to 2010 (World Bank & United Nations, 2011) or a decrease by an estimated 15 percent in GDP per capita – induced by precipitation only over the 1960-2000 period (Barrios et al., 2010). Considering that the present analysis focuses on a later period (2000-2019), characterized by higher global mean temperature induced by climate change, the losses proposed in the report appear consistent with earlier findings.

As observed temperatures across the majority of V20 economies have already exceeded country-specific optimum temperatures, further warming will lead to a faster and faster acceleration of the increase in losses at the macroeconomic level. Countries that were close to their optimum, but still below, will start exceeding it and could potentially face more losses as a result of temperature stress on their economies. While not explicitly accounted for, the projected increase in the frequency of heat extremes (V. Masson-Delmotte et al., 2021), as recently observed in South Asia (e.g. India in May 2022), could also accelerate the reduction in GDP per capita growth over time.

## 3.2 ECONOMIC LOSSES INDUCED BY CHANGES IN PRECIPITATION PATTERNS

*Looking specifically at the effects of changes in hydrometeorology*, all V20 economies face reductions in their GDP per capita, due to a lack of adaptation to current precipitation patterns. These reductions range from about -15 percent in Timor-Leste, Yemen or South Sudan to -5 percent and less in Lebanon or Guyana. The majority of the V20 economies have hydrometeorological losses ranging from -5 to -10% percent in their GDP per capita growth potential.

While some countries (segments in green in Figure 4) experienced improved precipitation conditions over the last 20 years in comparison to the 1980-1999 period, their economies remain negatively affected by droughts and heavy rainfall. As the consequences of climate change progressively affect precipitation patterns, more countries in V20 are exposed to an increased economic burden on the ability to develop. Some countries such as Bangladesh experienced a 30% worsening in the reduction from -7% to almost -10%, induced by changes in precipitation patterns over the last 20 years.

The losses estimated in all V20 economies are compelling and shed a light on the

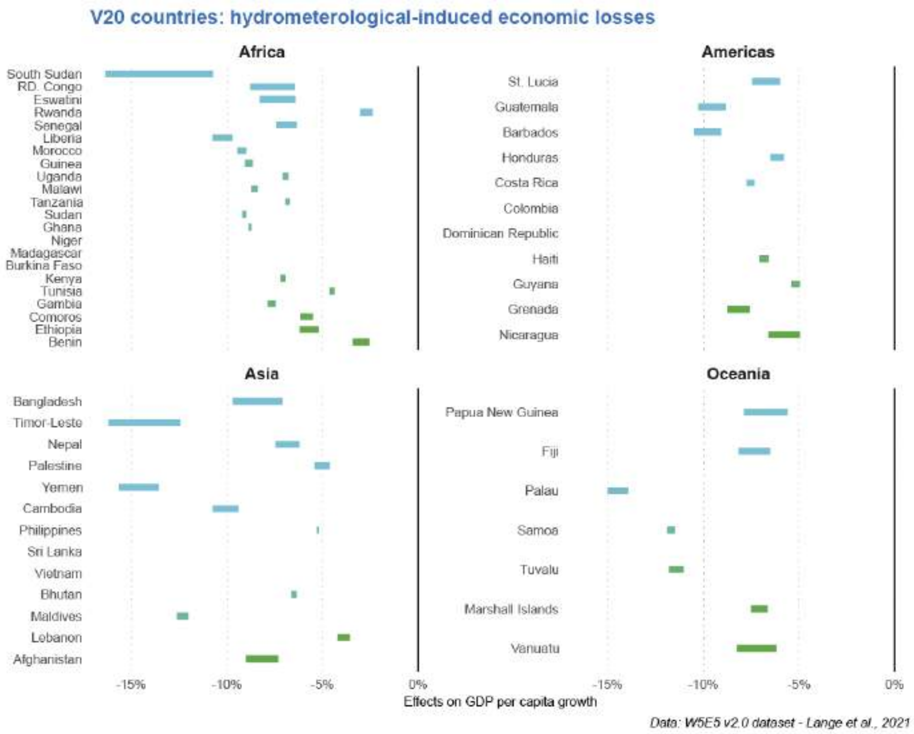


*Figure 4: Change in hydrometeorological-induced economic consequences between 1980-1999 and 2000-2019 in V20 economies. Segments in red indicate an increase in losses while green indicates a reduction. The analysis does not cover V20 economies for which insufficient data is available for a statistically robust analysis and V20 high-income countries. Authors' calculations with daily temperature and precipitation from W5E5 v2.0 dataset (Lange et al., 2021).*

urgent level of investments required to adapt to climate change. From an economic perspective, the scale of the losses, estimated as a reduction in GDP per capita growth, is an indication of the benefits that could be yielded by Governments and communities with adaptation measures that would contribute to reduce these losses. As such this preliminary estimate of losses associated with the lack of adaptation to current precipitation patterns is an essential element to facilitate investment decisions in resilience at the national and international level.

## 3.3 LOSS AND DAMAGE FROM AN HISTORICAL COUNTRY PERSPECTIVE

While the negotiations on the Subsidiary Bodies' will focus - among other issues - on loss and damage and the implementation of the Warsaw mechanism, it is essential to highlight the importance of such mechanisms at the country-level, to support communities facing the negative consequences of climate related-disasters. In this section the analysis focuses on two droughts that occurred in two countries: Tuvalu in 2011 and South Sudan in 2009.

In Tuvalu, a drought unfolded on the islands in 2011 with most of the population being negatively affected by its consequences. According to the model used for this analysis the country was expected to lose almost US$ 800 of GDP per capita (median GDP per capita for 2010 to median in 2011) from about US$ 3,300 to US$ 2,500. In the case of South Sudan, the drought led to an estimated US$ 500 decrease in GDP per capita from 2008 to 2009. The estimated GDP per capita from the model used for this analysis is in line with the GDP per capita that actually occurred, as estimated by the World Bank for the same years, for example for South Sudan dropping from about US$1,800 to US$1,300 - with limited rebound for the following year 2010.

While both countries were affected by droughts, Tuvalu even displaying potentially higher estimated losses than South Sudan, their GDP per capita as per the World Bank followed an opposite trajectory. Indeed, in Tuvalu, measured GDP per capita indicated that the country's economy actually grew between 2010 and 2011 despite the negative impact of the drought. While a significant decrease was observed in South Sudan, comparable to what could be expected from the drought (as confirmed by the model results). One of the explanations of the unexpected growth that occurred in 2011for Tuvalu could actually be related to international aid flows that increased substantially from US$ 13.9 million or 27% of GNI in 2010 to US$37.3 million or 64% of GNI in 2011. In Tuvalu, this increase in ODA contributed to totally offset the negative consequences of the drought at the macroeconomic level - with the country even experiencing a double-digit growth for the year.

This sudden inflow of external resources that contributed to reduce the negative consequences of the climate-related disasters (at least at macroeconomic level) could be compared to an international mechanism on loss and damage to accompany countries while the disaster

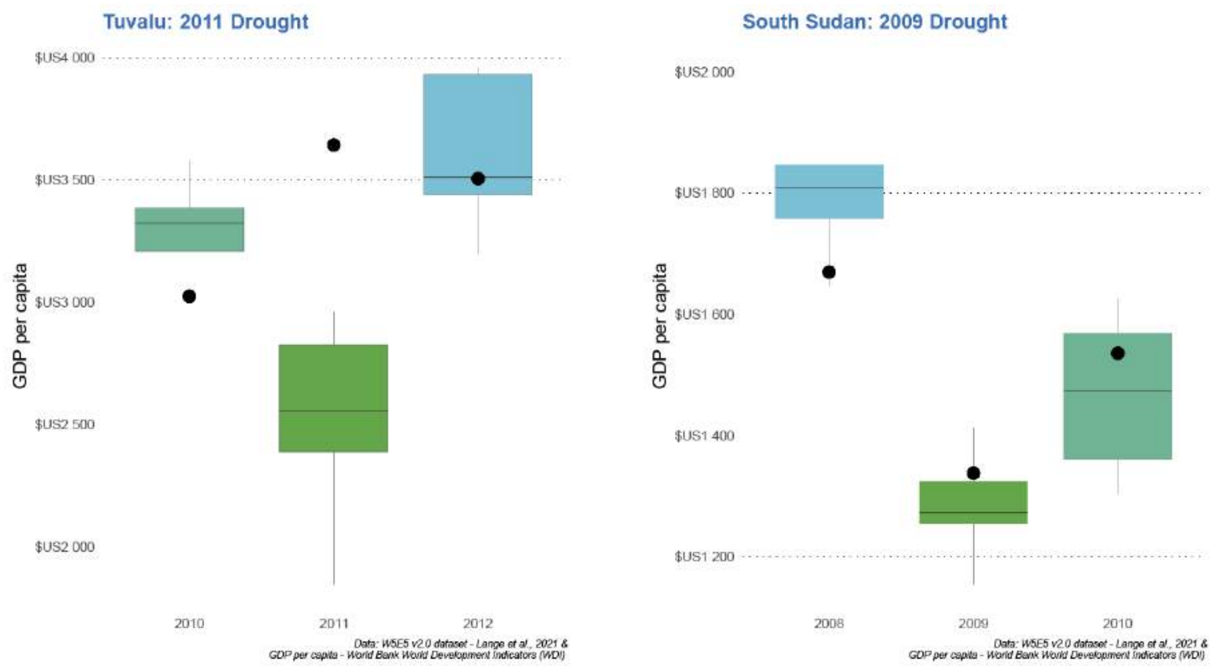


*Figure 5: Comparison between observed GDP per capita (black dots, source: World Bank data) and estimated (boxplots) for this analysis of droughts in Tuvalu in 2011 and in South Sudan in 2009. Data: authors' calculations.*

unfolds and in its aftermath. The 2011 Tuvalu drought is an illustration of the benefits that could be associated with a mechanism, at the national, regional or international level that would support countries in the aftermath of climate-related disasters - in line with the on-going negotiations on loss and damage at the UNFCCC, although it must be noted that no mechanism will be able to compensate for lives lost.

## 4. CONCLUSIONS

The results presented in this study are preliminary and will be consolidated in the course of 2022 in the lead up to the publication of the Climate Vulnerability Monitor. Some elements related to econometrics and calibration can and will be further improved until publication of the final results, while additional datasets will be explored. The main expected improvements relate to the level of uncertainties associated with the calibration and therefore definition of optimum temperature and associated losses. However, as presented in the final section of the report, the model in its current state displays a satisfactory ability to reproduce historical data and patterns observed across V20 economies.

Even though the results are preliminary, these are strong reminders of: (1) the urgency of acting on climate change with stringent mitigation measures in line with the objective of the Paris Agreement of keeping global mean temperature increase below 1.5°C, (2) the need to scale up the amount invested in adaptation globally while ensuring the effectiveness of the projects and programmes being implemented and finally (3) the necessity to put in place a mechanism to address loss and damage from the national to the international levels.

# 5. METHODS AND MODEL COMPARISONS

## 5.1 METHODS AND DATA

With the emergence of a warming signal across all geographies of the V20, this study takes stock of the extent to which the countries already experience economic losses in response to climate change. To differentiate the between losses associated with natural climate variability and climate change, this analysis compares economic losses which occurred over the last 40 years against a counterfactual climate data set (Mengel et al., 2021), in which anthropogenic climate change would not have occured and would therefore have had no consequences on precipitation and temperature patterns. By comparing losses in these two settings (actual observations vs. counterfactual), the analysis allows for a first-of-its-kind attribution of economic losses to anthropogenic climate change.

The methodology implemented for this study is a combination of an approach published in 2015 (Burke et al., 2015) in which mean annual temperature drives a multi-country regression combined with a more recent approach (Baarsch et al., 2020) in which precipitation levels are normalized to facilitate comparison of heterogeneous precipitation levels across countries. In addition, still building on this last paper, the results of the regression analysis are calibrated at the country level to ensure that the vulnerabilities estimated econometrically is the most accurate representation of a country's reality.

The assessment is based on an econometric analysis that relates GDP per capita to temperature and precipitation. As such, the analysis is economy-wide and the results provided account for direct and indirect climate-related and socioeconomic drivers that affect GDP per capita. The temperature-based analysis employs temperature change over time as a proxy to understand how climate change through its wide-ranging impacts can affect an economy, and not only the direct interactions of temperature changes alone. In addition, in estimating economic losses associated with climate change over time, the method only accounts for the effects for GDP growth. As the economy would have grown at a higher pace without climate change, it is possible that the methodology used underestimates the losses, since a larger economy would have allowed for more interactions between economic actors, more innovation, facilitated price discoveries among suppliers, etc. which would most likely have resulted in higher growth levels.

It is worth noting that as a consequence of using mean annual temperature in the econometric analysis, an optimum temperature is estimated. An optimum temperature is a level at which both warming and cooling leads to negative economic consequences. Usually, the shape of the curve is steeper for temperatures above the optimum, indicating that economic losses of warming are more serious than those of cooling. In some cases, particularly for countries with lower temperature than the rest of the studied countries, the optimum temperature can be lower than the current temperature observed in the country. In any cases, this should imply that the country's economic performance will - in any case - benefit from an increase in temperature:

1. it is also necessary to consider the effect of hydrometeorological extremes (see section below) that can yield significant damages and economic losses.

2. to account for the temperature heterogeneity within a country, e.g. even if most population is located along the coastline another part resides in warmer and / or drier inland areas. This is typically the case for Morocco and other Mediterranean countries.

3. to also ponder the fact that some economic sectors - especially agriculture - could already be detrimentally affected by economic losses from current temperature levels while the rest of the sectors could face losses at higher levels of warming.

The study first explores the extent to which V20 have reached their optimum temperature, then estimates economic losses attributable to climate change over the last 20 years and finally appraises the extent to which precipitation alone has affected economic losses over the same period.

In a risk perspective, to also account for the uncertainties associated with the Bayesian calibration, the analysis on the attribution of economic losses to climate change focuses on the 10th percentile of the distribution. While this amplifies the amount of losses experienced by V20 economies, it also highlights the on-going negative impacts and risks associated with a rapidly changing climate. Interestingly, even for countries with optimum temperatures close or below their current temperature level, losses are also observed in the 10th percentile of the distribution indicating that such level of optimum does not immunize countries against negative impacts of climate change. Also, the use of the 10th percentile is also relevant owing to the fact that for some countries, temperature level below the optimum (hence a positive effect on growth) can wholly or partly offset the negative consequences of hydrometeorological extremes.

Essential to note is that this study is not comprehensive. While the whole economy is covered, using GDP as a central metric, not all anthropogenic climatic effects are included. Most crucially for V20 economies, temperature and precipitation may not fully reflect all effects of tropical cyclones, sea-level rise and storm surges. This is an even more important caveat when estimating future loss and damage from anthropogenic climate change, where sea-level rise contributes to exceeding thresholds to land loss and/or fresh water management, loss of biodiversity, etc.

## 5.2 MODEL COMPARISON

In this part we put our focus on two additional countries in which one or several climate-related disaster(s) occurred within a given year. Two countries and year were selected: Colombia for the 2009 flooding events and the Philippines for the 2009 tropical cyclone season. The figures (5 to 7) illustrate the ability of the model used for this analysis to capture the GDP per capita dynamic of different climate-related disasters on a country's GDP per capita. In 2009, the Philippines experienced more than twenty typhoons and tropical storms, causing more than US$ 903 million in damages. The two most destructive typhoons were Parma and Ketsana which caused 934 deaths, 736 severe Injuries and 84 missing people and a total of US$ 790 million in damages. Domestic resources for food and shelter amounted to US$ 7 million and international donations reached over US$ 38 million. In 2010, Colombia experienced its heaviest and deadliest rainfalls of the last 40 years impacting 95% of the country. 301 people were killed and 2.2 million were displaced. Thousands of hectares of crops and damages to infrastructure amounted to asset losses of US$ 5.2 billion. In order to resource the recovery, Colombia lowered the threshold of taxability for high earners to raise US$ 1.6 billion in tax revenue. Colombia also utilized a US$ 150 million credit line from the World Bank.

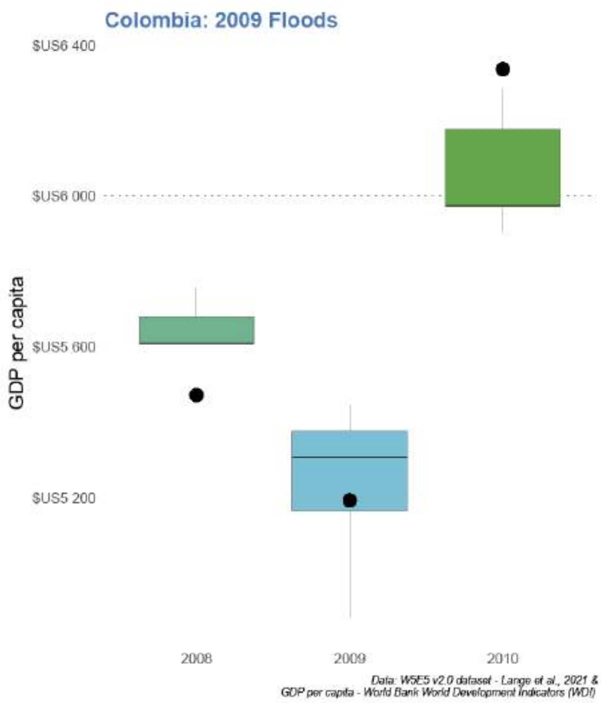


*Figure 6: Snapshot comparison between observed GDP per capita (black dots, source: World Bank data) and estimated (boxplots) for this analysis of floods in Colombia. Data: authors' calculations.*

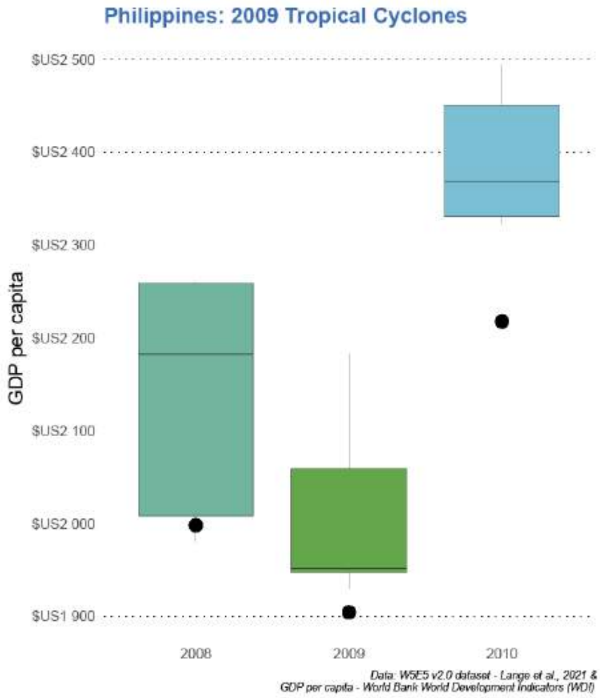


*Figure 7: Snapshot comparison between observed GDP per capita (black dots, source: World Bank data) and estimated (boxplots) for this analysis of tropical cyclones in the Philippines. Data: authors' calculations.*

# 6. ACKNOWLEDGEMENTS


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## ABOUT THE V20

Formed in 2015, the V20 Group of Finance Ministers is a dedicated cooperation initiative of economies systematically vulnerable to climate change. V20 Group members are also states of the Climate Vulnerable Forum (CVF). The Group's incoming chair is the Republic of Ghana. The V20 membership stands at 55 economies including Afghanistan, Bangladesh, Barbados, Benin, Bhutan, Burkina Faso, Cambodia, Colombia, Comoros, Costa Rica, Democratic Republic of the Congo, Dominican Republic, Ethiopia, Eswatini, Fiji, The Gambia, Ghana, Grenada, Guatemala, Guinea, Guyana, Haiti, Honduras, Kenya, Kiribati, Nicaragua, Lebanon, Liberia, Madagascar, Malawi, Maldives, Marshall Islands, Mongolia, Morocco, Nepal, Niger, Palau, Palestine, Papua New Guinea, Philippines, Rwanda, Saint Lucia, Samoa, Senegal, South Sudan, Sri Lanka, Sudan, Tanzania, Timor-Leste, Tunisia, Tuvalu, Uganda, Vanuatu, Viet Nam and Yemen.

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# 7. ENDNOTES

1 The optimum temperature is estimated using the Bayesian calibrated results of an econometric model (see further details in section on Methods).

2 https://climateactiontracker.org/global/temperatures/

3 https://climateactiontracker.org/global/temperatures/

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# CLIMATE VULNERABLE ECONOMIES LOSS REPORT

Economic losses attributable to climate change in V20 economies over the last two decades (2000-2019)

V20 Vulnerable Twenty Group
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