OPPORTUNITY GREEN

How inaction will cost more than the IMO's Net Zero Framework

November 2026

Summary

- By 2050, the total economic impacts of climate change are projected to far exceed the costs of implementing the IMO's Net Zero Framework (NZF). This gap widens further by 2100.
- Latin America, Africa and the Caribbean are among the regions most exposed due to their vulnerability to extreme weather events, economic reliance on agriculture, and low-climate readiness in the case of Africa in particular.
- Even when climate impacts are scaled down to reflect shipping's current 3% contribution to global emissions, the benefits of action continue to exceed the costs, according to most estimates.
- Beyond avoided damages, the NZF can both unlock substantial economic opportunities and – under the current drafting – distribute compliance revenues to help offset these costs. These are deliberately missing from this assessment, which assumes maximum costs and minimum benefits.
- Given the challenges of quantifying climate change's economic impacts, the estimates in this report are likely conservative, making the economic case for the NZF even more compelling.

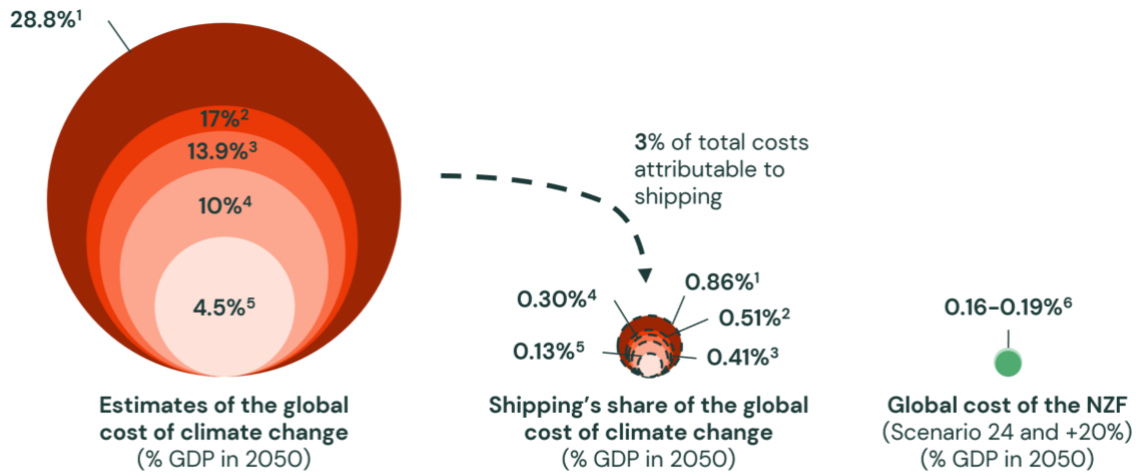
1. Global costs

At the global level, the IMO's NZF is estimated to cost between 0.16 and 0.19% of GDP in 2050 compared to business-as-usual.[i] This is an intentionally pessimistic estimate: the upper value assumes NZF costs to be 20% higher than those of Scenario 24 in the IMO's comprehensive impact assessment and excludes any associated economic opportunities.

Even so, **the costs of the NZF are significantly lower than estimates of the economic losses resulting from climate change.** Even adjusting for shipping's 3% share of global emissions,[ii] most studies estimate the economic impacts of climate change in 2050 to exceed the cost of the NZF (see Figure 1).

Fig. 1: Comparing estimates of the global cost of climate change and shipping's share of those costs with the cost of the NZF.

Area of the circle represents the cost as measured in percentage of global GDP loss in 2050.



[1]Bilal and Kanzig (2024): 12-20% fall in world GDP for every 1°C of warming. The lower estimate has been used for estimated 2.4°C warming, in line with RCP8.5.
[2]Wenz and Kuik (2024): Based on 2.4°C warming by 2050.
[3]Swiss Re, 2021 (2021): Figure for 2.6°C warming by 2050.
[4]Burke et al (2018): 2.5–3°C warming would lead to GDP losses of 10% at by 2050.
[4]Waidelich et al (2024): 3°C of warming would lead to 10% loss of global GDP.
[5]S&P Global Ratings (2022): Assumes 4.5°C by 2050 under RCP8.5.
[6]IMO (2024): Lower figure represents Scenario 24 of IMO comprehensive impact assessment; higher figure adds additional 20%.

IPCC RCP8.5 predicts 2.4°C warming by 2050[xi]

2. Regional assessments

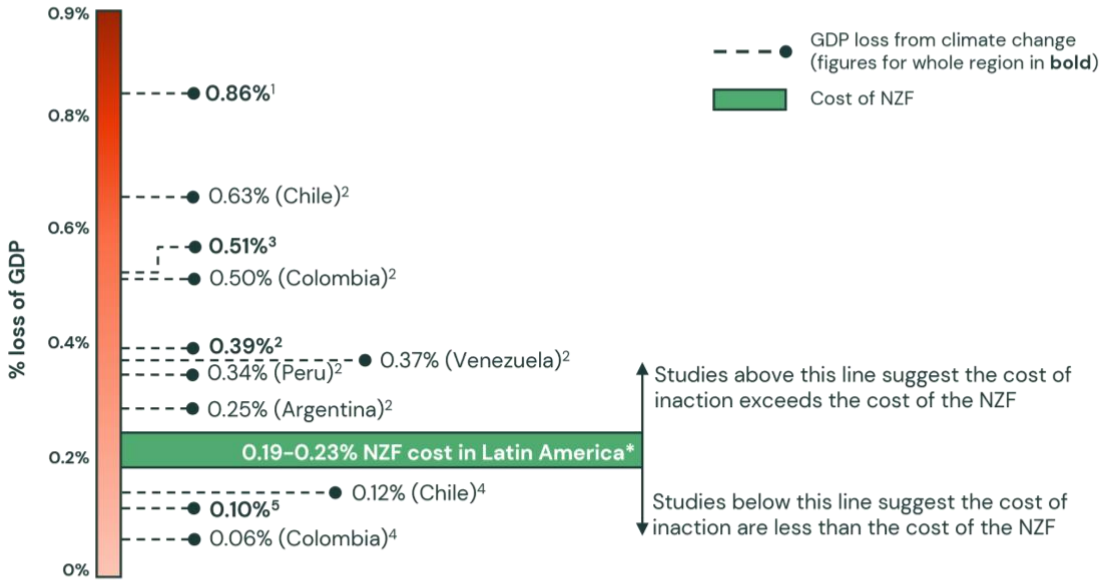
The following sub-sections examine the anticipated costs of the NZF and those of climate change for three regions: Latin America, Africa and the Caribbean.

2.1. Latin America

In Latin America, the cost of the NZF is estimated to be between **0.19 and 0.23% of GDP in 2050**.[a] Figure 2 compares these costs with estimates from the literature of shipping's share of the economic losses resulting from climate change in 2050, under a business-as-usual trajectory. More of the estimates expect shipping's share of climate losses in Latin America to be greater than the costs of the NZF.

Fig. 2: Comparing estimates of shipping's share of the cost of climate change in Latin America with the regional cost of the NZF, measured as GDP loss in 2050.

Estimates of the cost of climate change are 3% of the total GDP losses estimated in each study in order to account for the share of costs attributable to emissions from shipping. Estimates of the regional cost of the NZF are in green.



*Cost of NZF in 2050 by % of regional GDP (Low = Scenario 24, high = Scenario 24 + 20%). Source: IMO (2024).

[1]Bilal and Känzig (2026): Assume a permanent 1°C increase in global temperature causes 12-20% decline in GDP. Despite Latin American expected to be one of the worst effected regions, the lower end of that estimate has been used and calculated for a 2.4°C rise, as predicted in RCP8.5.
[2]Swiss Re (2021): Datapoints assume 2.6°C warming by 2050.
[3]Waidelich et al (2024): 17% losses in poorer, low-latitude countries at warming of 3°C.
[4]Kahn et al (2019) Data for 2050 under RCP8.5.
[5]Van der Borght (2023): Impacts from temperature only; excludes extreme weather, droughts and price shocks (RCP8.5).

Note: Each study uses different methods, assumptions, discount rates and climatic and eco-social factors in their calculations and so are not directly comparable. The figure above is purely an illustration of how the final calculations from each these studies compare to the costs of the NZF.

[a] The lower estimates are calculated by the average cost of Scenario 24 of the IMO's comprehensive impact assessment for each country in the region, weighted by share of GDP. As with the global figure, the upper bound adds 20% to these costs. Data comes from IMO CIA. Regional figures calculated through weighted average of cost countries in region.

The economies and wider societies of Latin America are highly vulnerable to the impacts of climate change. The estimates in Figure 2 are therefore likely to be conservative:

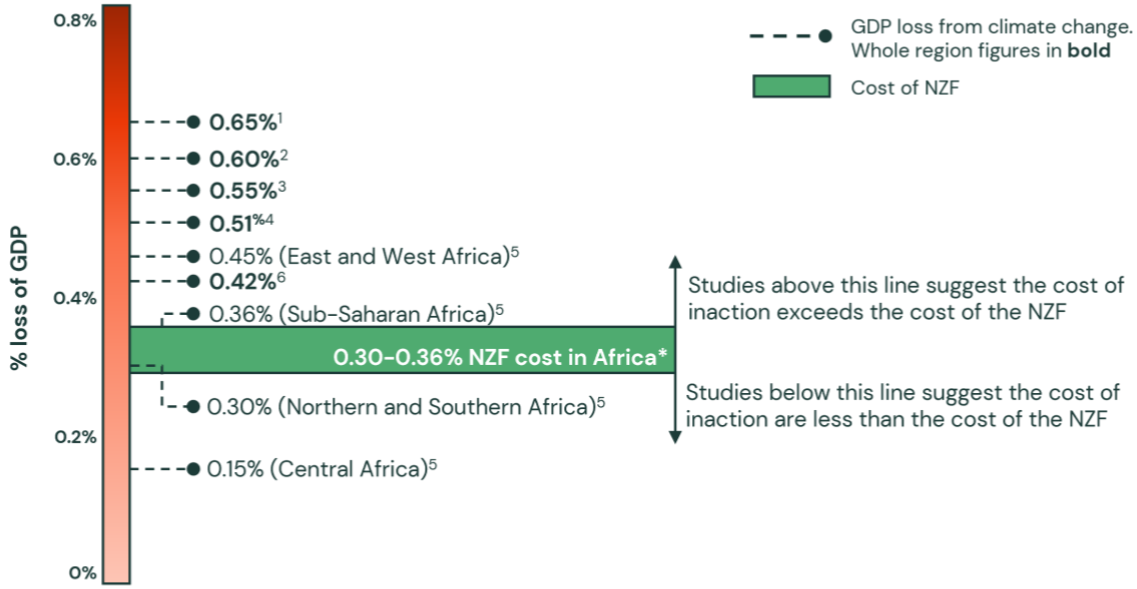
- Agriculture and related activities represent a large share of economic activity in many Latin American countries. These sectors are likely to be disproportionately impacted by climate change.[iii] **Subsistence farming and other reproductive activities are also frequently excluded from GDP accounts** and so these impacts will be in addition to those in many of the estimates**.**
- Latin American is highly vulnerable to extreme weather events – including hurricanes, floods, droughts and the impact of a changing and intensifying El Niño. This will create increased costs. Several of the studies above exclude the impacts from such events. Even under moderate warming, the economic impact of droughts alone is estimated by the World Bank to cost 2-5% of GDP in Argentina by 2050.[iv] Furthermore, physical damage from extreme heat and weather are estimated to cost 2.5% and 3.1% of GDP in Colombia and Paraguay in 2050, respectively.[v,vi] In Central America, nearly 40% more land area was affected by extreme drought between 2010 and 2019 than between 1950 and 1959.[vii]
- Regions at lower latitudes and with higher average temperatures are expected to see increased negative impacts on economic activity.[viii] Countries with higher levels of multidimensional poverty will also see higher impacts.[ix]

2.2. Africa

In Africa, the cost of the NZF is estimated to be between **0.30 and 0.36% of GDP in 2050**. Figure 3 compares these costs with estimates of shipping's share of the economic losses resulting from climate change in 2050, under a business-as-usual trajectory, for Africa. As with Latin America, more estimates expect shipping's share of the climate damages to exceed the costs of the NZF.

Fig. 3: Comparing estimates of shipping's share of the cost of climate change in Africa with the regional cost of the NZF, measured as GDP loss in 2050.

Estimates of the cost of climate change are 3% of the total GDP losses estimated in each study in order to account for the share of costs attributable to emissions from shipping. Estimates of the regional cost of the NZF are in green.



*Cost of NZF in 2050 by % of regional GDP (Low = Scenario 24, high = Scenario 24 + 20%). Source: IMO (2024).

[1]Swiss Re (2021): Datapoints assume 2.6°C warming by 2050.
[2]Christian Aid (2022): Assumes 2.7°C by 2050.
[3]Horowitz (2009): Based on 7% loss for every 1°C rise in temperature in Africa (assuming warming of 2.4°C by 2050 based on IPCC predictions).
[4]Waidelich et al (2024): 17% losses in poorer, low-latitude countries at warming of 3°C.
[5]ADB/UN (2019): Data for 2050 under RCP8.5.
[6]Deloitte (2022): Data for 2070 under RCP8.5.
[7]Baarsch et al. (2020): Assumes 2.3°C by 2050.

Note: Each study uses different methods, assumptions, discount rates and climatic and eco-social factors in their calculations and so are not directly comparable. The figure above is purely an illustration of how the final calculations from each these studies compare to the costs of the NZF.

As a region, Africa is also highly vulnerable to the impacts of climate change:

- Many African economies are highly dependent on climate sensitive sectors, most notably rain-fed agriculture. **The IPCC identifies negative impacts on food production as one of Africa's key climate risks**. Anticipated changes in rainfall patterns, droughts, floods and rising temperature are likely to have a direct effect on food security and exports,[x] with crop yields potentially reducing by up to 50%.[xi] As noted above, **subsistence farming and other reproductive activities are frequently excluded from GDP accounts.**
- **Africa is highly exposed to weather and climate extremes**, including droughts, floods, heatwaves, tropical cyclones, and changing rainfall regimes.[x] It is also vulnerable to the impacts of climate tipping points, as outlined further below.
- **According to the African Development Bank, the continent is the second-most climate vulnerable region of the world and displays the lowest**

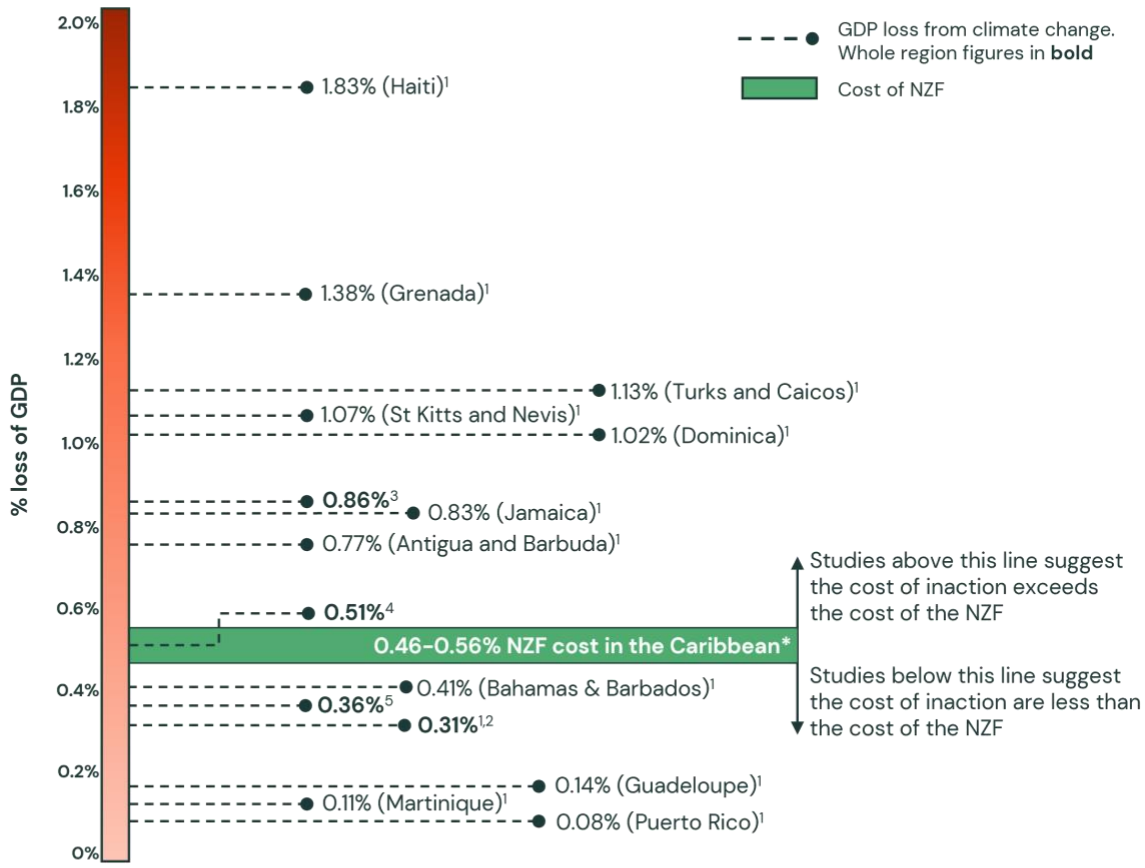
climate readiness.[xii] Depending on the future socio-economic scenario, this could increase inequalities within and between countries and leave some African economies significantly poorer than today.[xiii]

2.3. Caribbean

In the Caribbean, the cost of the NZF is estimated to be between **0.46% and 0.56% of GDP in 2050**. Figure 4 compares these costs with estimates of shipping's share of the economic losses resulting from climate change in 2050, under a business-as-usual trajectory, for the Caribbean region.

Fig. 4: Comparing estimates of shipping's share of the cost of climate change in the Caribbean with the regional cost of the NZF, measured as GDP loss in 2050.

Estimates of the cost of climate change are 3% of the total GDP losses estimated in each study in order to account for the share of costs attributable to emissions from shipping. Estimates of the regional cost of the NZF are in green.



*Cost of NZF in 2050 by % of regional GDP (Low = Scenario 24, high = Scenario 24 + 20%). Source: IMO (2024).

[1]Bueno et al, 2008: Includes impacts from hurricane damages, loss of tourism revenue and infrastructure damage only. Costs based on percentage of 2004 GDP vs BAU. The age of this study should be noted. However, there is a lack of more up-to-date data on the impact of climate change on aggregate GDP for the Caribbean region.
[2]Caricom, 2011: Also limited to costs from increased hurricane damages, loss of tourism revenue and infrastructure damages. As above, the age of this study should also be noted.
[3]Bilal and Känzig (2026): Assume a permanent 1°C increase in global temperature causes 12-20% decline in GDP. Despite impacts from extreme weather causing the Caribbean expected to be one of the worst effected regions, the lower end of that estimate has been used and calculated for a 2.4°C rise, as predicted in RCP8.5.
[4]Waidelich et al, 2024: 17% losses in poorer, low-latitude countries at warming of 3°C.
[5]ECLAC, 2023: Considers impacts from "the intensification of climate shocks", only, across six Caribbean countries.

Note: Each study uses different methods, assumptions, discount rates and climatic and eco-social factors in their calculations and so are not directly comparable. The figure above is an illustration of how the final calculations from each these studies compare to the costs of the NZF.

The economies of Caribbean nations are highly vulnerable to the impacts of climate change with losses expected to be above the global average.[xiv] Island nations are projected to experience particularly high impacts due to their geographical characteristics and dependence on tourism, agriculture and international trade.

- A study of the vulnerability of small island states, including in the Caribbean found that under a business-as-usual scenario, damage from climate change will result in the loss of between 1.7 and 6.5 years' worth of GDP.[xv] Another analysis suggests that **100% of the GDP of nine Caribbean states** is at risk from climate impacts, even under moderate stress scenario.[xvi]
- Caribbean states are particularly vulnerable to the impacts of extreme weather. The IPCC notes that climate impacts are amplified for small island nations, given their small land areas, remoteness and the fact that they are bounded by ocean.[xvii] **On average, extreme weather events cost small island nations 18% of their GDP, compared to a world average of around 3%.**[xviii] In 2017, Hurricane Maria cost Dominica over 225% of its GDP[xix] while the costs of Hurricane Dorian to the Bahamas in 2019 amounted to more than a quarter of the country's GDP.[xx]
- Caribbean economies are highly dependent on tourism, a sector which will be heavily impacted by climate change – both in terms of reduced visits and damage to infrastructure. **Extreme weather events are expected to have significant negative economic impacts on tourism revenues in the Caribbean**.[xxi]
- Agriculture is another contributor to Caribbean economies, accounting for around 10% of employment in the Dominican Republic and Saint Lucia. As a sector, **agriculture is highly vulnerable to environmental degradation, drought and crop losses from storms**.[xxii]
- Overall, there is a shortage of reliable estimates for the impact of climate change on Caribbean GDPs in 2050. Those that do exist are likely to understate the potential impacts. For example, the existence of tipping points (discussed further below) and their effect on GDP are very difficult to model and are therefore excluded from most estimates.[xxiii]

For all three regions, losses become substantially higher as we approach the end of the century. Estimates for Latin America and Africa suggest **losses of over 30% of GDP in 2100**,[xxiv] or 0.9% as adjusted to shipping's current share of global emissions

3. The challenge of GDP

Quantifying the economic impacts of climate change is notoriously difficult. Estimates are broad and uncertain. This is due to different methods of calculation, assumptions regarding linearity, discount rates, uncertainty of economic responses to warming and impact on specific industries, and uncertainty regarding climate tipping points. For this reason, a range of studies are presented in this analysis highlighting different values from the literature.

Due to the wide range of estimates and methods, the IPCC's Sixth Assessment Report does not provide singular figures or ranges. It does, however, conclude that the **damage is likely to be higher than previously assumed.**[xxv] A recent study suggested that **previous research has underestimated the macroeconomic damage from climate change by three to five times**.[xxvi]

Many studies rely on historical data to predict future impacts, despite no precedent existing for climate change. They also rely on linear models which do not accurately represent the non-linear economic, social and ecological impacts of climate change, such as the collapse of crop yields. Many studies also use country-level data for both climate and GDP impact, which underestimate local variation and neglects global systemic impacts.

Most studies modelling the economic impacts of climate change do not effectively model **climate tipping points**. Tipping point events can cause climate change to become irreversible and self-reinforcing. Crossing the critical thresholds at which these events occur will have catastrophic impacts on global, regional and national economies.

A recent study provided best estimates for the warming scenarios at which various tipping point events could occur.[xxvii] Both the rate of warming and overshoot duration will also affect the risks of these tipping points. Note, the IPCC's business-as-usual scenarios predict 2.4°C of warming by 2050 and over 5°C by 2100.[xxviii]

- Low-latitude Coral Reefs (1.5°C, uncertainty range: 1-2°C)
- Abrupt thaw of boreal permafrost (1.5°C, range 1-2.3°C)
- Collapse of the West Antarctic icesheet (1.5°C, range 1-3°C)
- Collapse of the Greenland ice sheet (1.5°C, range 0.8-3°C)
- Disruption of Sahel / W. African monsoon (2.8°C, range 2-3.5°C)
- Amazon rainforest dieback (3.5°C, range 2-6°C)
- Collapse of boreal permafrost (4°C, range 3-6°C)

- Collapse of Atlantic Meridional Overturning Circulation (AMOC) (4°C, range 1.4-8°C)

Using impacts on GDP to assess the NZF's value is therefore problematic, given the substantial uncertainty surrounding estimates of climate-related GDP losses. Reliance on this metric risks undervaluing the NZF by failing to capture the full range of potential climate risks and benefits.

Conclusion

This briefing provides a conservative comparison of the costs of the NZF and the costs of climate change. In doing so, it deliberately overstates the likely costs of the NZF and does not include the wider economic and strategic opportunities the NZF could unlock, including supporting the maritime transition. Even on this narrow measure, the NZF represents strong value for money. Most estimates consider the cost of inaction to far outweigh investment in the NZF.

Opportunity Green

At Opportunity Green we use legal, economic and policy knowledge to tackle climate change. We do this by amplifying diverse voices, forging ambitious collaborations and using legal innovation to motivate decision makers and achieve climate justice.

www.opportunitygreen.org

Legal disclaimer

Opportunity Green gives no warranty, express or implied, to the accuracy or completeness of the information in this document and does not accept responsibility or liability of any kind for any action made by anyone in reliance on this document or the use of the information contained in this document. The figures provided and tabulated are based on publicly reported information.

This paper was written by Nick Langridge on behalf of Opportunity Green. Any omissions or errors are the fault of the authors alone.

Further information

Dr Nick Langridge
Research Officer – Economics and Finance
nick@opportunitygreen.org

---

[i] IMO, 2024. Report of the Comprehensive impact assessment of the basket of candidate GHG reduction mid-term measures – full report on Task 3 (Impacts on States). Available: UNCTAD - 2024 - Report of the Comprehensive #impact assessment of the basket of candidate GHG reduction mid-term meas.pdf

[ii] International Maritime Organization, 'Fourth Greenhouse Gas Study 2020' (2020). Available: https://www.imo.org/en/ourwork/environment/pages/fourth-imo-greenhouse-gas-study-2020.aspx

[iii] ECLAC, 2023. Economic Survey of Latin America and the Caribbean 2023. Available: Economic Survey of Latin America and the Caribbean 2023. Financing a sustainable transition: investment for growth and climate change action | Economic Commission for Latin America and the Caribbean

[iv] World Bank, 2022. Argentina Country Climate and Development Report. Available: Open Knowledge Repository

[v] World Bank, 2023. Columbia Country Climate and Development Report. Available: Open Knowledge Repository

[vi] World Bank, 2025. Paraguay Country Climate and Development Report. Available: Open Knowledge Repository

[vii] Romellano et al. 2021. The 2021 report of the *Lancet* Countdown on health and climate change: code red for a healthy future. *The Lancet,* 398 (10311).

[viii] Waidelich et al. 2024. Climate damage projections beyond annual temperature. *Nature Climate Change*, 14, pp. 592–599

[ix] Burke, Hsiang and Miguel, 2015. Global non-linear effect of temperature on economic production. *Nature,* 527, pp.235-239

[x] Trisos, C.H., I.O. Adelekan, E. Totin, A. Ayanlade, J. Efitre, A. Gemeda, K. Kalaba, C. Lennard, C. Masao, Y. Mgaya, G. Ngaruiya, D. Olago, N.P. Simpson, and S. Zakieldeen, 2022: Africa. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

[xi] Porter et al. 2014 - Porter, J. R., L. Xie, A. J. Challinor, K. Cochrane, S. M. Howden, M. M. Iqbal, D. B. Lobell, and M. I. Travasso. 2014. Food Security and Food Production Systems. *In Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK and New York, NY, USA.

[xii] African Development Bank. 2022. African Economic Outlook 2022. Available: ADB African Economic Outlook 2022.pdf

[xiii] Burke et al. 2015. Global non-linear effect of temperature on economic production. *Nature,* 527, pp. 235-239

[xiv] Thomas et al. 2020. Climate Change and Small Island Developing States. *Annual Review of Environment and Resources*, 45, pp.1-27

[xv] Choudhury et al. 2025. From Vulnerability to Value: The Economic Payoff of Adaptation in Small Island States. *Global Centre on Adaption*. Available: From Vulnerability to Value: The Economic Payoff of Adaptation in Small Island States - Global Center on Adaptation

[xvi] S&P Global Ratings. 2022. Weather Warning: Assessing Countries' Vulnerability to Economic Losses from Physical Climate Risks., Available: 101529900.pdf

[xvii] Mycoo et al. 2022. Small Islands. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. *Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

[xviii] Saghir and Ijjasz-Vasquez. 2025. Small Costs for Large Gains: Climate Resilience in Small Island Developing States. *The Payne Institute for Public Policy*. Available: Small Costs for Large Gains: Climate Resilience in Small Island Developing States - Payne Institute for Public Policy

[xix] UN. 2022. National Consultation: Sustainable Recovery and Resilience towards achieving the Sustainable Development Goals in the Commonwealth of Dominica. Available: Microsoft Word - Concept Note Program- National Consultation- Dominica -Final Rev 14 Mar 2022

[xx] Roy. 2024. How the Caribbean Is Building Climate Resilience. *Council on Foreign Relations*. Available: How the Caribbean Is Building Climate Resilience | Council on Foreign Relations

[xxi] Granvorka and Strobl. 2013. The Impact of Hurricane Strikes on Tourist Arrivals in the Caribbean. Tourism Economics, 19 (6); Cevik and Ghazanchyan. 2020. Perfect Storm: Climate Change and Tourism. *IMF Working Paper*. Available: Perfect Storm: Climate Change and Tourism

[xxii] ECLAC. 2023. Economic Survey of Latin America and the Caribbean 2023. Available: Economic Survey of Latin America and the Caribbean 2023 | Economic Commission for Latin America and the Caribbean

[xxiii] Titelman et al. 2023. Economic and Fiscal Implications of Climate Change for Vulnerable Countries in Central America and the Caribbean. *Task Force on Climate, Development and the IMF*. Available: TF-WP-013-FIN.pdf

[xxiv] Kalkuhl & Wenz. 2020. The impact of climate conditions on economic production. Evidence from a global panel of regions. *Journal of Environmental Economics and Management*, 103, 102360

[xxv] IPCC, 2022. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press: Cambridge, UK and New York, NY, USA.

[xxvi] Bilal and Känzig, 2026. The Macroeconomic Impact of Climate Change: Global Vs. Local Temperature. The Quarterly Journal of Economics, 141 (2), pp. 889-944

[xxvii] McKay et al. 2022. Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science,* 377 (6611)

[xxviii] Lee, J.-Y., et al., 2021: Future Global Climate: Scenario-Based Projections and Near-Term Information. In: *Climate Change 2021 The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press

Additional references in figures

Burke et al. 2018. Large potential reduction in economic damages under UN mitigation targets. *Nature, 557, pp. 549-553*

S&P Global Ratings. 2022. Weather Warning: Assessing Countries' Vulnerability to Economic Losses from Physical Climate Risks., Available: 101529900.pdf

Swiss Re. 2021. The economics of climate change. Available: The economics of climate change

Van der Borght. 2023. Los efectos del cambio climático en la actividad económica de América Latina y el Caribe: una perspectiva empírica. *CEPAL*. Available: Los efectos del cambio climático en la actividad económica de América Latina y el Caribe: una perspectiva empírica | CEPAL

Wenz and Kuik. 2024. Economic Impacts: The Economic Consequences of the Climate Crisis. In: Wiegandt (eds*) 3 Degrees More*. Springer, Cham