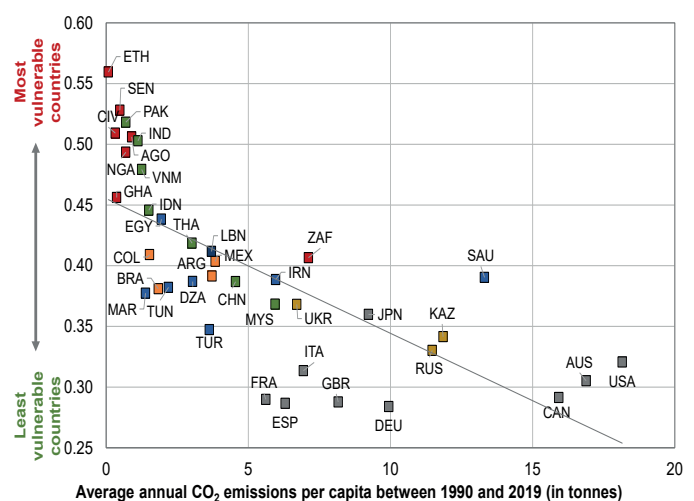


## Emerging Economies and Climate Change

*Elise Gaillat, Vincent Guiet*

- The economic effects of climate change are becoming increasingly consequential as the pace of long-term environmental changes accelerates and extreme weather events increase in frequency and intensity. Vulnerability to climate change has become central to identifying and assessing potential risks to the growth trajectories of emerging economies. A country may be considered vulnerable due to its physical exposure to climate change, the sectoral composition of its economy or its adaptive capacity.
- Most of the major emerging economies are low contributors to global warming, yet they are much more vulnerable to its consequences than advanced economies, albeit to differing degrees of exposure (see chart on this page). The countries most exposed to environmental changes (rising sea levels, desertification) and extreme weather events are those in tropical areas in sub-Saharan Africa, Asia and Latin America.
- The sectoral and geographic structure of some emerging economies increases their vulnerability to climate change. Those particularly dependent on rain-fed agriculture are expected to suffer lower crop yields (sub-Saharan Africa and Southern Asia), whereas countries where most of the economic activity is in coastal regions will have to contend with rising sea levels (Southeast Asia). Arid and semi-arid regions (North Africa and the Middle East) could see disastrous consequences from water stress.
- Not all emerging economies have the same adaptive capacity to cope with these changes, and the variation between them is closely tied to their level of development. The lack of infrastructure or medical professionals, for example, could significantly exacerbate the consequences of climate change in numerous countries. International cooperation is both needed and warranted to reduce the impacts of climate change on these economies and the associated side effects.

**Vulnerability to climate change and CO<sub>2</sub> emissions by country**



Source: World Bank, ND-GAIN, DG Trésor.

How to read this chart: Vulnerability is measured by the ND-GAIN index, which ranges from 0 to 1. The colours correspond to different regions (major advanced economies are in grey).

# 1. Climate change has become a key determinant of the trajectories of emerging economies<sup>1</sup>

In its latest assessment report,<sup>2</sup> the International Panel on Climate Change (IPCC) confirmed that climate change is affecting every region across the globe and that it is unequivocally human caused. Through long-term environmental changes (rising temperatures, lower crop yields, sea level rises, etc.) and extreme weather events (floods, droughts, etc.), the consequences are and will be major for all of the world's economies.<sup>3</sup> As an example, the summer 2022 floods in Pakistan that caused 1,700 deaths resulted in a 2.2% loss of annual GDP and a 5.9-percentage-point increase in the poverty rate, according to the World Bank.

To understand and forecast the macroeconomic trajectories of emerging economies, it has become essential to assess their vulnerability to climate change. But while it is generally possible to assess the economic impact of a weather event after the fact, it is more challenging to quantify the degree of vulnerability of individual economies in advance.

There are three components to a country's vulnerability to climate change: (i) the degree of physical exposure of the economy to climate disruptions, i.e. to the direct consequences of a long-term environmental change or extreme weather event; (ii) the sectoral structure of its economy, which could potentially render it more fragile due to a dependence on affected sectors (particularly the primary sector); and (iii) its capacity to adapt to long-term changes and extreme weather events (access to drinking water, quality of health infrastructure, institutional capacity). The University of Notre Dame Global Adaptation Index (ND-GAIN), a composite indicator, offers a way to quantify these three components (see Box 1).

Country risk analysis – which seeks to measure the macroeconomic, financial and political vulnerability of a country in order to determine the level of risk of an investment or the country's creditworthiness – can

no longer ignore the risks associated with climate change. Generally speaking, this type of assessment looks at five factors: real economy, external balance, public finances, banking sector, and institutional stability. *DG Trésor*, which has a tool based on these five criteria, will soon be adding a sixth criterion to factor in climate risk, using ND-GAIN data.

While greenhouse gas (GHG) emissions in major emerging economies continue to increase, they remain significantly below those of advanced economies, whether measured on a per capita basis or in terms of historic emissions. After factoring in emissions from goods imported and consumed (carbon footprint), there is an even greater difference between advanced and emerging economies. Whereas high-income economies are estimated<sup>4</sup> to be responsible for 58% of the global CO<sub>2</sub> footprint accumulated since the Industrial Revolution (onset in 1750), apart from major GHG emitters China (14% and currently the leading emitter) and Russia (7%), the 29 other emerging economies in our study are estimated to be responsible for just 17%.

Yet emerging economies are much more vulnerable to the economic and social consequences of climate change. An IMF study<sup>5</sup> also shows that vulnerability to climate change (as measured by the ND-GAIN Index) has a greater impact on creditworthiness, and therefore risk of default, for emerging and developing countries compared to advanced economies. A 1% increase in climate vulnerability, as measured by the ND-GAIN indicator, was found to increase long-term sovereign bond yield spreads by 310 basis points for emerging and developing economies, compared to just 70 basis points for advanced economies. This disproportion between causes and consequences results from geographical and economic characteristics of emerging and developing countries.

(1) Our study looks at 31 emerging economies selected based on: (i) their weight in the global economy; (ii) their demand for French exports; and (iii) France's exposure to their sovereign debt. They are: Angola, Côte d'Ivoire, Ethiopia, Ghana, Nigeria, Senegal, South Africa (sub-Saharan Africa); Argentina, Brazil, Colombia, Mexico (Latin America); China, India, Indonesia, Malaysia, Pakistan, Thailand, Vietnam (Asia); Kazakhstan, Russia, Turkey, Ukraine (emerging Europe); Algeria, Egypt, Iran, Lebanon, Morocco, Qatar, Saudi Arabia, Tunisia, United Arab Emirates (Middle East and North Africa).

(2) [IPCC\\_AR6\\_SYR\\_SPM.pdf](#)

(3) B. Carantino, N. Lancesseur, M. Nakaa and M. Valdenaire (2020), "The Economic Effects of Climate Change", *Trésor-Economics*, no. 262.

(4) According to the Global Carbon Project.

(5) S. Cevik and J. Tovar Jalles (2020), "This Changes Everything: Climate Shocks and Sovereign Bonds", *IMF Working Paper*, no. 2020/079.

### Box 1: How the ND-GAIN Index works

The ND-GAIN indicator, created in 2013 by the University of Notre Dame (Indiana, United States), uses data over a 20-year period to annually rank 181 countries according to their vulnerability to climate change. Vulnerability scores are calculated based on 36 indicators across three components, crossed with six life-supporting sectors (water, infrastructure, human habitat, ecosystem services, food and health):

- Exposure component: Measures the nature and degree to which a country is exposed to the physical risks of climate change, using projections up to 2050 (e.g. grain yields, flood risk, population changes).
- Sensitivity component: Measures the degree to which a country's six life-supporting sectors are negatively affected by climate change. Two countries with different economic and demographic structures would experience different consequences to the same extreme weather event or long-term environmental change (e.g. dependence on food imports, percentage of the population living in areas where elevation is below five metres).
- Adaptive capacity component: Measures the ability of a country to reduce potential damage and respond to the consequences of climate change (e.g. quality of transportation infrastructure, access to electricity and drinking water).

For each indicator, countries are ranked based on scores from 0 to 1 (where 1 indicates the country most at risk for the indicator). The mean of the scores for the 36 indicators is then taken to produce a final score for each country (from 0 to 1, where 1 is the worst score) so they can be ranked based on their degree of vulnerability to climate change. Switzerland has therefore been deemed to be the least vulnerable country with a score of 0.25, and Niger the most vulnerable with 0.67.

There are not many climate vulnerability indicators to choose from.<sup>a</sup> We opted for the ND-GAIN because it is one of the most complete: (i) it measures both physical risks and transition risks; (ii) it is transparent (its data sources and explanatory documentation are public); (iii) it covers almost all of the world's countries; (iv) the time series it uses range from 1990 to 2022, making it a good tracking and comparison tool. It does have limitations, however, such as the fact that it gives equal weighting to the 36 sub-components used to determine final scores.

a. We considered six potential indicators for this study: (i) Climate Risk Index (Germanwatch); (ii) Physical Vulnerability to Climate Change Index (FERDI); (iii) Climate Change Performance Index (Germanwatch); (iv) Energy Transition Index (World Economic Forum); (v) Climate Vulnerability Index (Maplecroft); (vi) ND-GAIN (University of Notre Dame, United States).

## 2. Increased physical exposure

By virtue of their geographic location, emerging economies are more exposed to the physical effects of climate change than their advanced counterparts, in terms of both long-term environmental changes (e.g. rising temperatures, rising sea levels, soil degradation) and extreme weather events (e.g. droughts, floods).

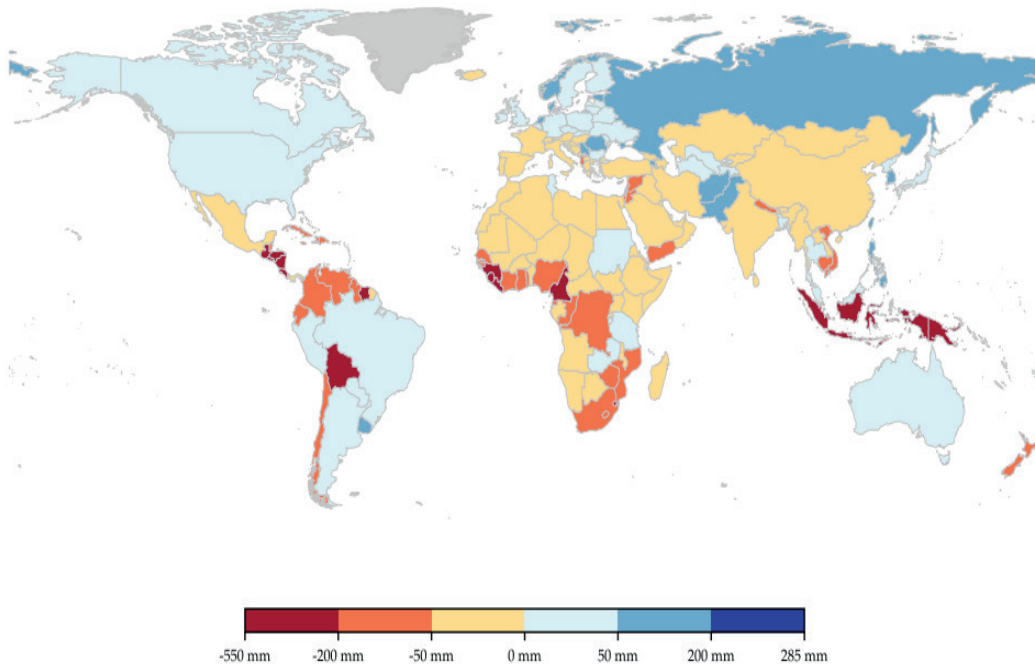
Over the long term, due to changing temperatures and precipitation patterns (see Chart 1), we can expect to see larger declines in crop yields in low-altitude areas,<sup>6</sup> where most emerging economies are located, in contrast to advanced economies closer to the poles, which could see improved yields. The decline in crop yields, particularly grain crops (key sources of calorie intake), attributable to a decrease in arable

land due to soil degradation and desertification,<sup>7</sup> is more pronounced in Africa, particularly Western Africa, than the rest of the world. Countries in Southern Asia (India, Pakistan) are also among those hardest hit by environmental changes caused by disruptions in the water cycle (disrupted monsoon patterns), severe water stress and rising temperatures. Southeast Asia is expected to see a significant rise in sea levels by 2050; the Asian Development Bank (ADB) is forecasting a rise of more than 70 centimetres, which is 20% higher than the global average. Similarly, rising sea levels in the Gulf of Guinea put Western African countries at risk of being submerged (with Lagos, the largest city in Africa, at particularly high

(6) C. Rosenzweig, J. Elliott, D. Deryng, J. W. Jones (2013), "Assessing Agricultural Risks of Climate Change in the 21st Century in a Global Gridded Crop Model Intercomparison", *Potsdam Institute for Climate Impact Research*, vol. 111, no. 9.

(7) Desertification is defined as the loss of biological or economic productivity in arid, semi-arid or subhumid areas due to soil erosion and the lasting loss of natural vegetation.

**Chart 1: Difference in annual precipitation, 2001-2017 vs 1900-1950**



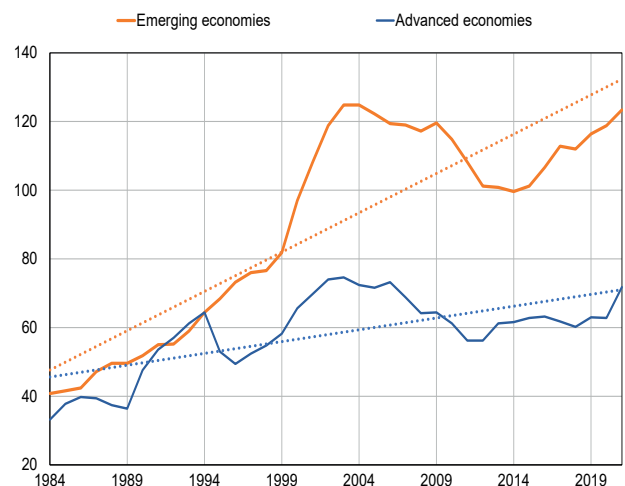
Source: Bandt, O. , Jacolin, L. and T. Lemaire (2021). “Climate Change in Developing Countries: Global Warming Effects, Transmission Channels and Adaptation Policies”.

risk) and changing precipitation patterns are increasing the risk of floods. Water stress<sup>8</sup> will also strongly affect countries located in arid and semi-arid regions, which includes many emerging economies in North Africa, the Middle East and parts of Southern Asia. Moreover, rising temperatures and biodiversity loss (due in particular to deforestation) will promote the spread of diseases, particularly in tropical and equatorial areas (sub-Saharan Africa, Southern Asia).

Since the 1980s, emerging countries have been seeing an increasing number of extreme weather events, to a greater extent than advanced countries (see Chart 2). Emerging economies, largely located near the equator, are home to ecosystems that are much more vulnerable to temperature changes than temperate areas. Sub-Saharan African economies are particularly exposed to the intensification of extreme weather events. According to the IMF, such events have nearly quadrupled there since the 1980s, compared to a 2.5-fold increase on average in other emerging economies. In the summer of 2022, Nigeria suffered its most devastating floods in its history, resulting in 600 deaths and the displacement of 1.5 million people. In Southern Asia, according to the ADB,<sup>9</sup> extreme heat spikes affecting 60% of the region could result in a 10% loss of agricultural output by

2050. In the spring of 2022, record temperatures led to a collapse in crop yields, forcing India to ban wheat exports due to concerns about its own food security. In Latin America, the intensification of *El Niño* and *La Niña* episodes<sup>10</sup> has brought torrential rains, floods (in Argentina and the south of Brazil) and periods of drought (in Colombia and the north of Brazil), significantly impacting agricultural output, energy production and water supply, among other things.

**Chart 2: Number of extreme weather events related to climate change**



Source: IMF.

How to read this chart: The types of extreme weather events taken into account are droughts, heatwaves, floods, wildfires and landslides.

(8) Where the demand for water exceeds the available water resources in a given geographical area.

(9) “Asian Megacities Threatened by Climate Change – Report”, 6 February 2018, Asian Development Bank.

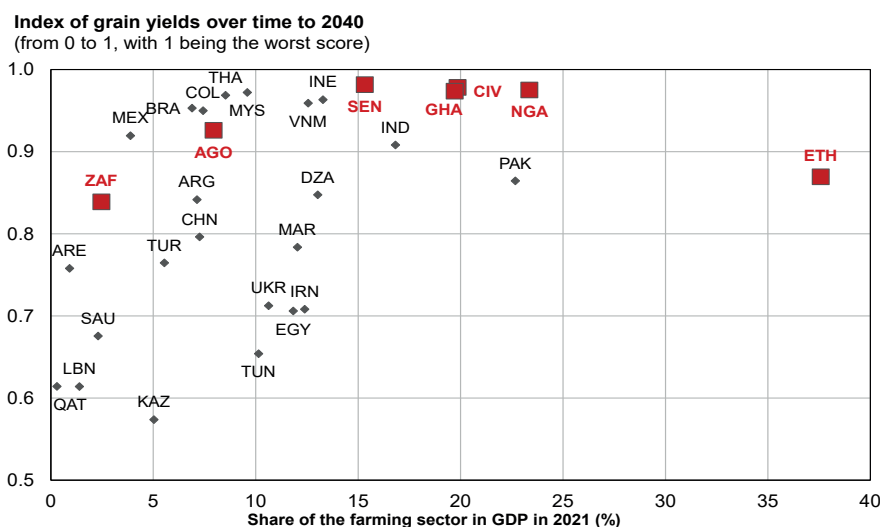
(10) Climate phenomena where abnormally high temperatures (El Niño) or abnormally low temperatures (La Niña) in the Pacific Ocean result in atmospheric disruptions.

### 3. Considerable diversity in terms of sector sensitivity

The sectoral structure of emerging economies amplifies their sensitivity to climate disruptions compared to advanced economies. Given the heavy weight of the primary sector<sup>11</sup> (crop and livestock farming and fishing) in these economies, the consequences of a decrease in agricultural output in connection with extreme weather events (droughts, floods) or longer-term changes (loss of fish populations, etc.) are likely to affect a larger share of GDP and the population, in terms of employment. For the most vulnerable farming populations in emerging economies (particularly in sub-Saharan Africa and Southern Asia), agriculture is mostly sustenance farming, which heightens the consequences of a climate disaster on food security. Moreover, in some regions where agriculture is mainly rain-fed (i.e. irrigation systems are not used), the intensification of extreme weather events is likely to lead to extreme fluctuations in food production (in terms of both crops and livestock), exacerbating price volatility. For the most vulnerable populations, who spend a larger share of their income on sustenance, such price swings undermine their access to food.

In sub-Saharan Africa, the primary sector – which accounts for a highly significant share of GDP (see Chart 3), employment and consumption – is particularly vulnerable, whereas its demography, and therefore food consumption, are dynamic. Additionally, repeated episodes of extreme heat, diminishing water resources and decreased forage production have a considerable impact on livestock farming, in a region where pastoralism plays a major economic role. This vulnerability of sub-Saharan Africa’s primary sector will have significant humanitarian and macroeconomic consequences, considering the already high prevalence of undernourishment in the region. For instance, in Nigeria, the largest economy and most populous country in Africa, where the agricultural sector accounts for roughly one-quarter of GDP and three-quarters of employment, increasing desertification (affecting an estimated 35% of the country) poses a significant threat to food security. According to the World Bank, if sea levels were to rise by one metre, which is a possibility by 2100, it would result in a loss of 75% of arable land in the Niger Delta.

**Chart 3: Sensitivity of the agricultural sector to a collapse in grain yields**



Source: ND-GAIN, World Bank.

How to read this chart: Sub-Saharan African countries are shown in bold and red. The index uses a 0-to-1 scale (where 1 is the biggest decline) to measure the percentage change between (i) annual average grain yields between 1980 and 2009, and (ii) estimated annual yields between 2040 and 2070 under the IPCC’s RCP4-5 emissions scenario.

(11) According to the World Bank, the primary sector accounts for 10.7% of GDP in emerging economies, on average, as compared to 1.4% for OECD countries.

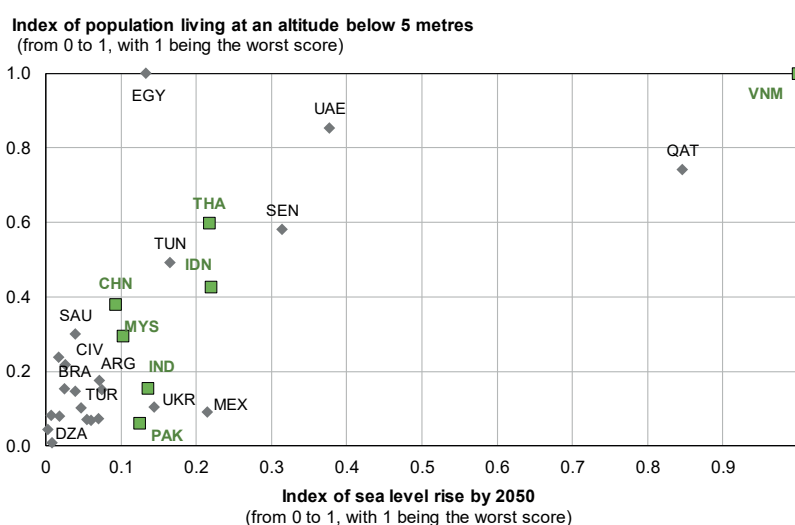


There is variation in the sensitivity of emerging Asian economies, between China, the richest and least vulnerable country, and emerging Southeast Asian economies (Thailand, Vietnam, Indonesia) and Southern Asian economies (India and Pakistan), which are made more vulnerable by their dependence on the primary sector and the geographical distribution of their populations. In Southeast Asia, a significant rise in sea levels (see below) would impact the region's major economic centres, which are primarily located in coastal areas (see Chart 4). In Jakarta, which accounts for half of Indonesia's GDP, some 18% of GDP is expected to be vulnerable to floods by 2030. Flooding and saltwater intrusion are expected to make 10% of the region's rural agricultural land unfarmable, in countries that depend heavily on the primary sector<sup>12</sup> for both domestic consumption and exports. According to the World Bank, in Vietnam, the world's fourth largest exporter of rice, 2.6 million tonnes of rice are projected to be lost each year by 2040 due to rising sea levels, the equivalent of 40% of its 2020 export volume. As for China, it is mainly vulnerable to rising temperatures and extreme precipitation patterns, which threaten labour productivity. In its most exposed areas (Shanghai, Wuhan and Shenzhen), extreme heat and humidity could reduce the average number of outdoor working hours by some 10% by 2050, which equates to an annual loss of 2% to 3% of GDP.<sup>13</sup>

While emerging economies in the Middle East and North Africa may seem less exposed to the physical risks of climate change, they do have a greater degree of sectoral sensitivity. With more than 60% of their populations living in areas with high water stress (compared to 35% worldwide), a decrease in water resources could result in economic losses estimated at between 6% and 14% of GDP by 2050, according to the World Bank. This is a particular concern for Algeria, Egypt and the Gulf countries, where water consumption already largely exceeds renewable drinking water resources. The agricultural sector, which accounts for just 6% of the region's GDP, is expected to be less affected than that of other emerging economies, on average (except in Algeria). But these countries' strong dependence on food imports (in particular grains) exposes them to climate change impacts beyond their borders and ensuing food price fluctuations.<sup>14</sup>

Although the effects of the energy transition are outside the scope of the ND-GAIN indicator, it is something that presents significant challenges for Persian Gulf countries, which will see a decline in demand for oil and gas and the income it brings in. This could be viewed, in part, as an indirect impact of climate change. While the timescale over which these risks could materialise is uncertain, these countries are anticipating a loss of income by adopting relatively similar diversification strategies (referred to as "visions"), for example in the new tech and tourism sectors, *via* their sovereign wealth funds.

**Chart 4: Sensitivity of emerging economies to rising sea levels**



Source: ND-GAIN.

How to read this chart: Asian countries are shown in bold and green.

(12) The primary sector accounts for 14% of GDP in Vietnam, 13% in Indonesia and 8% in Thailand.

(13) McKinsey Global Institute, "Climate Risk and Response in Asia".

(14) As an example, between 2010 and 2011, Russia imposed export restrictions following a historic drought that cut wheat production by 40%. These restrictions affected Egypt, which imports 50% of its wheat from Russia, at an estimated cost of \$700m in 2010.

Emerging economies in Latin America appear less sensitive to climate change than those in sub-Saharan Africa and Asia. Although higher temperatures, rising sea levels and biodiversity loss are not insignificant physical risks, the region does have a relatively diversified economic structure, making it less sensitive to climate shocks. For example, it has a smaller rural share of its population than the emerging economy average (16% as compared to 37%) and is less dependent on the primary sector (5% of GDP as compared to 10%). That being said, more frequent extreme weather events do present a threat to some

key sectors – energy in particular. Brazil and Colombia are both highly dependent on water resources for their electricity production (64% and 68% of their generating capacity, respectively), resources which have been depleted by increasingly frequent and intense droughts. In Brazil, a 2001 drought reduced its hydropower generating capacity to almost nothing, costing 1.5% of GDP. According to the International Energy Agency, by the end of the century, the region will see its hydropower generation fall by 17% on average, due to climate change pressures on water availability.

#### 4. Limited adaptive capacity and the need for international cooperation

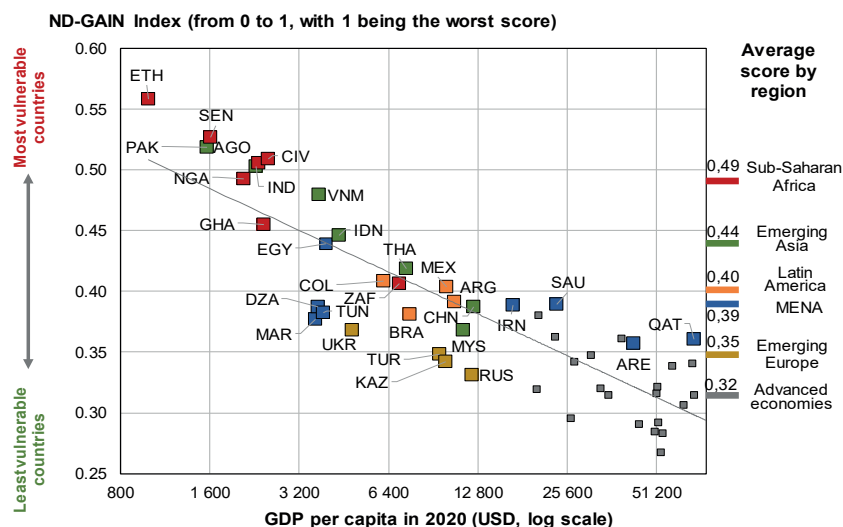
Emerging countries' capacity to adapt to climate change is limited, as it is closely tied to level of economic development (see Chart 4). Limited financial resources, less developed infrastructure in some countries (particularly water and healthcare infrastructure), lower housing quality and less effective governance all exacerbate the consequences of climate change and related natural disasters. On average, as a percentage of GDP, the economic costs of climate change are estimated to be 3.6 times higher for low-income countries than their richest counterparts.<sup>15</sup>

Sub-Saharan Africa is the region with the weakest adaptive capacity. Agriculture, which is primarily rain-fed, will strongly suffer from the intensification of droughts (particularly in Southern Africa) due to a lack of irrigation systems and access to fertilisers. A shortage of medical professionals and

infrastructure is also likely to substantially limit these countries' capacity to manage outbreaks of diseases associated with biodiversity loss (see below).

To limit the effects of climate change, some emerging economies have already begun taking mitigation measures (to reduce greenhouse gas emissions) or adaptation measures (to limit the consequences of rising temperatures). For example, in 2008, Vietnamese authorities set up a programme to address the effects of rising sea levels, since 5% of the country's land – particularly in the Mekong Delta, a vital agricultural region – are at risk of disappearing with a 1-metre sea level rise. So far, €1.1bn has been invested in the programme, funding projects such as new hydraulic infrastructure and flood management research.

Chart 5: Vulnerability to climate change (aggregate ND-GAIN score) and GDP per capita



Source: ND-GAIN, World Bank.

(15) S&P Global Ratings, "Weather Warning: Assessing Countries' Vulnerability to Economic Losses from Physical Climate Risks", April 2022.

National adaptation policies may have the effect of crowding out investment and consumption. This is the case in some of the most fragile countries in sub-Saharan Africa and Asia, where crowd-out effects appear to have been exacerbated by limited fiscal resources to diversify public investment and support households affected by climate shocks. Increased spending to mitigate or adapt to the effects of global warming (agriculture investment to support grain yields, household spending on food) may come at the expense of other sectors – such as education and infrastructure – where investment is needed for development and economic convergence.

International cooperation and financial support, whether bilateral or multilateral, are also critical to ensuring resilience to climate change, particularly since it is often

less expensive to invest in adaptation measures than it is to respond to a natural disaster and the ensuing global consequences. International agreements such as the Paris Climate Accords and the Addis Ababa Action Agenda, both adopted in 2015, have proposed a framework for cooperation that would see official development assistance (ODA) more rapidly directed towards climate objectives. Bilateral ODA from OECD countries for climate change mitigation and adaptation measures grew from \$24bn in 2014 to \$37bn in 2021. The fast-tracking of such financial assistance will be a critical challenge in the coming years, to ensure that the world's most vulnerable countries are able to adapt to and mitigate the impacts of climate change – a crisis for which they are hardly responsible.

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