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## Meeting the Sustainable Development Goals in Small Developing States with Climate Vulnerabilities: Cost and Financing

by Johanna Tiedemann, Veronica Piatkov, Dinar Prihardini, Juan Carlos Benitez, and Aleksandra Zdzienicka



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## Abstract

Small Developing States (SDS) face substantial challenges in achieving sustainable development. Many of these challenges relate to the small size and limited diversification of their economies. SDS are also among the most vulnerable countries to the impact of climate change and natural disasters. Meeting SDS sustainable development goals goes hand-in-hand with building their climate resilience. But the additional costs to meet development and resilience objectives are substantial and difficult to finance. This work adapts the IMF SDG Costing methodology to capture the unique characteristics and challenges of climate-vulnerable SDS. It also zooms into financing options, estimating domestic tax potential and discussing the possibility of accessing 'climate funds.'

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[1] This work benefited greatly from discussions with experts and economists from various institutions and academia acknowledged in Section VII. Johanna Tiedemann conducted this work during the IMF Fund Internship Program.

## List of Acronyms and Abbreviations

| | |
|---|---|
| ADB | Asian Development Bank |
| AEs | Advanced Economies |
| AfDB | African Development Bank |
| AR5 | the IPCC 5th Assessment Report |
| CAT-DDO | Catastrophe Deferred Drawdown Option |
| CCPA | Climate Change Policy Assessment |
| CCRIF | Caribbean Catastrophe Risk Insurance Facility |
| CERC | Contingent Emergency Response |
| CIF | Climate Investment Funds |
| COVID-19 | Coronavirus disease |
| CTF | Clean Technology Fund |
| CRI | Global Climate Risk |
| DFID | United Kingdom Department for International Development |
| EMs | Emerging Markets |
| EU | European Union |
| ESR | Institute of Environmental Science and Research Limited |
| FAD | Fiscal Affairs Department |
| FSM | Federated States of Micronesia |
| GCCA+ | Global Climate Change Alliance |
| GCF | Green Climate Fund |
| GDP | Gross Domestic Product |
| GEF | Global Environment Facility |
| GFDRR | Global Facility for Disaster Risk Reduction and Recovery |
| GHG | Greenhouse Gas |
| HDI | Human Development Index |
| HIV | Human Immunodeficiency virus |
| IADB | Inter-American Development Bank |
| IFC | International Finance Corporation |
| IMF | International Monetary Fund |
| IPCC | Intergovernmental Panel on Climate Change |
| kW (h) | Kilowatt (-hour) |
| LIDCs | Low-Income Developing Countries |
| ln | Natural logarithm |
| MDB | Multilateral Development Bank |
| MENA | Middle East North Africa |
| NDC | Nationally Determined Contribution |
| ND-GAIN | Notre Dame, Global Adaptation Initiative |
| OECD | Organisation for Economic Co-operation and Development |
| PCRIC | Pacific Catastrophe Insurance Company |
| PCRAFI | Pacific Catastrophe Insurance Company |
| % | percent |
| ppt | percentage point |

| | |
|---|---|
| PFM | Public Financial Management |
| RAI | Rural Access Index |
| RAT | Revenue Administration Tool |
| RCP | Representative Concentration Pathways |
| RE | Renewable Energy |
| SDG | Sutainable Developemnt Goals |
| SDS | Small Developing States |
| SISRI | Small Island States Resilience Initiative |
| SFA | Stochastic Frontier Analysis |
| SLR | Sea-level rise |
| SROCC | Special Report on the Ocean and Cryosphere in a Changing Climate |
| SSA | Sub-Saharan Africa |
| UN | United Nations |
| UNCTAD | United Nations Conference on Trade and Development |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNICEF | United Nations Children's Fund |
| UNSTAT | United Nations Statistics Division |
| US$ | United States Dollar |
| VNR | Voluntary National Review |
| WASH | Water Sanitation and Hygiene |
| WDI | World Development Indicators |
| WEO | World Economic Outlook |
| WHO | World Health Organization |

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## I. INTRODUCTION

Climate-related hazards and subsequent disasters affect lives, livelihoods, socio-economic systems, and infrastructure. The risks and uncertainty associated with the occurrence and impact of these events result in high costs for economic growth and development. Climate-related disasters and exposure to natural hazards can keep or move people back into poverty (Hallegatte and others 2016, 2017). This creates a strong nexus between increasing climate resilience and achieving sustainable development. On the one hand, the absence of climate resilience remains one of the main challenges that prevent sustainable and inclusive development.[2] On the other hand, building climate resilience of infrastructure, emergency and health systems, public and private institutions, and the financial sector can help reduce not only the direct damage and well-being losses but also ensure more sustainable economic development. Achieving climate resilience requires adequate knowledge, education, well-planned and targeted decisions to build economic, institutional, and policy preparedness, and the involvement of the private sector. Uncertainty on the exact effects and longer-term trajectories of climate change adds to these challenges.

Small developing states are aware of the development-climate nexus as some of the most exposed and vulnerable countries to adverse effects of climate change and natural hazards.[3] Along with their commitment to the UN Sustainable Development Goals (SDGs), their development objectives and strategies are interlinked with the goal of increasing climate resilience (e.g., National Development Plans, Voluntary National Reviews for the UN High-Level Political Forum, Nationally Determined Contributions).[4] Despite the authorities' commitments, progress in meeting Sustainable Development Goals and increasing climate resilience is uneven, which partly reflects the particularities of SDS. The small size of their economies and, often, remoteness constrain access to human, natural, and financial resources and information, and limit preventative and response capacity, thereby exacerbating the impact of climate change and adding to development challenges.

The purpose of this paper is to analyze two aspects of these challenges in SDS exposed to climate-related hazards: (i) additional spending needs to achieve selected SDGs and (ii) options to finance these needs. Our focus is on general trends across income groups, regions, and sectors using publicly available data and information to provide a framework that country teams could further calibrate to each country's specificity. To this end, we extend the IMF SDG Costing methodology (Gaspar and others 2019) that focuses on five SDGs, including specific targets in

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[2] Climate resilience refers to the capacity of social, economic and environmental systems to deal with or respond to a hazardous event or trend related to disasters and effects of climate change (World Bank, 2019, Climate Change Knowledge Portal, Glossary).

[3] Small Developing States (SDS) are developing countries that are Fund members with a population below 1.5 million as of 2011 and income per capita below International Development Assistance-related level as identified in the IMF Guidance Note (IMF 2018).

[4] This paper reviewed NDCs up to August 2020. Countries are revising their NDCs for COP26 for end-2021. NDCs at https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/nationally-determined-contributions-ndcs.

health, education, water, sanitation, and hygiene (WASH), energy, and roads, to 25 SDS.[5, 6] Our main contribution is threefold:

- We estimate spending needs for SDS considering their country-specific factors, such as climate exposure and vulnerabilities. Our cost estimates for physical infrastructure account for spending needs to increase climate resilience of existing and new infrastructure in energy, roads, and WASH. We also account for maintenance, rehabilitation and upgrading of existing infrastructure and faster capital depreciation of new infrastructure. To the extent possible, we use country-specific unit costs derived from sectoral projects and estimates. For health and education SDGs— as in Gaspar and others—, we use a benchmarking approach. We select SDS peers as countries with similar income levels, climate vulnerabilities, health and geographic conditions but that have reached better health and education outcomes and are better prepared to deal with climate distributions.

- We construct a multidimensional database for SDS largely excluded from the previous work due to data availability issues.[7] We gather country and sectoral data through text mining and analysis of about 800 reports, projects, and development plans.[8] We validate this data through information received from sectoral experts across various development partners (e.g., the Asian Development Bank, the InterAmerican Development Bank, United Kingdom Department of International Development, the World Bank), academia, IMF Regional Capacity Development Centers, IMF desk economists, and by comparing our estimates with previous analyses (e.g., Rosenberg and Fay 2019).[9]

- We discuss options available for SDS with climate vulnerabilities to finance their development needs. We estimate their domestic revenue potential (including carbon taxation), examine the possibility of accessing external financing for climate-related disasters, and discuss broad considerations (e.g., debt vulnerabilities) to analyze space for development financing in SDS.

Our sample consists of 25 SDS (Annex 1) distributed across lower middle-, upper middle-, and high-income country groups in the Caribbean, Pacific, Sub-Saharan Africa (SSA), and the Middle East and North Africa (MENA). We consider SDS with substantial (i.e., above global average) climate vulnerabilities based mainly on the Notre-Dame Global Adaptation Initiative Index (ND-

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[5] Health refers to SDG 3; education, to SDG 4; WASH to SDG 6.1 and 6.2 under SDG 6 Clean Water and Sanitation; energy to SDG 7.1.1. under SDG 7 Clean and Affordable Energy; and roads to SDG 9.1.1 under SDG 9 Industry, Innovation, and Infrastructure.

[6] These five of 17 SDGs were selected given the critical role of public financing in these areas as well as the spillover effects that advancing these SDGs could have for inclusive growth and sustainable development (see Gaspar and others 2019 and the references included there). This paper focuses on the climate-development nexus and thus how climate change resilience is integrated into core infrastructure and social SDGs. It does not consider a standalone SDG13 on climate action that also includes objectives on strengthening resilience and adaptive capacity to climate-related disasters.

[7] Gaspar and others (2019) consider six SDS: Belize, Bhutan, Djibouti, Guyana, Mauritius, and Timor-Leste.

[8] A complete list of sources is available upon request.

[9] See Acknowledgments (Section VI).

GAIN) and for which sufficient data is available.[10,11] The estimates are based on the information and data available at the end-2019.

Our estimates indicate that additional annual spending needs for the median SDS to meet a handful of targets under the five SDGs between 2019 and 2030 are substantial: about 6.7 percent of 2030 GDP in 2030. Spending for physical infrastructure would need to be scaled up immediately by an additional 3.7 percent of 2030 GDP per year to reach the SDG targets in 2030. Health and education spending would need to increase by 3 percentage points of GDP until reaching 8 percent of GDP in 2030. The speed and quality of this adjustment will affect how quickly SDS will improve their health and education outcomes._These median estimates are subject to significant variability within country groups, regions and sectors. Additional annual spending needs are the largest in lower middle-income SDS (8.6 percent of 2030 GDP) and the lowest for high-income SDS (6 percent of 2030 GDP). Additional costs are the highest in the Caribbean (7.7 percent of 2030 GDP), then the Pacific (6.5 percent of 2030 GDP), and SSA and MENA (6.2 percent of 2030 GDP) SDS.

A multitude of factors—such as country-specific unit costs, SDG performance and targets—explains cost variations. Climate resilience is also an important cost driver. Rehabilitation, upgrades, and maintenance of existing infrastructure inflate these spending requirements. Our results show that meeting SDGs often requires improving spending efficiency and reallocation, particularly in SDS with already significant health and education spending.

While SDS can, in principle, use domestic revenue or access 'climate funds' to finance some development needs, in practice, however, these financing options are much narrower. First, increasing domestic revenue requires consistent country-specific tax policy and administration efforts coupled with continuous capacity development. Hence, revenue gains will take time to materialize, especially given SDS' limited capacity, large informal sectors, and narrow economic and tax bases. Importantly, possible revenue gains are relatively small—we estimate them between 1 and 4 percentage points of GDP—and domestic revenue mobilization efforts alone are insufficient to meet development needs. Second, while untapped external financing options for climate change adaptation, mitigation, disaster preparedness and response are available, SDS face difficulties accessing them. This is in part due to climate funds' administrative requirements and prerequisite arrangements, and to the limited resources and capacity—including in public financial management—of SDS to fulfill these requirements. Data availability and high transaction costs for accessing specific financial instruments create additional challenges. Finally, frequent shocks (e.g., natural, climate-related, economic, and health disasters) limit the scope to finance development needs as SDS must maintain adequate buffers. Their debt is also highly sensitive, increasing rapidly following these disasters limiting borrowing space. Therefore, external technical and financial support from the international community (e.g., in line with their

[10] ND-GAIN is developed by Notre-Dame University (https://gain.nd.edu/our-work/country-index/)

[11] The estimates for Tonga are available in its Climate Change Policy Assessment (Daniel and others 2020).

UNFCCC Paris Climate Commitments) is critical to ensure progress and avoid development setbacks following shocks.[12]

Despite our tailored approach to capture SDS characteristics and challenges, the assessment we provide needs to be updated by country economists in collaboration with the authorities and sectoral experts. It needs to account for the impact of the COVID-19 crisis on SDG performance and targets, and available financing, particularly in tourism-dependent SDS. Given substantial uncertainty and data availability, an assessment of this crisis impact could only be done qualitatively (Box 1). We also rely on aggregate information from existing sectoral projects and studies to estimate the cost of climate-resilient infrastructure. These results are subject to significant uncertainty related, for instance, to the impact of ongoing climate change (Box 2 in Section III) and would benefit from further refinement to better reflect the risks.

**Box 1: COVID-19 Crisis and Progress toward Sustainable Development in SDS**

*Experience with pandemics and economic crises leave no doubt that the COVID-19 crisis will adversely affect the overall progress toward sustainable development. While it is too early to assess quantitatively, the extent of the impact will depend on each country's ability to cushion the initial shock and shape the recovery. This shock absorption has multiple dimensions, some particularly relevant for SDS (e.g., financing and implementation capacity, structural vulnerabilities and low preparedness). We use a simple conceptual framework to discuss some of them qualitatively.*

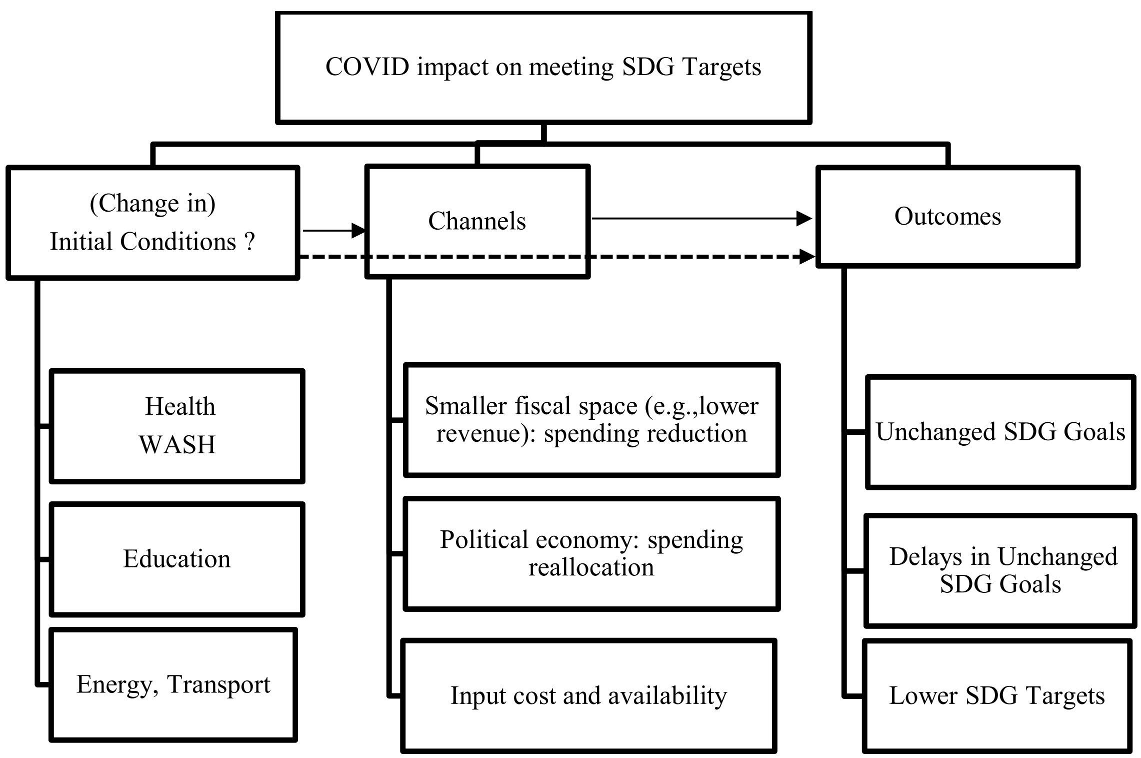
**Change in initial conditions**. The impact of COVID-19 on SDGs depends on (i) where each country was in terms of meeting its SDG targets at the pandemic's outbreak (so-called 'initial conditions') and (ii) how the shock has affected SDG performance until now ('change in initial conditions'). Initial economic conditions in terms of size of fiscal buffers and financing space are also important factors. For instance, countries that entered the pandemic with better-prepared health and WASH sectors and/or managed to timely and effectively channel the resources towards these sectors saw fewer changes in SDG performance. In fact, by containing the pandemic impact on health, these countries also cushioned its impact on the overall economy (IMF 2020 a b). However, the reallocation of efforts (including spending, particularly in countries with lower fiscal buffers) to fight the pandemic could have some setbacks for other health or WASH outcomes. This is most likely the case for countries with weaker preparedness and high vulnerabilities to various health issues (e.g., epidemics, vector- and water-borne diseases, non-communicable diseases, nutrition and immunological challenges). The COVID-19 outbreak and subsequent containment measures have resulted in school closures and interrupted many ongoing investment projects, which have affected education performance and caused capital losses. Capital losses are even larger for SDS with high climate

[12] Under the UNFCCC, advanced economies have committed to mobilizing US$100 billion per year by 2020 to help developing countries tackle and adapt to climate change. Only a small part of this financing has been mobilized so far (https://climateactiontracker.org/).

vulnerabilities and lower infrastructure resilience, resulting in a failure to provide regular and emergency infrastructure maintenance.

**Channels.** Various estimates indicate that the health and economic impacts of COVID-19 lead to permanent economic losses (IMF 2020 a). Now more than ever, maintaining progress towards sustainable development and reaching 2030 targets requires more substantial reform and spending efforts. The availability of financing is the key factor ('channel') in this regard for many countries, including SDS (Section V below). The pandemic already affected SDS domestic revenue (e.g., from tourism; Babii and other forthcoming) and even more so constrains —and for longer—their capacity to mobilize domestic revenue and access to external funds. Both will undeniably result in lowering and reallocating development spending in the next decade. The political economy will largely influence the type and speed of undertaken measures, including spending reallocation. The socio-political priorities could have shifted or be forced to do so, given the lack of available financing, inputs and mobility restrictions. Financing constraints, coupled with higher input costs, capacity constraints and socio-political pressures, pose serious threats to climate resilience in infrastructure and social sectors.

**Impact of the COVID-19 shock on SDGs: Conceptual Framework**




Source: Authors.

**Outcomes**. The COVID-19 shock will affect progress toward sustainable development in many countries, including SDS (Benedek and others 2021). Outcomes vary across SDGs depending on (a change in) initial conditions, financing and structural constraints, as well as the efficiency of implemented policy measures. There may be sectoral winners. For instance, if the population's health and well-being become the top short- medium or long-term priorities, or if SDS concentrate efforts to adapt faster to on-line learning and work (Georgieva 2020). But there may be even greater sectoral losers if input cost and availability (through supply chain distribution) force SDS to postpone their plans to increase climate resilience and move toward safely managed WASH, and clean, affordable energy.

Overall, SDS could fail in *building back better* if post-pandemic recovery plans do not result in increased preparedness and resilience of disaster risk and emergency systems, sectors, and infrastructure. [13] The threat to progress toward sustainable development in SDS is even larger if all countries fail to align policies that hasten the economic recovery with those that lead to positive environmental outcomes. The COVID-19 crisis can compound future challenges if GHG emitters continue to rely on fossil fuels for energy generation, transport and production rather than pursuing vital mitigation efforts.

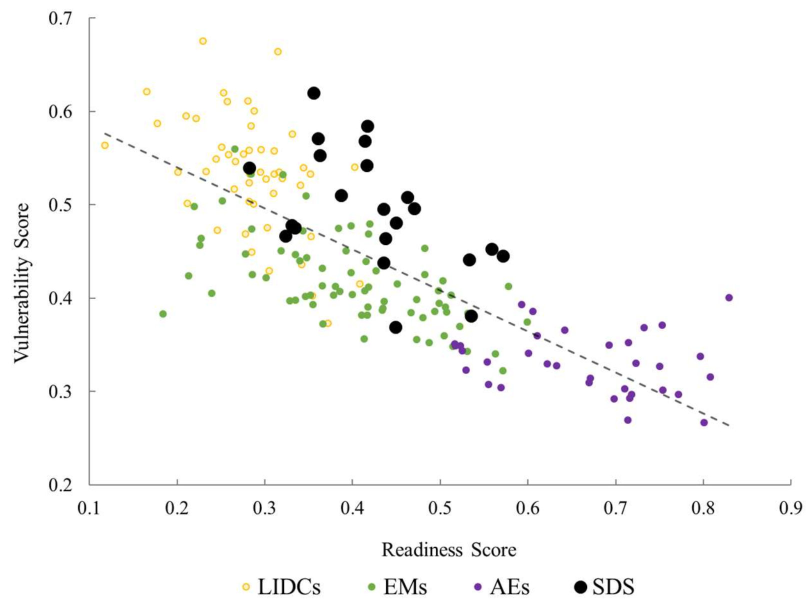
The rest of the paper is organized as follows. Section II discusses SDS development, climate-related challenges and progress in meeting SDG goals. Sections III presents the methodology and data used to estimate costs to meet selected sustainable development and climate resilience goals. Section IV discusses the results. Section V examines financing options, such as domestic revenue potential and external climate funds. And finally, Section VI concludes.

[13] This is in line with the Sendai Framework for Disaster Risk Reduction 2015-2030: Enhancing disaster preparedness for effective response and to Build Back Better in recovery, rehabilitation and reconstruction.

## II. SDS Growth-Climate Nexus and Progress Toward Sustainable Develoement

SDS are among the most vulnerable countries in the world to the adverse effects of climate change, as well as natural and climate-related hazards (Figure 1).

**Figure 1. Climate Vulnerabilities and Policy and Institutional Readiness**
(Scores, 2019)




Source: Notre Dame, Global Adaptation Initiative (ND-GAIN).
Note: The vulnerability score is based on 36 indicators in food, water, health, ecosystem services, human habitat and infrastructure. The readiness score is based on three components: economic readiness, government readiness and social readiness to deal with climate vulnerabilities. Higher scores indicate higher vulnerabilities and better readiness. LIDCs: low-income developing countries; EMs: emerging market economies; AEs: advanced economies; SDS: small developing states in our sample. See annex 1 and 4 for more details.

Many SDS face exposure to both the short- and long-term effects of climate change impacts and geo-meteorological hazards (Annex 2). These events, such as storms, cyclones/typhoons or earthquakes, can occur frequently and, often, with high severity effects varying across countries due to their geographic differences. Over the longer-term, some SDS will face growing risks from climate-related events, including flooding, extreme heat, prolonged drought and related water availability issues, in addition to other more extreme weather events.

The impact of such events has already resulted in particularly high socio-economic costs in SDS. There is also a strong awareness that increasing climate resilience is a sine qua non for achieving sustainable development. A review of National Development Plans, sectoral strategies and projects, Voluntary National Reviews for the UN High-Level Political Forum, Nationally Determined Contributions, investment and sectoral projects demonstrates SDS authorities' commitments to meet their Sustainable Development Goals and SDG-climate resilience interlinked objectives.[14]

Progress in meeting SDGs—and increasing climate resilience—is uneven (Figure 2). Generally, more developed countries, including among SDS, experienced better sectoral and SDG performance (Gaspar and other 2019). For instance, almost 100 percent of the population has access to energy on/off the grid in the middle upper- and high-income SDS and access to basic water in high-income SDS.[15] In contrast, in lower middle-income SDSs, access to basic water, sanitation, and hygiene remains limited, and access to renewable energy is generally low.

In many aspects, this uneven progress reflects the particularities of SDS. For instance, access to roads—defined by the share of rural population with access to all-season roads within 2 km—is relatively good, given the relatively small size of many SDS. However, many roads are in poor condition and do not comply with an all-weather standard given climate vulnerabilities and generally low maintenance (Figure 2, infrastructure vulnerabilities). SDS have improved their population health outcomes and access to health services in recent years but still lag countries with a similar level of development and climate vulnerability (‘peers’ hereafter). These lags reflect substantial needs in providing adequate health services, a lack of financing, some inefficiencies in spending policies but also capacity issues, often related to the small size of the SDS economy and population. The remote location of some SDS (e.g., the Pacific Small Island Developing States) is also an important issue.

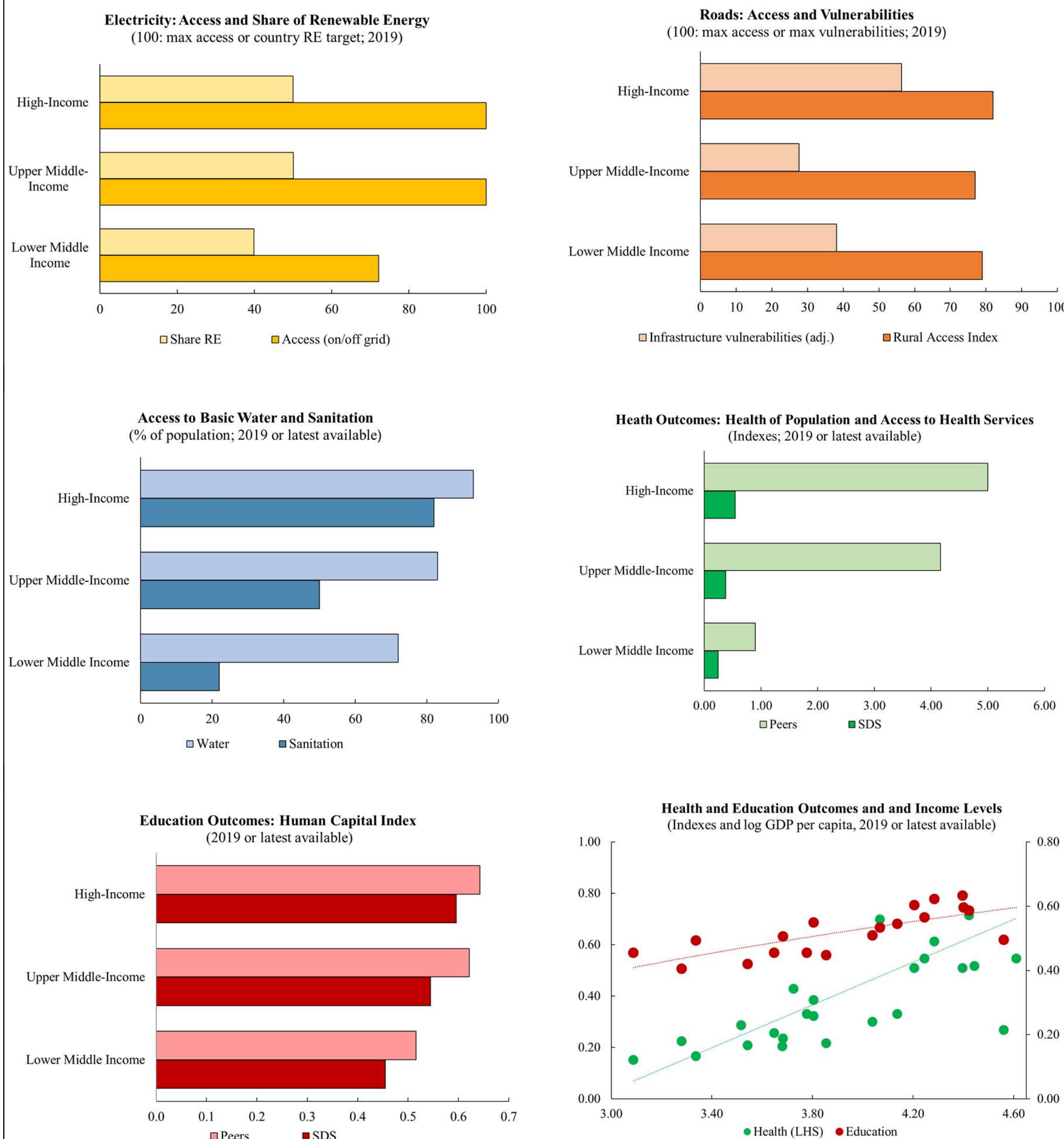
The next section focuses on understanding and analyzing one aspect of these challenges: additional costs to meet selected SDG targets and increase climate resilience.

[14] SDGs’ targets and indicators are universal and apply to all countries. When adopting SDG targets and indicators, countries nationalize implementation and monitoring and reflect their own development plans with their own levels of ambition.

[15] IMF Guidance Note (IMF 2018) classifies SDS in four income groups: (i) high-income SDS, as countries with GDP per capita above US$12476, (ii) upper middle-income, as countries with GDP per capita between US$4036 and US$12475; (iii) lower middle-income SDS as countries with GDP per capita between US$1026 US$4035; and (iv) low-income SDS with GDP per capita below US$1025. Our sample (Annex 1) does not include low-income SDS.

**Figure 2. SDS: Progress in Meeting Selected SDG Targets**

(2019 or latest available)




Sources: VNRs, NDCs, National Development Plans, World Bank, ADB, AfDB, IADB, WHO, ND-GAIN, WEO.

Note: Indexes (level for 2019 or the latest available) for electricity, roads, and WASH vary between 0 -100 (best performance), except infrastructure vulnerabilities (100=worse performance). Adjusted indexes for health outcomes vary between 0-10 (best performance). Human Capital Index varies between 0-1 (best outcomes). Targets refer to the national development targets set in alignment with the Sustainable Development Goals and are usually reported in the VNRs, NDCs and National Development Plans. Peers are countries with a similar level of development, climate and health vulnerabilities and geographic characteristics (Section III.B). ND-GAIN stands for the Notre-Dame Global Adaptation Initiative Index (https://gain.nd.edu/our-work/country-index/).

## III. COSTING SDGS IN CLIMATE VULNERABILE SDS: APPROACH

Following Gaspar and others (2019), we use an input-outcome approach to estimate country-specific additional costs to achieve selected development goals in selected SDS, accounting for their vulnerabilities to the effects of climate change. As in Gaspar and others, our approach differs between SDGs focused on physical infrastructure and those that are related to social development sectors (health and education). This section discusses successively these two methodologies, including their extensions to account for climate vulnerabilities in SDS, and data issues.

### A. Physical Infrastructure (Roads, Energy/Electricity and WASH)

***Approach***

Physical infrastructure refers to the sectors of roads, energy/electricity and access to water, sanitation and hygiene (WASH). Additional annual spending needs for each country $i$ in each of the sectors can be considered as a function (Equation 1) of inputs, their unit cost and other country-specific factors.

$$\boldsymbol{Annual\ \ Spending}_{\,i,\,2030} = \boldsymbol{f}(\boldsymbol{I_i^{e,Gap2030}}, \boldsymbol{C_i^e}, \boldsymbol{X_i^{e,2030}}) \qquad \textbf{(1),}$$

where:

- **Inputs (I)** are estimated (*e*) as additional kilometers of all-weather roads, additional kWh of energy consumption and additional spending on water and sanitation infrastructure needed to close the gap (*Gap2030*) between the current SDG performance and 2030 targets for each country. National targets are computed based on the most recent rural access index (RAI), share of the population with access to electricity on/off the grid and share of the population having access to basic and safely managed WASH.[16] Inputs for WASH, roads (e.g., new, rehabilitated/upgraded) and energy mix (e.g., share and type of renewable energy, transmission infrastructure) are country specific.

- **Unit cost (C)** reflects country-specific weighted average costs of roads, energy and WASH mix to construct and maintain infrastructure, distribute electricity and provide WASH to final users in rural and urban areas. We account for higher depreciation in climate-vulnerable SDS by increasing the cost of adding new infrastructure to 6 percent, compared to 5 percent used

[16] In SDG 9, indicator 9.1.1 is defined as "the proportion of the rural population who live within 2 km of an all-season road". The Rural Access Index is used in this instance to quantify this measure. In SDG 7, indicator 7.1.1 is defined as "the proportion of the population with access to electricity" and is measured as the share of people with electricity access at the household level, comprising electricity sold commercially both on- and off-grid. In SDG 6, indicator 6.1.1 is defined as the "proportion of the population using safely managed drinking water services", defined as one located on-premises, available when needed and free from contamination.

in Gaspar and others (2019).[17] We also account for the additional cost of emergency repairs, upgrades and rehabilitation of existing infrastructure.[18] The cost of upgrades sometimes covers the need to extend existing infrastructure to accommodate population growth.

- **Other factors (X)** account for other country-specific factors such as economic growth, population growth and density, internal migration and topography.

***Data***[19]

We focus on SDSs (IMF 2018) that have at least average exposure to past and future climate change risks and natural hazards according to the Global Climate Risk Index and ND-GAIN (Annex 1 and 4) and those for which sufficient data is available.[20] Our country sample comprises 25 SDS: Antigua and Barbuda, the Bahamas, Belize, Bhutan, Cabo Verde, Comoros, Djibouti, Dominica, Fiji, Federated States of Micronesia (FSM), Grenada, Guyana, Kiribati, Maldives, Mauritius, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Seychelles, Solomon Islands, Timor-Leste, Tuvalu and Vanuatu. These SDS include mainly island and coastal states (Annex 4) highly exposed to sea-level rise (Annex 2).

Most data and information obtained for this study are from 2019, or the latest official country documents, communications or available sectoral projects. For instance, SDG targets are taken from the authorities' development plans or information reflected in their Voluntary National Reviews. For information on new infrastructure, we use country-specific energy, road and WASH plans to compute the input mix and a weighted unit cost of construction. When available, we use the information from audited project documents available on AfDB, ADB, DFID-related projects and World Bank websites. We complement the information using SDS sectoral plans and budget statements.

Similar sources of information are used to gather data on the costs of rehabilitation, upgrading, and maintenance of the existing infrastructure. When detailed plans are not available for roads, the current mix of (primary, secondary, tertiary) roads is assumed to increase proportionally with population and economic growth. In terms of road coverage, we follow Gaspar and others (2019), where each country aims to reach at least 75 percent in the Rural Access Index. When possible, the assessment of road vulnerabilities is based on the information available in specific projects (e.g., those of the World Bank). When detailed information is not available, rehabilitation

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[17] A 6-percent depreciation rate is calibrated based on discussions with sectoral experts. Refining the assessment by desk economists in collaboration with SDS' authorities is needed to further reflect country-specific circumstances.

[18] SDS' infrastructure vulnerabilities reflect the effects of climate change and disasters stemming from natural hazards, including geophysical and meteorological impacts (e.g., earthquakes, flooding, strong winds, earth erosion), and weak adaptation of initial construction coupled with a lack of regular maintenance. Following sectoral reports and projects, we do not estimate the cost of reprofiling existing infrastructure against all—even extreme and very rare—climate events.

[19] See Annex 4 for Summary Statistics, Annex 3, for more details on data sources.

[20] CRI is developed by Germanwatch (https://germanwatch.org/en/cri).

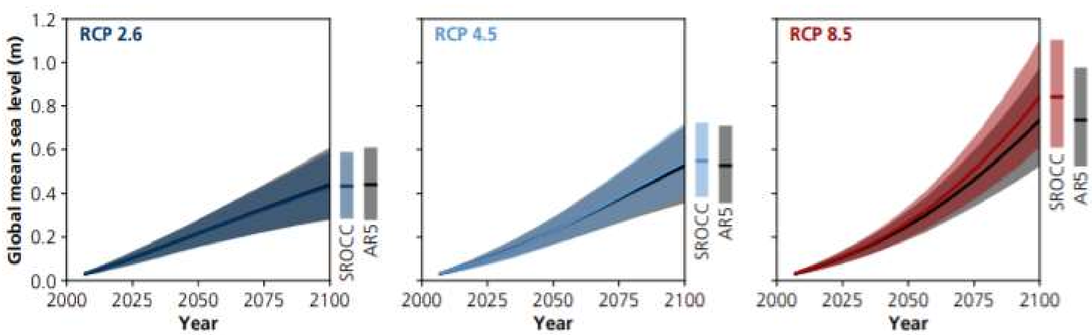
costs are approximated using regional average costs from Rozenberg and Fay (2019) adjusted by country-specific factors (e.g., relative import deflators). For WASH, we update the access data (e.g., UNICEF and WHO 2019) and use unit costs estimated by Hutton and Varughese (2016). These estimates account for maintenance needs but do not include the cost of building climate-resilient infrastructure. We add these costs using the estimates from Miyamoto (2019 a b) and Hallegatte and others (2019 a b), accounting for climate-related and natural hazards risks faced by SDS. As is the case of project-based assessments, there is a significant level of uncertainty regarding how to treat the impact of ongoing climate change (Box 2). Data on demographics are taken from the UN medium variant estimates, GDP and exchange rates are from the World Economic Outlook, import deflators are from the UNCTAD (Annex 3 for details on data sources).

**Box 2: Estimating Future Climate Change Impacts**

There are a broad range of projections concerning climate change and its impact on economic, social and development outcomes. The projections reflect uncertainty related to the extent of future effects and various modelling techniques. The scientific knowledge and modeling by the Intergovernmental Panel on Climate Change (IPCC) have enabled greater clarity on the range of likely projections.

Assessments of future changes are based on climate model projections using Representative Concentration Pathways (RCPs), which reflect the range of possible greenhouse gas emissions scenarios and mitigation policy actions. For instance, the IPCC (2019) demonstrates the range of global mean sea level rise based on RCP 2.6 (low), RCP 4.5 (medium) and RCP 8.5 (high) scenarios.[1]

**Projected Change in Global Mean Sea Level until 2100 relative to the average of 1986-2005**




Source: IPCC (2019)

The IPCC is currently in its Sixth Assessment cycle, during which new estimates will be analyzed and made available for release in 2022. The IPCC's latest 2019 *Special Report on the Ocean and the Cryosphere in a Changing Climate* highlights uncertainty in their projections for the end of the century, due to the changing nature of ice sheets (particularly in Antarctica). This change may result in higher sea-level rise projections, mostly for the higher emission scenarios.

Despite the progress in modeling and projections, uncertainty remains, and the range of RCPs demonstrates the variability of future climate change impacts, which also influences all work aimed at estimating spending needs to increase climate resilience. Over 110 countries have pledged to carbon neutralize by 2050, which, alongside potential commitments from large emitters, will ensure important progress on mitigation. Nonetheless, continued emissions of greenhouse gases will result in changes that are likely to increase the severity and pervasiveness of severe weather impacts on people and ecosystems. However, a more specific estimate of climate impacts and subsequent costs based on varying levels of projected change would require analysis of country-specific RCP scenarios.

This detailed work is beyond the scope of this paper. We do not directly analyze the broad range of estimates. Instead, we adopt an indirect approach using the existing estimates from country-specific sectoral projects, Hallegatte and others (2019 a b), and Miyamoto (2019 a b). These estimates are based on expert assessments of the current and future costs of climate resilience, including aggregation of country-specific probabilistic loss modeling and exposure profiles. We also look beyond the exposure profile and focus on the vulnerability of SDS to the impact of climate-related events that reflects their geographic location, socio-economic conditions and coping capacity. The ND-GAIN index is our main comparative point. This measure brings together dozens of variables to account for a country's exposure, sensitivity and adaptive capacity, with most measures being 'actionable', or representing actions or results of actions taken by governments, communities, civil societies and non-government organizations. We do not have access to many underlying assumptions used in these works, resulting in a significant level of uncertainty, particularly regarding the treatment of the impact of ongoing climate change, and thus the cost of climate-resilient infrastructure.

[1/] Of the 25 SDS in this study, 20 are island states, an additional four states are coastal and one is landlocked. At least 20 SDS in the study are exposed to risks of tropical cyclones, typhoons or hurricanes. The impacts of SLR are significant in many of the countries assessed. Of 18 coastal states for which there is data under an RCP 8.5 scenario, by 2100 it is expected that impacts of coastal flooding will affect anywhere between 5 to 80 percent of the population (country dependent). For many of these countries, infrastructure and essential services are likely to be impacted, particularly in coastal areas (Climate Central 2019). Likewise, the travel and tourism sectors are likely to be affected by coastal flooding and coastal change, and the sector can make up anywhere from 10 to 56 percent of a country's GDP among the SDS (World Travel & Tourism Council 2019). For other natural hazard exposure details, see the Annexes.

***Example of application to electricity/energy***

Table 1 illustrates the application of this approach to estimate additional spending to meet energy/electricity targets for an indicative SDS in 2030.

SDS 'A' plans to provide 100 percent of renewable energy (RE) to all by 2030 using a mix of solar, wind and geothermal energy generation sources. Currently, 100 percent of the population has access to electricity on/off the grid. 67 percent of the provided energy is generated through renewable sources (mainly solar) and 33 percent through fossil (diesel). The estimates of energy consumption in 2030 are based mainly on projected population and economic growth between

2019 and 2030. The additional energy generation capacity needed for this energy demand accounts for the planned renewable energy mix, improvement in transmission efficiency and a reduction in other technical and non-technical losses. The estimates also consider plans to build additional climate-resilient infrastructure and rehabilitate, upgrade and maintain existing networks as reelected in the sectoral projects. A weighted unit cost (about US$6100) of generation, transmission, maintenance and distribution of one kW accounts for all these factors. The additional annual cost to meet SDS 'A's energy targets is about US$230 million and, with the depreciation of new infrastructure, about 2.1 percent of 2030 GDP per year. The approach assumes that country A will immediately scale up the spending and maintain this level until 2030.[21]

**Table 1. SDS 'A': Additional Cost to Meet Energy Targets in 2030**

| | | |
|---|---|---|
| Unit cost, incl. generation, transmission and distribution costs (weighed average by energy type in US$/kW) | **6,100** | |
| Years to complete | 11 | |
| | **2019** | **2030** |
| Access to RE electricity (% of population) | 67 | 100 |
| Consumption (KWh per capita) | 662 | 1,755 |
| **Average annual cost of required investment (US$ billion)** | | **0.23** |
| Cost of depreciation at completion | | 0.07 |
| **% of 2030 GDP** | | **2.06%** |

Sources: Authors' estimates.

We use a similar approach to estimate additional spending needs to meet road and WASH targets. For roads, we estimate additional kilometers needed to ensure road access for all (proxied by the RAI at least 75 percent) based mainly on population and economic growth in SDS A between now and 2030. The estimates also account for this country's plans to rehabilitate, upgrade, and maintain existing infrastructure. A unit cost—a weighted average of planned roads by type—of providing additional kilometers of roads in at least 'fair' condition accounts for all these factors. The estimates of the cost to provide basic and improved access to WASH are based on country-specific calibration by Hutton and Varughese (2016) and 'climate-event' estimates by

[21] We assume, as in Gaspar and others (2019), that infrastructure spending would decline to about 60 percent to cover the depreciation of the capital stock build through 2030.

Miyamoto (2019 a b) and Hallegatte and others (2019 a b). For SDS A, we update the percentage of the rural and urban population with basic and improved access and calibrate the targeted population based on the latest population growth and internal migration projections, until 2030.

### B. Social Development Sectors (Health, Education)

***Approach***

We focus on social development sectors related to health and education. Rather than country-specific targets, the IMF SDG Costing approach estimates a change in spending needed to improve health and education outcomes compared to countries that have a similar level of economic development, but higher sectoral outcomes. We extend this approach, selecting peers not only based on their income level but also their similar climate vulnerabilities, geographic characteristics (island, coastal, territorial dispersion) and health (e.g., similar prevalence of diseases) conditions.[22] We select peer countries with higher-performing health and education outcomes but also higher developed levels of overall preparedness to deal with climate issues using the ND-GAIN Index. The peer sample includes some better-performing SDS but also non-SDS. The number of peers for each SDS varies between 7 and 16 countries.

A change in health and education spending between 2019 and 2030 is a function (Equation 2) of input and unit costs estimated in relative terms (*r*) compared to the peers. Factors such as economic and population growth between now and 2030 remain country specific (e).

$$\Delta\, \boldsymbol{Spending}_{\boldsymbol{i},\ \mathbf{2030-2019}} = \boldsymbol{f}(\boldsymbol{I}_{\boldsymbol{i}}^{\boldsymbol{r},\boldsymbol{Gap}\mathbf{2030}}, \boldsymbol{C}_{\boldsymbol{i}}^{\boldsymbol{r}},\ \boldsymbol{X}_{\boldsymbol{i}}^{\boldsymbol{e},\mathbf{2030}}) \qquad \textbf{(2),}$$

where:

- **Inputs (I)** include the number of teachers (in pre-school to tertiary education), doctors, and all other medical staff, and other current and capital spending on health and education for an SDS compared to its median peer.
- **Unit costs (C)** consist of average teacher and medical staff wages compared to the median peer.
- **Other factors (X)** include population growth and structure, enrolment rates, and economic growth.

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[22] To identify the peers, we group our 25 SDS countries and their peers into three groups: (i) Group 1 includes countries with GDP per capita below US$3500 at end-2019; (ii) Group 2, countries with GDP per capita between US$3500 and 7000; and Group 3, countries with GDP per capita between US$7000-19000. Group 3 includes the Bahamas. To reflect our sample income composition, we use higher income brackets than in Gaspar and others (2019) that use income bins of US$0-3000, US$3000-6000, US$6000-18000.

***Data***

SDG 3 and SDG 4 indexes that summarize health and education performance are not available for most SDS. For our SDS and their peers, we approximate SDG 3 using the latest available sub-indicators of adult and children health outcomes and access to health services taken from WHO and UNICEF ('health index adjusted' hereafter).[23] For education, we use the Human Capital Index and its education components (World Bank) when available or individual national indicators such as enrollment rates or years of schooling (UNICEF). We use the ND-GAIN index to capture climate vulnerabilities and general readiness to deal with these issues. We use the same sub-indicators to compare with SDS peers. The WHO's Global Health Observatory Data is used to measure the number of medical staff (i.e., both doctors and other health services, or community health workers). The UNESCO data is used to capture the ratio of pre-school through tertiary education teachers to students, and current and capital spending in education. The information on medical staff and teacher salaries is generally taken from the Salary Explorer website. We complement and cross-check this data using World Bank reports and information available on SDS national statistical office websites where available. Data on demographics are taken from the UN medium variant estimates, GDP and exchange rates, from World Economic Outlook and import deflators, from the UNCTAD (Annex 3 for details on data sources).

***Example of application to the health sector***

Table 2 illustrates the application of this approach to estimate a change in health spending for an SDS 'B' between end-2019 and 2030 to reach the median health outcomes of its better-performing peers. A similar approach is used to estimate a change in education spending.

To reach better health outcomes of its peers, country B would need to increase overall health spending by about 3.3 percentage points of GDP between now and 2030. Additional spending should be channeled to increase the number of doctors and medical staff and other current (e.g., provisions of medical goods, maintenance, transport) and capital spending that are now below the peer median.

[23] Computed as an average of Health Conditions and Access to Health Services. Health Conditions include indicators of Malaria and Tuberculosis incidence, HIV infections, child mortality, percentage of children who are underweight, the number of people requiring interventions against neglected tropical diseases. Access to Health Services includes indicators such as immunization coverage, physician (medical doctors) density and maternal mortality ratio.

**Table 2. SDS 'B': Change in Health Inputs to Reach SDG Health Outcomes by 2030**

| | 2019 (or latest) | 2030 |
|---|---|---|
| **Main factors** | | |
| Doctors per 1,000 population | 0.2 | 1.1 |
| Other medical personnel per 1,000 population | 1.0 | 3.8 |
| Doctor wages (ratio to GDP per capita) | 13.9 | 8.0 |
| Other current and capital spending (% total spending) | 70.2 | 63.8 |
| **Results** | | |
| Health spending (percent of GDP) | 3.3 | 6.6 |
| Per capita spending (USD 2019) | 97.4 | 316.7 |
| Health outcomes (adjusted heath and access index) | 0.2 | 0.45 |

Sources: Authors' estimates.

Note: The results report the current health inputs and spending for an illustrative SDS 'B' (column 2019 or latest) and the median of health inputs and spending for peer countries (column 2030) with better health outcomes. The assumption is that to reach the health outcomes of better-performing peers, country 'A' will need to adjust its health inputs and spending to the peers' level between now and 2030. Health outcomes index: a higher number indicates better performance.

The medical wage bill is currently higher than in peer countries and would need to progressively decrease to their level by 2030 while maintaining efforts to retain qualified professionals. The approach also assumes efficiency gains—comparable to those reached by peers with higher health outcomes. The approach does not impose the timing of when country B is expected to reach the level and composition of health spending of comparable peers. However, it implicitly assumes that the speed and quality of the adjustment will affect health outcomes.[24]

## IV. Cost of Meeting Development and Climate Goals

### A. Aggregate Results

This section discusses general trends and provides aggregate results across income groups, sectors and regions. It zooms in on the composition of additional spending estimates, including factors behind additional costs and the allocation of spending categories (e.g., new versus existing infrastructure).

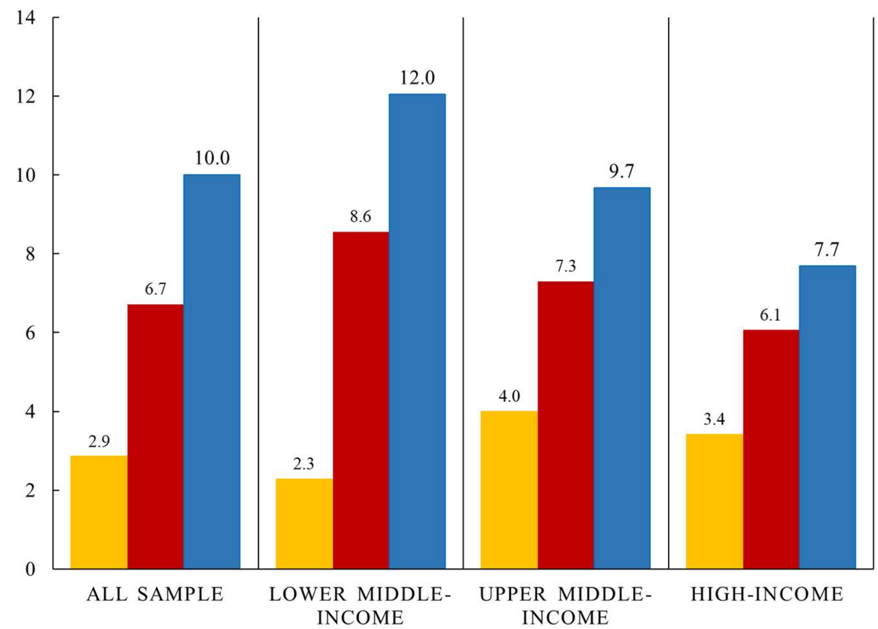
***By income groups***

Figure 3 indicates that the median additional annual spending needed to meet the five SDS development goals is estimated at around 6.7 percent of 2030 GDP in 2030.

[24] Following Gaspar and others (2019), we assume the spending on health (and education) will continue without making any specific assumptions on their levels.

**Figure 3. SDS with Climate Vulnerabilities: Additional Cost to Meet Five SDGs in 2030**

(median, 25th and 75th percentile)




Source: Authors' estimates.

Note: Red bars indicate median estimates for each income group. Yellow and blue bars represent, respectively, the lower (25th) and upper (75th) percentile of each country group distribution. For health and education, the estimates report a difference between the share of GDP in spending consistent with better performance in 2030 and the current spending as a share of GDP. For physical infrastructure, the estimates show the annual spending in percent of 2030 GDP to close the infrastructure gap between 2019 and 2030 targets.

***By sectors***

Estimates also vary across sectors in each income group (Figure 4).

Median additional costs on energy, roads and WASH account for 55 percent of total additional costs. In other words, SDS would need to spend 3.7 percent of 2030 GDP more every year until 2030 to reach its SDG targets in physical infrastructure. [25] To reach better health and education outcomes, SDS would need to increase spending by 3 percentage points of GDP till reaching about 8 percent of GDP in 2030 (compared to about 5 percent of GDP at present).[26]

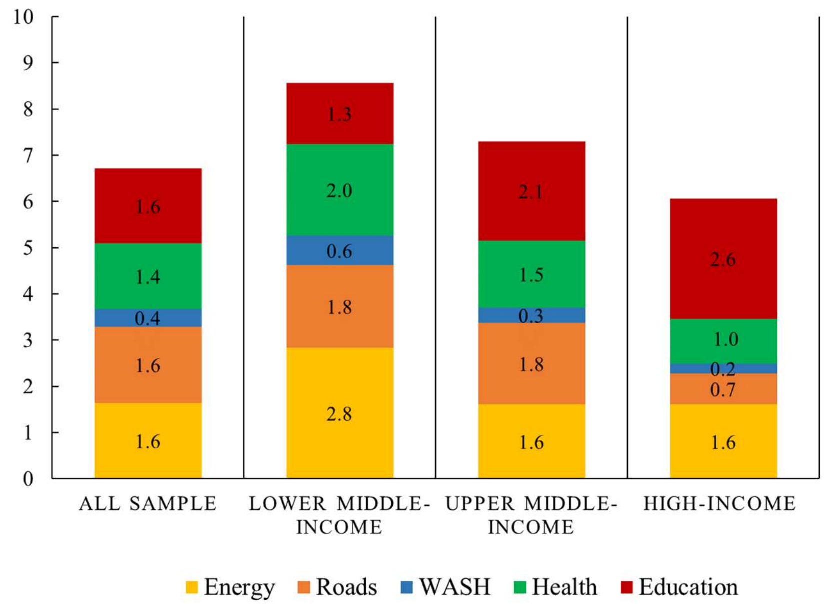
[25] These estimates do not capture the incremental capital, operational and maintenance costs for the most expensive technologies. For instance, the reverse osmosis of seawater for consumption in some countries that already face water scarcity.

[26] The pace at which SDS reach the level of spending needed will depend on the trajectory of their fiscal space, financing opportunities, sectoral planning specificities and other country-specific conditions and choices until 2030.

For lower middle-income SDS, additional spending on physical infrastructure accounts for about 60 percent of the total additional cost. Limited access to infrastructure, including to WASH, explains a large part of the additional spending requirements (Figure 2 in Section II).

**Figure 4. SDS with Climate Vulnerabilities: Additional Cost to Meet SDGs in 2030**

(By Sectors, in percent of 2030 GDP)




Source: Authors' estimates.
Note: For health and education, the estimates report a difference between the share of GDP in spending consistent with better performance in 2030 and the current spending as a share of GDP. For physical infrastructure, the estimates show the annual spending in percent of 2030 GDP to close the infrastructure gap between 2019 and 2030 targets.

For high- and upper middle-income SDS, the additional spending needs on roads and energy infrastructure is estimated at about 40 percent of the total additional costs. Their plans to move towards 'clean' energy generation and more resilient infrastructure (Figure 2 in Section II) largely explain additional spending requirements. Access to improved WASH accounts for about 3-5 percent of the total additional cost.

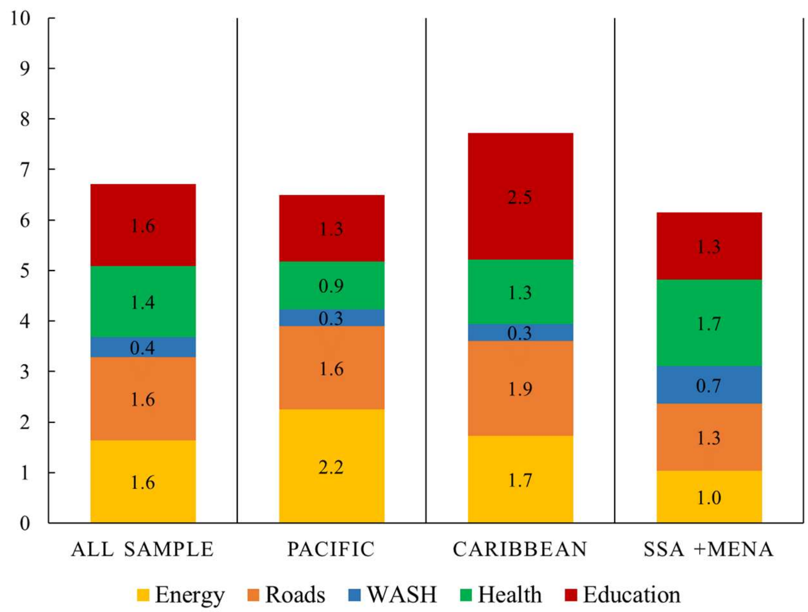
In lower middle-income countries, additional spending needs on health are significant—a 2 percentage points of GDP increase by 2030—compared to a current median spending of about 5 percent of GDP (Annex 4). Additional costs to reach higher education outcomes is smaller but adds up to about 8 percent of GDP spent currently in this sector. In upper middle-income SDS, additional spending needs on health account for about 20 percent of the total. Reaching the health outcomes of their peers requires increasing spending by about 1.5 percentage points of GDP by 2030, compared to about 5 percent of GDP currently. Additional spending on education accounts for about 30 percent of the total additional costs.

For high-income SDS, reaching the health outcomes requires increasing current spending by about 1 percentage point (compared to about 5.8 percent of GDP now) . Additional spending requirements on education are the largest among the income groups. This relatively large increase can be partially explained by a relatedly lower current (3 percent of GDP) level of education spending.

***By regions***

**Figure 5. SDS with Climate Vulnerabilities: Additional Cost to Meet SDGs in 2030**

(By regions, in percent of 2030 GDP)




Source: Authors' estimates.

Note: For health and education, the estimates report a difference between the share of GDP in spending consistent with better performance in 2030 and the current spending as a share of GDP. For physical infrastructure, the estimates show the annual spending in percent of 2030 GDP to close the infrastructure gap between 2019 and 2030 targets.

A regional comparison (Figure 5) indicates that additional costs to meet selected SDG targets are the largest in the Caribbean SDS, then the Pacific and Sub-Saharan Africa and finally, the Middle East and North Africa (SSA+MENA) SDS. By sector, additional costs are the largest in the energy and road sectors in the Pacific SDS. Additional spending needs for energy and roads is the lowest in Sub-Saharan Africa and the Middle East and North Africa SDS. For these SDS, however, the additional spending requirements to improve access to WASH and health are the largest. Additional spending needs to improve education outcomes are the largest in the Caribbean SDS.

## B. Spending Composition

***Spending drivers***

A multitude of factors (Equations 1 and 2) and their interactions affect additional spending needs and contribute to cross-country differences.

First, there is the level of development and performance in meeting SDG targets. For instance, Caribbean countries included in the sample are mainly upper middle- and high-income SDS with already relatively higher SDG performance in some sectors (e.g., health, WASH). In contrast, the sample of Pacific, SSA and MENA SDS includes more upper and lower middle-income countries, with relatively lower outcomes in these sectors.

Second, even more developed SDS still lag their peers in education and health performance, which requires both increasing spending—particularly if the current level is relatively low—and its efficiency. Moreover, country-specific development targets (e.g., quality of infrastructure, renewable energy goals) influence additional spending requirements.

Third, there is also a considerable variation in the unit costs of construction and service provision across regions.[27] Vulnerabilities to the effects of climate change and disasters explain some part of cost variation across countries and regions (see below). [28] Structural factors, such as geographical location and dispersion, the structure of local production, imports, the labor market, institutional preparedness (e.g., legislation, regulations, governance framework, sectoral planning, data availability) are equally important cost drivers.[29]

Finally, these factors are often mutually reinforcing, adding to additional costs. For instance, a weak governance framework and lack of maintenance can affect WASH utility performance, roads, electricity, health and education infrastructure conditions widening the gap and increasing the cost to meet SDG targets. Rehabilitation spending is significant even with already relatively high coverage and access to these utilities and infrastructure. In some cases, access to natural resources and labor may be available but difficult to manage in terms of governance, accountability and quality, which increases unit costs. For other countries, unit costs can be driven by the remote location, lack of natural and human resources. Some remote SDS can experience high transport costs for specialized healthcare services that are not otherwise

[27] Our estimates (available upon request) indicate, for instance, that the median unit cost in current US$ per kW of energy generation, transmission, maintenance and distribution is 14 percent higher in Pacific SDS than in the Caribbean SDS.

[28] There is also a significant uncertainty related to the estimate of the effect of climate change and natural disasters, depending on the intensity and frequency of these events (Box 2).

[29] For most lower- and middle-income SDS across all regions, there can also be high costs associated with accurate and relevant data to inform resilience spending. This includes, for example, adequate and accessible LiDAR survey data to inform infrastructure improvements and investment needs. This also includes investment in adequate Early Warning Systems ahead of a natural hazard.

available in-country. In education, some countries may spend more to attract and retain teachers and staff, while others struggle with accountability and merit-based measures.

***Cost of climate-resilient infrastructure***

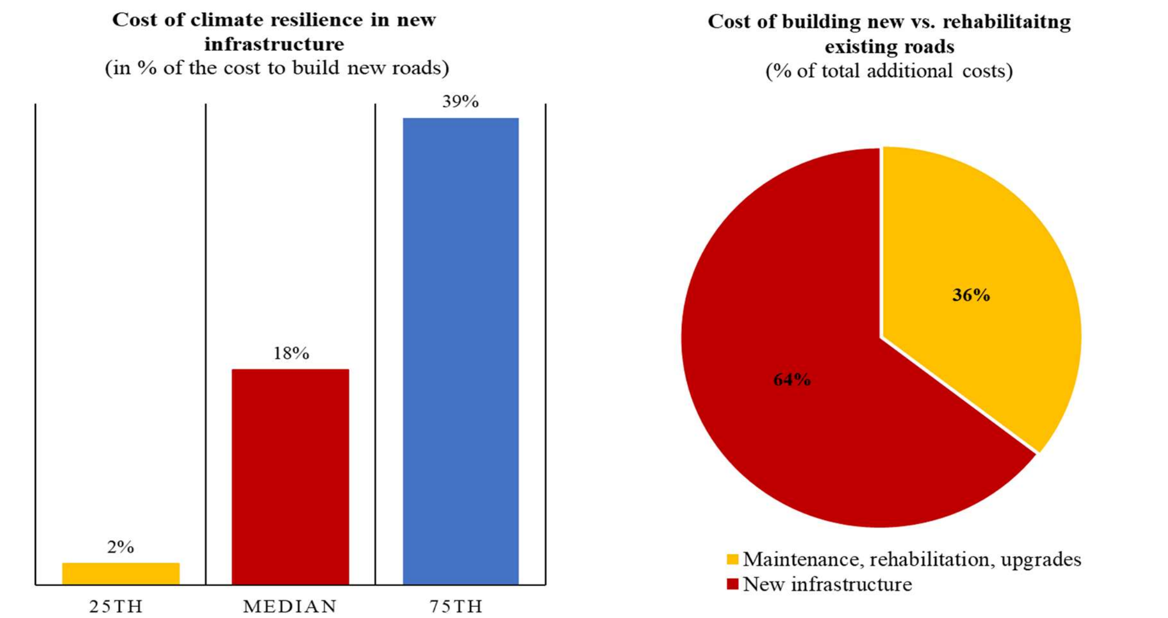
The cost of climate-resilient infrastructure explains a large part of additional spending needs (OECD 2018). It broadly consists of additional capital and current spending. The former includes building new resilient infrastructure and rehabilitating or upgrading existing infrastructure. The latter relates to additional spending to manage assets in countries exposed to the effects of climate change and natural disasters. Planning, monitoring (e.g., early warning systems) and maintenance are a large part of the management costs.

We estimate the cost of climate resilience in new road infrastructure using country-specific costs, accounting for countries' import structure and the standard unit cost of constructing one kilometer of roads across countries (Gaspar and others 2019). The results indicate that the cost of climate resilience could explain between 2-40 percent of the total cost to build new roads in our SDS sample (bar chart).[30] This cost varies across countries depending on their geographic location, exposure to climate risks, type of roads and other structural factors (previous section). The project-based approach also allows deriving the cost of rehabilitating, upgrading and maintaining existing road infrastructure, which accounts for about 36 percent of the total additional costs in our sample (pie chart).

A more in-depth analysis is needed to estimate the country-specific costs of climate resilience for other physical infrastructure. For WASH, for instance, we use the country-specific cost estimates from Hutton and Varughese (2016) that also account for capital maintenance (around 30 percent of initial capital). We use Hallegatte and others (2019 a b) and Miyamoto (2019 a b) to approximate the average cost of increasing the resilience of WASH infrastructure depending on their vulnerabilities to extreme weather events and natural hazards. Based on the literature, this improvement cost can vary between 5 to more than 100 percent of the total capital cost depending on the sensitivity to each type of extreme weather event and climate-related disasters. For energy infrastructure, we generally use country-specific costing to build new renewable energy infrastructure, improve transmission efficiency and finance maintenance.

[30] The estimated costs may still include country-specific risk premiums not directly related to climate resilience and not captured in import prices.

**Figure 6. SDS: Cost of Climate Resilience to Meet SDGs in Road Infrastructure**




Source: Authors' estimates.

***Spending reallocation and efficiency gains***

Cost estimates to meet SDG targets in WASH, roads, and energy already give some indications of spending reallocation needed between new construction, its maintenance, and rehabilitation of existing infrastructure. The need for reallocation of spending among different categories is even more visible in the case of health and education SDGs. The estimates—based on the benchmarking exercise (Section III. B)—also point out the need to increase spending efficiency.

Table 3 shows that the median additional increase in spending to reach higher health outcomes in SDS varies between 1-2 percentage points of GDP by 2030. This cost is still substantial, knowing that SDS median health expenditure already exceeds 5 percent of GDP per year based on the latest available data.

Reaching better health outcomes would require increasing the number of medical staff in all SDS between now and 2030. Mindful of efforts to retain skilled professionals, some reallocation of spending between wages and other current (e.g., provision of medical goods, maintenance of infrastructure and equipment, training) and capital expenditure would need to occur between now and 2030. To meet health SDGs, SDS need not only spend more but mainly to spend better. Sectoral plans indicate potentially high-efficiency gains from better targeting and control of overseas health expenditure of SDS residents and improvements in public procurement.

**Table 3. SDS: Change in Health Inputs to Reach Health Outcomes of Peers**
(median by income groups)

| | Lower Middle -Income | Upper Middle-Income | High-Income |
|---|---|---|---|
| **Additional health spending (ppt of GDP)** | 2.0 | 1.5 | 1.0 |
| **Number of medical staff per 100 patients** | 2.2 | 1.2 | 0.4 |
| **Other current and capital in total spending** | -0.7 | -17.3 | -21.4 |
| **Wages to GDP per capita** | -4.4 | 0.7 | 2.4 |

Source: Authors' estimates.
Note: The results for each income group report median differences between health inputs and spending consistent with better performance in 2030 and the current heath inputs and spending for each group. A positive (negative) value indicates the lower (higher) performance of each SDS income group compared to its peers. The assumption is that to reach the health outcomes of better-performing peers, each SDS will need to adjust its health inputs and spending to the peers' level. For instance, a positive number of medical staff per 100 patients indicates that SDS underperform compared to peers with better health outcomes, and to reach better health outcomes, SDS need to increase the number of medical staff to their peers' level.

Table 4 depicts similar results for adjusting education spending. Median education spending is between 3 and 7.9 percent of GDP based on the latest available data (Annex 4).

Reaching higher education outcomes comparable with peers would require increasing the overall spending envelope by 1.3-2.6 percentage points of GDP by 2030. Enrollment rates are relatively high in primary and secondary education but could increase in pre-primary and tertiary education. Ratios of students per teacher are relatively higher in upper middle-income SDS and could decrease to the level of the peers with better education outcomes. High-income SDS have some scope to increase the number of students per teacher. Compared to GDP per capita, median teacher wages are moderately above their peers for lower middle-income SDS and broadly in line for the other two groups. Some reallocation in other current and capital spending would be needed to increase teachers' training, maintenance of school building and improving the resilience of school infrastructure in high-income SDS. For instance, some savings through efficiency gains and better targeting of overseas tertiary education spending could be possible for lower and upper middle-income SDS.

Overall, spending reallocation and efficiency gains can provide some room to finance additional spending. Adequate public financial management systems and sound infrastructure governance can significantly enhance public investment efficiency in many SDS (Allen and others 2020, Mitchell and others 2020).[31] For instance, increasing allocation and improving execution of

[31] Adequate public financial management systems are also required to ensure appropriate targeting of efforts toward the SDGs and climate resilience. Linking PFM processes with development and climate objectives is crucial toward tracking progress and includes monitoring of public investments at a whole-of-government level to ensure strong links to climate change mitigation and adaptation projects (e.g., Allen and others 2020, CCPAs)

maintenance expenditure is expected to result in less spending on emergency repairs and rehabilitation work. Also, for public and private sector participants, bordering the knowledge of cost and cost-effectiveness of climate resilience measures, as well as creating incentives to modify behavior and reduce risk and exposure, can boost spending reallocation and efficiency (World Bank 2016). Still, much more is needed to support SDS development and climate resilience, especially to continue the progress towards SDGs following the COVID-19 crisis (Box I).

**Table 4. SDS: Change in Education Inputs to Reach Education Outcome of Peers**
(median by income groups)

| | Lower Middle-Income | Upper Middle-Income | High-Income |
|---|---|---|---|
| **Additional education spending (ppt of GDP)** | 1.3 | 2.2 | 2.6 |
| **Students to teacher ratio** | 0.3 | -1.6 | 1.5 |
| **Enrolment rate in pre-primary to tertiary education** | 22 | 17 | 22 |
| **Other current and capital spending in total spending** | -6.9 | -0.6 | 7.0 |
| **Wages to GDP per capita** | -1.3 | 0.1 | 0.2 |

Source: Authors' estimates.
Note: The results for each income group report median differences between education inputs and spending consistent with better performance in 2030 and the current education inputs and spending for each group. A positive (negative) value indicates the lower (higher) performance of each SDS income group compared to its peers. The assumption is that to reach the education outcomes of better-performing peers, each SDS will need to adjust its inputs and spending to their peers' level. For instance, a positive number associated with enrollment indicates that SDS have scope to increase the number of students compared to peers with better education outcomes.

## V. Financing for Climate and Development

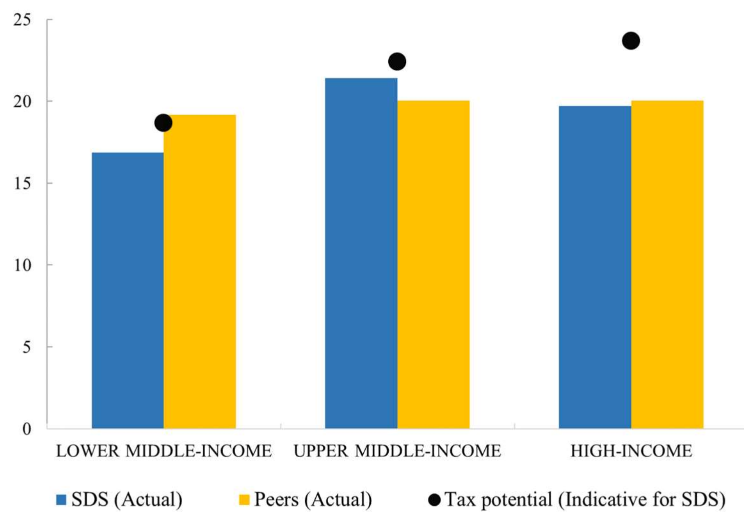
This section discusses options to finance development needs in SDS. It focuses first on estimating tax potential to increase domestic revenue in our SDS sample. Subsequently, this section provides an overview of available external options for climate change adaptation, mitigation and disaster preparedness and response, discussing the main difficulties of SDS in accessing 'climate financing.' Finally, it broadly discusses fiscal space issues through the lens of SDS debt levels, their sensitivity to shocks and fiscal buffers.

### *Domestic revenue*

SDS have some scope to increase domestic revenue (Figure 7). For instance, the current tax ratio of lower middle-income SDSs—of about 17 percent of GDP—is 2 percentage points of GDP below that of countries with a similar development level and climate vulnerabilities but better development and policy outcomes (Section III for selections of the peers). The tax levels of upper middle- and high-income countries are broadly similar at around 19.5 percent of GDP and in line with their peers' median.

**Figure 7. Current and Potential Tax Revenue for SDS**

(median by income, percent of GDP, 2019)




Source: RAT, WEO, Authors' estimates.
Note: Blue and yellow bars indicate actual tax revenue (% of GDP) in 2019 for small developing states and their peers (median by income group, excluding resource-rich peers), respectively. The peer countries are those with similar GDP per capita and climate vulnerabilities, but better policy and institutional preparedness. Dots show average tax potential in % of GDP, estimated using a Tax Frontier Analysis (Appendix 5 for details).

Once we compare actual tax revenue with potential tax revenue that SDS could collect given their economic structure (Tax frontier analysis in Annex V), tax revenue potential increases more visibly with the income. For high-income countries, the average gap between potential and actual tax revenue is relatively large (about 4 percentage points of GDP).[32] This indicates that high-income SDS have room to improve their tax revenue through tax policy and revenue administration reforms. The gap is lower—at about 1-1.8 percentage point of GDP—for upper middle-income and lower middle-income SDS, suggesting that for these SDS, increasing tax revenue may require both structural and fiscal measures to diversify their economic base and generate revenue gains from tax policy and revenue administration measures.

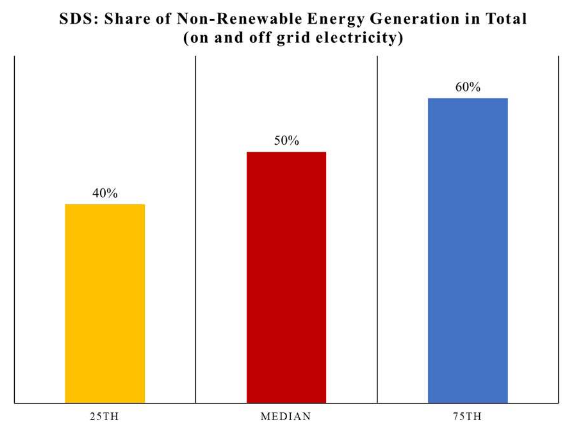
While the assessment of specific structural, tax policy and revenue administration measures, as well as their prioritization, is beyond the scope of this paper, energy and fuel taxation reforms could have far-reaching beneficial effects. For instance, many SDS could align energy and fuel prices with underlying costs (e.g., Box 3) using excise taxation, a carbon tax or by removing

[32] Annex 5 discusses the approach applied to estimate the tax frontier for SDS. These estimates account for, for instance, the size of tourism and agriculture sectors, government wage bills, geographic dispersion of the country and the extent of remittances.

subsidies.[33] These reforms need to be implemented gradually, and with appropriate compensation packages, to avoid any negative welfare effects on the most vulnerable segments of the population.

**Box 3: Small but Important Role of Energy Taxation**

Many SDS still rely on imported petroleum products, particularly diesel, for their energy needs (Figure). Ensuring that energy prices reflect underlying generation, transmission, and distribution costs can help raise some revenue to finance sustainable development.



Source: ADB, AFDB, IADB, IRENA, World Bank, Authors' computation.

Policy options and their calibrations depend on country-specific circumstances and should include additional safeguards to protect the most vulnerable population. SDS could adjust indirect taxation (value-added tax and excise) and import duties and introduce carbon taxes on fuel products to reflect the negative environmental and health externalities from their use (e.g., GHG emissions and local air pollution). Similarly, SDS could ensure that electricity prices reflect supply costs that vary by type of electricity generation and depend on generation efficiency. Moving toward renewable energy, such as solar, has the potential to reduce both GHG emissions and generation costs. Increasing the share of renewable energy generation also provides scope to remove electricity subsidies without resulting in a large increase in electricity tariffs.

Various estimates show that introducing a carbon tax on fuel at $35 per ton (e.g., through increasing existing excise taxes) could help generate additional revenues of between 0.4 - 1 percent of GDP in 2025.[1] In some SDS, removing the subsidy provided to state utilities for diesel costs and electricity tariff subsidies would reduce expenditure by about 1 percent of GDP.

These additional gains fall short of fully financing development spending needs. However, they play an important signaling role for the international community that SDS are doing their part in mobilizing resources to finance resilience efforts and contributing to global mitigation.

[1/] The results are based mainly on a mitigation spreadsheet model developed by Parry and others (2016 2017) and applied to Belize, St. Lucia, Grenada, Maldives, Micronesia, Seychelles and Tonga (Bonato and others 2018, Cheasty and others 2017, 2018, Daniel and others 2021, Davies and others 2019 a and b, Authors' estimates). The sectoral model projects energy use as a function of factors, such as exogenous technological change, global oil prices and domestic carbon taxation. The model calibration is country specific.

[33] For many SDS, incorporating the externalities from GHG emissions into existing fuel excises would have a similar effect as a carbon tax, since the bulk of their GHG emissions are from the combustion of fuels.

Domestic revenue gains are possible but relatively small and backloaded compared to substantial development spending requirements.[34] However, domestic revenue efforts—particularly in terms of climate taxation—play an important signaling role of SDS commitments to contribute to global mitigation efforts and finance even a small part of their adaptation spending (e.g., contribution to the maintenance and/or smaller, local community development projects). This signaling role is important to help access external financing for climate and development.

***Access to 'climate financing'***

Many SDS have access to external financing for climate change adaptation, mitigation and natural disaster preparedness and response through Multilateral Development Banks, multilateral and bilateral climate funds, regional insurance mechanisms, and contingent financing arrangements offered by development partners.[35, 36] In addition, SDS authorities are increasingly seeking ways to leverage private sector investments for climate change projects.

Different mechanisms of 'climate financing' serve different needs and are applicable at different times. Some examples include:

- *Multilateral Development Banks (MDBs)* offer grants, contingent grants and concessional loans that can be accessed by both low- and middle-income small states. Financial support can be broadly tied to development and climate objectives, however financing facilities can also be designed to specifically meet sector priorities, such as in support of water and sanitation outcomes that account for water-related climate risks (World Bank 2020). Along with grant and loan-based financing for low to middle-income countries, the MDBs have also extended equity, guarantee and investment loan instruments for middle- to high-income countries. Together, the MDBs in 2019 committed a total of US$61 billion in climate finance in all economies where they operate, US$41 billion of which was for low- and middle-income countries (AfDB and other 2020). A significant portion of MDB climate finance includes trust-funded operations that are channeled through the MDBs. Nonetheless, roughly $US38.5 million was from MDBs own accounts for low- and middle-income economies.

- *Climate Funds or Climate-Related Financial Intermediary Funds* also offer grants, contingent grants, concessional loans, equity, guarantees and results-based financing that can support

[34] These gains in domestic revenue from fuel taxation will erode over time, for example due to the switch towards renewable energy.
[35] This includes financing for infrastructure, policy change and in some cases for mitigation, including transition costs toward a low-carbon economy.
[36] In principle, SDS could benefit from financing committed under the UNFCCC. Advanced economies have committed to mobilizing US$100 billion per year by 2020 to help developing countries tackle and adapt to climate change. Although still far from the goal, efforts have been improving and in 2018 climate finance provided and mobilized by developed countries had totaled USD 78.9 billion. In that year, 70 percent went to climate change mitigation while only 21 percent went to adaptation (OECD 2020).

both public and private entities. These funds can support anything from renewable energy to ocean preservation and can often mobilize additional funding from the private sector. The climate fund architecture is complex with dozens of national, regional and international instruments that have various eligibility requirements, criteria, processing and average time requirements. These can include ex-ante resilience and adaptation, as well as post-recovery efforts. Some examples are included in Annex 6.

- *Regional, country group or sector- specific funds* support climate change adaptation and mitigation. For example, *the Energy and Environment Partnership Africa* provides early-stage grant financing for projects in several African countries, including Seychelles, for renewable energy projects. Funding is made available to companies, non-profits and social enterprises. Another example, the *Asia Pacific Climate Finance Fund* is a multi-donor fund supporting ADB member countries with the implementation of financial risk management products to help unlock capital for climate investments and improve resilience.

- *Several bilateral funds* have also been established to contribute to either broad or sector-specific objectives. For instance, the *Global Climate Change Alliance (GCCA+)*, an EU initiative, supports least developed countries and small island developing states with climate change mainstreaming, increasing resilience to climate-related stresses and shocks, and sector-based climate change adaptation and mitigation strategies. Another example, the *Nordic Development Fund* supports climate change adaptation and mitigation investment in low-income and lower middle-income countries.

- *Regional insurance mechanisms* have also become a critical financing instrument for governments responding to climate-related disasters and extreme weather events. For example, the *Caribbean Catastrophe Risk Insurance Facility* (CCRIF) and the *Pacific Catastrophe Insurance Company* (PCRIC) both enable multi-country risk pooling and insurance instruments for parametric policies that provide short-term liquidity when a policy is triggered, for example, for cyclones or earthquakes. These mechanisms emphasize speed for pay-outs. The Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) further provides support through disaster risk modeling and assessment tools that go alongside technical assistance for integrated financial solutions, and many of the existing parametric mechanisms have enabled broader work streams on data and asset exposure. The African Risk Capacity, a specialized agency of the African Union, also supports several African countries such as Comoros and Djibouti to plan, prepare for and respond to extreme weather events through customized early warning and contingency planning support and parametric insurance and risk-pooling instruments.

- *Contingent financing arrangements* offered by development partners have been put in place by several SDS, particularly in low and middle-income categories. This includes the *Contingent Emergency Response (CERC) component through the World Bank*, which allows for redirection of any uncommitted project funds toward emergency response. Further emergency financing is provided through the *World Bank-supported Catastrophe Deferred Drawdown Option (CAT-DDO)*, a source of quickly disbursing finance following the declaration of an emergency or disaster; the *IMF's Rapid Credit Facility and Rapid Financing Instrument*, which provides rapid and low-access financing to address urgent balance of payment needs arising from exogenous shocks, such as natural hazards and subsequent disasters and the *ADBs Policy-Based Contingent Financing Instrument*, providing policy-based concessional loans and grant contingency financing in times of an emergency. The IMF's *Catastrophe Containment and Relief Trust* also enables the provision of grants for debt relief in the poorest and most vulnerable countries hit by natural hazards and public health disasters. The relief on debt service payments creates space to meet the balance of payments needs created by disaster containment and recovery.

As major financial investments are required from both public and private sources, governments also look to leverage private sector investments for climate change projects. This includes private equity, debt, grants and guarantees, including larger institutional investments through pension funds or insurance companies. There are also opportunities to leverage local capital and financial markets as a source of long-term debt financing for climate change projects, particularly environmental infrastructure. The Overseas Development Institute finds that National Development Banks can play an important role in supporting the transition to a low-carbon climate-resilient economy (Griffith-Jones et al., 2020). The IFC estimates that the NDCs of 21 emerging market economies will represent US$ 23 trillion by 2030 in investment opportunities (IFC, 2016). There are also opportunities at a national level to mobilize financing through green credits or loans to help direct efforts toward sustainability goals, in particular for mitigation efforts, including the low-carbon transition.

Despite the broad range and availability of climate financing, SDS can face significant challenges in access.[37] In some cases, climate funds can be too complex with heavy demands on project preparation, co-financing or other prerequisite implementation arrangements that are often beyond the capacity of many small states with limited resources (including human resources). Limited digital infrastructure and a lack of access to robust data can also prove prohibitive for many SDS to meet the requirements for proposal submission, monitoring and reporting (CPA, 2019). Anecdotal evidence suggests that becoming an accredited intermediary through which to channel funding can also be quite complex and rigorous for small states with low capacity. This low capacity also affects the management of climate-related projects in infrastructure, social sectors and early warning systems. Relatively weak alignment of public financial management processes with SDG and climate resilience goals is a common institutional constraint to many SDS.[38]

Along with challenges associated with initial access, many climate fund processes may have scope to further reduce the predictability and sustainability that is often required for climate change adaptation or mitigation financing. Processes for accreditation, program and project submission and approval not only take significant capacity, time and human resources, but they

[37] A broader assessment of access to climate finance options and barriers (Daniel and others 2021)

[38] See, for instance, Climate Change Policy Assessments available on https://www.imf.org/en/Topics/climate-change.

can also require many months and occasionally years of commitment without a guaranteed result (Tanner et al., 2019). Many SDS likewise face significant limitations in accessing private financing due to: i) small domestic markets and a narrow natural resource base; ii) an inadequate policy environment, including poor signaling as well as a lack of available information and data which can influence the choices of private actors; and iii) a lack of necessary scale to entice private sector investment and mobilization given other limiting factors such as geographic isolation, high cost and high risks (OECD and World Bank 2016). Improvements in data and hazard risk profiling, incorporating planning and policy signaling that integrates development and climate objectives, as well as strong public financial management (Section V.B.) at a national level can enable greater access to climate financing, and in the case of some SDS requires upfront support to strengthen these elements.

***Fiscal space: debt levels, external financing, fiscal buffers***

Finally, all SDS debt is highly sensitive to exogenous shocks, such as climate change events and natural disasters, external demand, commodity prices or health. This high sensitivity to shocks quickly limits their borrowing space. For instance, following frequent climate-related disasters, the debt levels quickly increased through the impact of these events on SDS economies and [new] debt contracted to finance reconstruction efforts. The impact of the current pandemic—comparable to some extent to a climate-related disaster—also illustrates these concerns. SDS general government debt averaged around 58 percent of GDP at end-2019. Debt levels varied between 36 percent of GDP for lower middle-income SDS to 61 and 66 percent of GDP for high- and upper middle-income countries. Following the pandemic, SDS debt ratios could increase up to 24 percentage points of GDP in two years (Figure 8 based on the October 2020 and October 2019 editions of the World Economic Outlook). The impact of the shock varies across country groups, with lower middle-income SDSs still expected to benefit more from grants and concessional financing.[39]

Frequent shocks also require maintaining some (liquid) fiscal and reserve buffers, for instance, in the form of emergency funds (e.g., Nishizawa and other 2019) and careful management of fiscal risks.[40] Quasi-continuous post-disaster reconstruction and emergency repairs of climate-vulnerable infrastructure also impose strains on the availability of financing for other development goals.

Limited fiscal space necessitates a careful calibration on how SDS should allocate their available funds across sectors to achieve the greatest efficiency gains. For instance, a cost-benefit analysis requires considering the second-round effect of additional SDG spending on economic growth

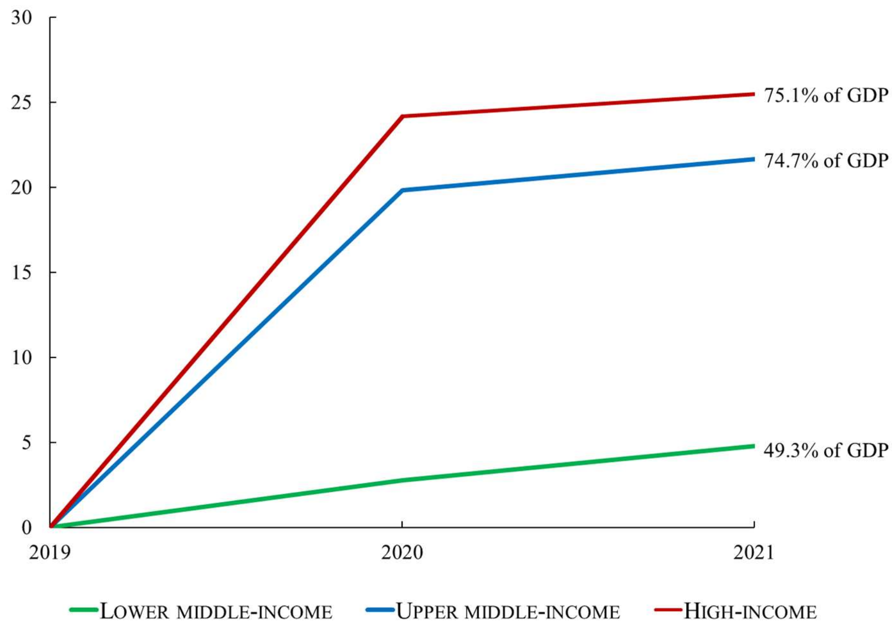
[39] One of the main differences between natural disaster shocks and the current pandemics is that following the former, all SDS usually benefit from some financial or in-kind support from the international community.

[40] SDS authorities must contend with the management of fiscal risks stemming from climate-related disasters as well as more traditional risks from the public and private sectors. Careful fiscal management is required to ensure available fiscal space for SDG attainment.

and climate resilience (IMF 2016, 2019, Benedek and others 2021). Prioritization within and between sectors also requires integrating policy objectives in financing allocation.[41]

**Figure 8. SDS: Impact of the COVID-19 Crisis on General Government Debt**

(ppt of GDP)




Source: WEO.

Note: Median percentage point of GDP difference between October 2020 and October 2019 WEO projections for General Government Debt. RHS numbers indicate median debt levels in % of GDP projected for end-2021 in October 2020 WEO.

## VI. Conclusions

SDS are among the most vulnerable countries to the impact of climate change and related hazards. The occurrence and impact of these events result in already high costs affecting economic growth and progress toward sustainable development. SDS are aware of the development-climate resilience nexus as reflected in their National Development Plans and international commitments. However, progress in meeting their SDG targets and increasing climate resilience has been uneven across countries and sectors. Substantial challenges—including additional spending needs—persist.

Annual spending needs to reach SDG targets in health, education and physical infrastructure are around 6.7 percent of 2030 GDP in 2030. There are significant variations across countries (e.g., the largest additional cost is estimated for lower middle -income SDS), regions and sectors. A multitude of factors—such as country-specific unit costs, SDG current performance and targets—

[41] Such analysis could be conducted at the country level within the Debt Sustainability Framework (see CCPAs, IMF 2016) and/or by developing a comprehensive Disaster Resilience Strategy (IMF 2019). For some SDS in our sample, policy priorities and cost-benefits analyses are already reflected in existing development plans and sectoral projects.

explain these variations. Our results also show that to meet SDG targets, SDS often needs to spend better, improving spending efficiency and reallocation. It requires adequate public financial management systems in health, education and sound infrastructure governance (e.g., to increase budgetary allocations to, and execution of, maintenance expenditure). There is also a need to broaden knowledge of cost and cost-effectiveness of climate resilience measures and modify behavior to reduce climate-related risks and exposure for both public and private participants.

SDS face significant challenges in effectively mobilizing financing for development. We estimate there is potential to increase domestic revenue by about 1 to 4 percentage point of GDP. However, revenue mobilization efforts take time and alone are insufficient to finance development needs. SDS also face difficulties accessing various 'climate funds,' due to often cumbersome administrative requirements from the funds, limited SDS' capacity to meet those requirements, and a lack of data. Besides that, the need to maintain fiscal buffers to deal with frequent shocks (nature, climate-related, economic, health) limits the availability of funds for development spending. SDS need to carefully manage risks, often building a layered approach to their financing (e.g., insurance, contingency lines). High debt sensitivity to these shocks quickly absorbs already limited SDS' borrowing space. Under these constraints, SDS often need to make difficult choices across and within sectors.

Challenges are not only financial. SDS face significant issues often related to the small size of their economies, a limited implementation and administrative capacity (e.g., in public financial management, analyzing and using different financing instruments) and with data availability.

The COVID-19 crisis has exacerbated challenges and limited financing options of SDS to meet the SDGs with possible severe and long-lasting effects on SDS' economies and populations. The development-climate nexus is evident and the threat to progress in sustainable development in SDS is even larger if other countries fail to align policies that hasten the economic recovery with those that lead to positive environmental outcomes. Advancing international cooperation through further technical and financial support is crucial to avoid severe setbacks in sustainable, inclusive, and resilient development. The post-pandemic recovery is also an opportunity to build forward better and improve SDS' climate resilience in the immediate and long term.

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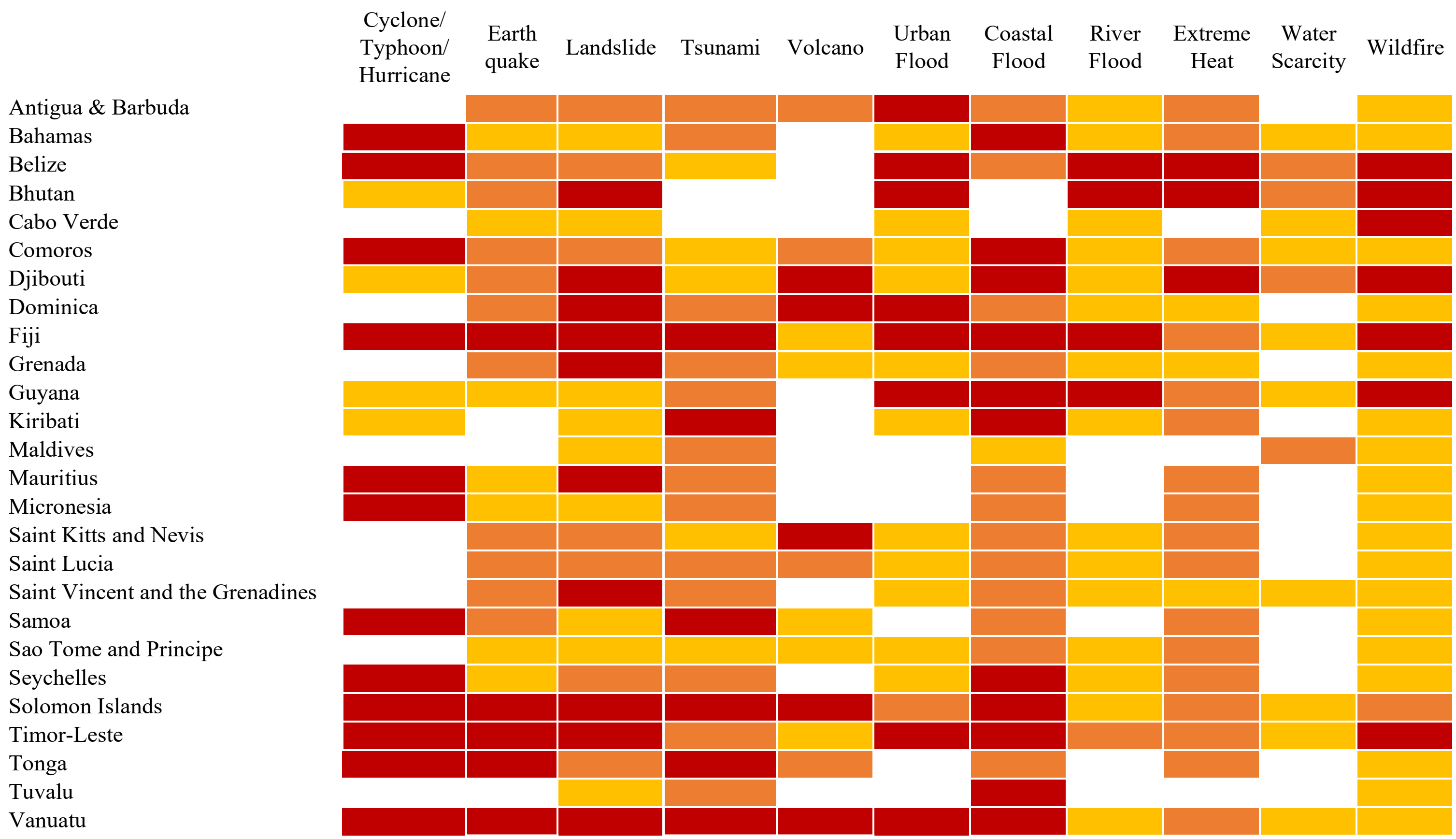
## Annex 1. Country Sample

| | Income Group | Region | Island States | Costal | Landlocked |
|---|---|---|---|---|---|
| **Antigua & Barbuda** | High-income | WHD | Y | | |
| **Bahamas** | High-income | WHD | Y | | |
| **Belize** | Upper middle-income | WHD | | Y | |
| **Bhutan** | Lower middle-income | APD | | | Y |
| **Cabo Verde** | Lower middle-income | AFR | Y | | |
| **Comoros** | Lower middle-income | AFR | Y | | |
| **Djibouti** | Lower middle-income | MENA | | Y | |
| **Dominica** | Upper middle-income | WHD | Y | | |
| **Fiji** | Upper middle-income | APD | Y | | |
| **Grenada** | Upper middle-income | WHD | Y | | |
| **Guyana** | Upper middle-income | WHD | | Y | |
| **Kiribati** | Lower middle-income | APD | Y | | |
| **Maldives** | High-income | APD | Y | | |
| **Mauritius** | Upper middle-income | AFR | Y | | |
| **Micronesia** | Lower middle-income | APD | Y | | |
| **Saint Kitts and Nevis** | High-income | WHD | Y | | |
| **Saint Lucia** | Upper middle-income | WHD | Y | | |
| **Saint Vincent and the Grenadines** | Upper middle-income | WHD | Y | | |
| **Samoa** | Upper middle-income | APD | Y | | |
| **Sao Tome and Principe** | Lower middle-income | AFR | Y | | |
| **Seychelles** | High-income | AFR | Y | | |
| **Solomon Islands** | Lower middle-income | APD | Y | | |
| **Timor-Leste** | Lower middle-income | APD | Y | | |
| **Tuvalu** | Lower middle-income | APD | Y | | |
| **Vanuatu** | Lower middle-income | APD | Y | | |
| **Total SDS** | **25** | | **21** | **3** | **1** |

Sources: WEO (2019)

Note: IMF Guidance Note (IMF 2018) classifies SDS in four income groups: (i) high-income SDS, as countries with GDP per capita above US$12476, (ii) upper middle-income, as countries with GDP per capita between US$4036 and US$12475; (iii) lower middle-income SDS as countries with GDP per capita between US$1026 US$4035; and (iv) low-income SDS with GDP per capita below US$1025. Our sample does not include low-income SDS.

## Annex 2. An indication of National Hazard Categories and Intensities in SDS




Source: ThinkHazard, GFDRR. .

Notes: ThinkHazard indicates the intensity of potential natural hazards and disasters by calculating the probability of frequency and severity. Red shows a climate-related disaster with high severity and frequency; Orange– a potentially damaging disaster that is expected to occur in a human lifetime; Yellow—a low or very low potentially damaging event less likely to occur in a human lifetime. The ThinkHazard exposure profiles have been used as a comparable example of the possible set of hazards across all SDS included in this study, however, the ThinkHazard assessment is not always complete due to a lack of comparable data. For example, some Caribbean islands such an Antigua and Barbuda, Dominica, Grenada, St Kitts and Nevis, St Lucia and St Vincent and the Grenadines are vulnerable to the impacts caused by hurricanes. Detailed individual country and regional assessments are needed to fully understand the costs of resilience in each country.

## Annex 3. Selected Data Sources

| Education | Energy | Health | Roads | Water and Sanitation |
|---|---|---|---|---|
| WEO 2019 | WEO 2019 | WEO 2019 | WEO 2019 | WEO 2019 |
| | IRENA | | | |
| Notre Dame-Global Adaptation Initiative (ND-GAIN), | Notre Dame-Global Adaptation Initiative (ND-GAIN), | Notre Dame-Global Adaptation Initiative (ND-GAIN), | Notre Dame-Global Adaptation Initiative (ND-GAIN), | Notre Dame-Global Adaptation Initiative (ND-GAIN), |
| Global Risk Index | Global Risk Index | Global Risk Index | Global Risk Index | Global Risk Index |
| World Bank Estates database (number of teachers, teacher to student ratio, enrolment rates) | World Bank World Development Indicators (current access to electricity, per capita electricity consumption) | WHO Global Health Observatory (doctor density, ratio of doctors to all other medical staff) | World Bank (Rural Access Index, population density, economic shares of manufacturing and agriculture) | Hutton and Varughese (2016) |
| UNESCO (share of non-teacher wages in current spending, shares of current no compensatory and capital spending) | | World Bank (share of doctor and nondoctor compensation in total spending) | CIA Factbook and International Road Federation World Road Statistics (current number of road kilometers, country area) | Burdescu and others (2020) |
| World Bank (HDI, WDI, GFDRR) | | OECD Health statistics (ratio of nondoctor compensation to doctor compensation) | | |
| UNICEF | | | | |
| UNSTAT | UNSTAT | UNSTAT | UNSTAT | UNSTAT |
| UNFCCC | UNFCCC | UNFCCC | UNFCCC | UNFCCC |

Source: Gaspar and others (2019); Authors.

## Annex 4. Summary Statistics

| | Climate Vulnerability | Rating of climate-related loss/GDP 1999-2018 | Greenhouse Gas Emissions | Policy and Institutional Readiness to Climate Change | Health Outcomes (Adjusted) | Education Outcomes (Adjusted) | Renewable Energy Generation Target | Rural Access Index | Access to Basic Water Services | Health Spending (latest available) | Education Spending (latest available) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (index 0 less to 1 more) | (rank 1 max loss to 180) | (% of total) | (index 0 less to 1 most) | (score 0 less to 10 more) | to add | (in % of total) | (0-100) | (% of total population) | (% of GDP) | (% of GDP) |
| *Median* | | | | | | | | | | | |
| Lower Middle-Income | 0.54 | 28.00 | 0.00 | 0.38 | 0.23 | 0.45 | 50.00 | 77.00 | 84.00 | 5.17 | 7.86 |
| Upper Middle-Income | 0.44 | 15.00 | 0.00 | 0.45 | 0.43 | 0.55 | 85.00 | 78.00 | 96.50 | 5.24 | 4.61 |
| High-Income | 0.48 | 14.00 | 0.00 | 0.43 | 0.55 | 0.60 | 50.00 | 83.50 | 98.00 | 5.76 | 3.00 |
| *Median* | | | | | | | | | | | |
| APD | 0.53 | 14 | 0.0 | 0.42 | 0.28 | 0.45 | 85 | 77 | 93 | 5.21 | 6.74 |
| WHD | 0.46 | 10.00 | 0.00 | 0.45 | 0.55 | 0.57 | 50 | 85 | 97 | 4.95 | 3.65 |
| SSA+MENA | 0.49 | 135 | 0.0 | 0.30 | 0.34 | 0.62 | 45 | 80 | 86 | 5.46 | 6.04 |
| **Total SDS** | | | **0.08** | | | | | | | | |
| **Median SDS** | **0.48** | **16** | | **0.42** | **0.33** | **0.51** | **70** | **81** | **96** | **5.24** | **5.56** |
| **Average SDS** | **0.49** | **40** | | **0.40** | **0.66** | **0.52** | **68** | **80** | **91** | **6.41** | **6.16** |

Sources: Global Climate Risk, IMF , NDCs, ND-GAIN, UNICEF, World Bank (WDI, HDI), WHO.

## Annex 5. Tax Capacity Estimates using Stochastic Frontier Analysis (SFA)

This annex discusses briefly the methodology used to estimated tax capacity in 19 SDS using an SFA (Martinez-Vazquez and others 2013) and provides the main results. The methodological approach follows Langford and Ohlenberg (2016) in the sense that we use a time varying true random effects model which takes into account random shocks, accounts for heterogeneity within the panel, and distinguishes between invariable or persistent structural factors and time-varying factors affecting countries' tax effort. However, we use a different specification to the one used by Langford and Ohlenberg (2016). Our specification is tailored, and the sample is limited to SDS to capture their unique characteristics compared to larger economies. This may lead to a different frontier compared with larger economies.[42] Furthermore, to better capture SDS features, we adjust and augment the standard set of explanatory variables used in the literature. The chosen specification attempts to mimic the most important tax bases from which SDS collect revenue. Another advantage of this selective approach is that targeted estimates –that also account for SDS data limitation–allow us to estimate tax potential for SDS usually omitted in the empirical work in this area.

### *Methodology*

An SFA models a production function (Equation 1) in which inputs—$X_{it}$—are transformed into tax revenues ($TR_{it}$) for country *i* in year *t*. In this approach, countries potentially collect less than it would be possible due to a level of inefficiency ($E_{it}$), this is random normally distributed and independent of the inefficiency shocks ($V_{it}$).

$$TR_{it} = f(X_{it}, \beta).\ E_{it}.\ exp^{V_{it}}; \qquad (1).$$

A set of inputs $X_i$ includes Gross National Income, the size of agriculture and tourism sectors, the government wage bill and a measure of geographic dispersion. If E equals 1, the country collects the maximum tax revenues possible, using the inputs.

The natural logarithm form of Equation (1) provides the basis for the basic econometric model as proposed by Aigner and others (1977):

$$ln(TR_{it}) = ln[f(X_{it}, \beta)] + ln(E_{it}) + \nu_{it}; \qquad (2).$$

Assuming the tax revenue input function $[f(X_{it}, \beta)]$ is linear in logarithms and defining the inefficiency as $u_{it} = -ln(E_{it})$:

$$ln(TR_{it}) = \alpha + \Sigma\beta\ ln(X_{it}) + \nu_{it} - u_{it}; \qquad (3).$$

[42] Estimating the frontier for a subset of countries with unique characteristics has been applied to countries with abundant natural resources (Fenochietto and Pessino 2013) and in Sub-Saharan Africa (Caldeira and others 2020).

Following Langford and Ohlenburg (2016) and using the specification (3), we use a time-varying inefficiency model for panel data that accounts for observable heterogeneity (Battese and Coelli 1995). The parameters of the stochastic frontier and the inefficiency model are estimated simultaneously to avoid bias. The unobserved time-invariant heterogeneity is captured in a "true random effects" model.[43] As in Langford and Ohlenburg (2016), we interpret unobserved heterogeneity as a lack of tax effort, suggesting that the influence of the unobserved factors could be overcome with tax policy and administration measures.

***Data***

We begin with 25 SDS listed in Annex 1 over the period from 1995 to 2019. Data are taken from the WoRLD, World Economic Outlook, World Development Indicators, International Financial Statistics and World Tourism Organization databases. Data on public sector employment and wage bills come from Gupta and others (2016). Data for selected indicators restrict our sample to 19 SDS: Antigua and Barbuda, the Bahamas, Belize, Cabo Verde, Comoros, Dominica, Grenada, Guyana, Maldives, Mauritius, Micronesia, Samoa, Seychelles, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sao Tome and Principe, Timor-Leste and Vanuatu.

**Appendix Table 1. Summary Statistics**

| Variables | High-Income | Upper Middle-Income | Lower Middle-Income | Entire sample average | Sample median | Observations |
|---|---|---|---|---|---|---|
| Tax revenue (without social security contribution) % of GDP | 17.7 | 20.2 | 14.3 | 17.2 | 17.5 | 659 |
| Gross National Incomeper capita in constant US$ | 14,049.7 | 4,878.3 | 2,311.9 | 5,185.0 | 3,051.8 | 565 |
| Geographic dispersion (in sq. km) | 79,902.8 | 60,093.4 | 403,661.6 | 198,839.5 | 45,389.3 | 690 |
| Value added in agriculture (% of GDP) | 2.8 | 11.6 | 21.8 | 13.7 | 11.6 | 646 |
| Tourism receipts (% of GDP) | 34.8 | 18.5 | 8.6 | 18.0 | 16.1 | 561 |
| Government wage bill (% of GDP) | 9.2 | 9.4 | 11.2 | 10.0 | 9.4 | 536 |

***Empirical Results***

Table 2 indicates the coefficients in the models used to estimate the maximum level (capacity) of tax revenue that could be theoretically mobilized given an SDS' economic structure and

[43] Greene (2005). It is important to note that the choice of how to model unobserved time-invariant heterogeneity in SFA can have a substantive impact on the estimated size of inefficiency (tax effort).

prevailing economic conditions.[44] The larger is the gap between the actual and theoretical tax revenue, the larger is scope for tax policy and revenue administration to reach the potential tax revenue. The gap for SDS is reported in Figure 7 of the main text.

The sign and statistical significance of the coefficients in the models are consistent with the literature, but also capture a specific economic and institutional structure of SDS.

**Appendix Table 2. Stochastic Frontier Analysis Coefficients**

| VARIABLES | Tax revenue |
|---|---|
| *Frontier* | |
| Ln (per capita Gross National Income) | 0.160*** |
| | (0.0205) |
| Ln (Tourism receipts as a share of GDP) | 0.0265* |
| | (0.0139) |
| Ln (Agriculture as a share of GDP) | -0.159*** |
| | (0.0215) |
| Ln (Public sector wage bill as a share of GDP) | 0.0888*** |
| | (0.0235) |
| Ln (Geographical dispersion) | 0.0217*** |
| | (0.00843) |
| Constant | 1.386*** |
| | (0.203) |
| *Inefficiency* | |
| Usigma | -4.718*** |
| | (0.537) |
| Vsigma | -4.780*** |
| | (0.208) |
| Theta | 0.286*** |
| | (0.0105) |
| Observations | 297 |
| Number of countries | 19 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- **Economic development**. Tax revenues increase with the country's income level and economic development as higher-income countries (society) has a higher ability to pay taxes (Bahl 1971). We use Gross National Income per capita—accounting for both GDP and

[44] Estimates of alternative specifications and robustness tests—available upon request—are broadly in line with the baseline.

remittances from the diaspora particularly significant in SDS—to capture the impact of these variables on tax revenue potential in SDS.

- **Sectoral development**. Tax revenues are unusually lower in countries with a larger share of agriculture in GDP. This sector is characterized by a higher number of tax exemptions, small producers, and a higher level of informality (Fenochietto and Pessino, 2013). In contrast, tax revenues are higher in countries with larger tourism receipts (as a share of GDP) as this sector is comprised of larger hotels and transportation companies (Glenday and others 2019).

- **Size of the public sector**. The impact of the public sector on tax revenue is ambiguous. On one side, in many developing countries, the public sector contributes to the bulk of personal income tax revenue. Hence, a larger public sector would imply higher taxes. On the other hand, a large public sector can indicate a less diversified economy and a narrowing of the tax base (e.g., the public sector does not pay corporate income tax), contributing to lower tax revenues. Our estimates indicate a positive coefficient associated with the size of the public sector—as a key economic actor—in SDS.

- **Geographic characteristics.** The main text stresses the impact of geographic location and dispersion on sustainable development and climate resilience goals. These characteristics are difficult to approximate by existing indicators. We use a distance in kilometers between the extreme north-south and east-west borders of each SDS to capture the dispersion and multiply it by import deflators to capture the impact of some SDS' distant location. The role of geographic characteristics on tax revenue is ambiguous. On the one hand, geographic dispersion may reflect a country's size, which is positively correlated with tax revenue. On the other hand, tax collection may be weaker in more 'disperse' countries with lower collection capacities. Our estimates indicate a positive relationship.

## ANNEX 6. EXAMPLES OF 'CLIMATE FUNDS'

***Global Environment Facility (GEF)***. Countries are eligible for GEF funding if they have ratified UNFCCC. The GEF is used for a range of climate and environment-related projects and operates through 18 partner agencies, which are selected to deploy funds. These are the only institutions that can access GEF funding directly. Special funds include the Special Climate Change Fund , which supports adaptation and technology transfer and the Least Developed Countries Fund , which is accessible specifically to LDCs that are vulnerable to adverse impacts of climate change.

***Green Climate Fund (GCF)***. A range of instruments, including grants, concessional loans, etc., that support the delivery of the NDCs. Developing country parties to UNFCCC are eligible. The GCF requires both a nationally designated authority and an Accredited Entity . Organizations seen to have specialized capacities in climate action may apply to be an Accredited Entity and can be private, public, non-governmental, sub-national, national, regional or international. The fund supports eight impact areas across two broad categories: low-emission sustainable development and increasing climate-resilience.

***Climate Investment Funds (CIF).*** Concessional finance is provided to accelerate climate action by empowering transformation in clean technology and renewable energy sources, making them cost-competitive with fossil fuels (e.g., Climate Investment Fund 2019). Recipient countries must meet the Official Development Assistance eligibility criteria and have an active MDB program. Specific funds include the Clean Technology Fund , the Pilot Program for Climate Resilience and the Scaling Up Renewable Energy in Low Income Countries Program .

***Adaptation Fund.*** Grants are provided to developing country members of the UNFCC list of parties, and financing flows through accredited implementing entities. Investments predominately support food security, agriculture, water management and disaster risk reduction projects for the promotion of community resilience.

***Climate Funds for preparedness and response.*** Activities that address the impacts of hazards are also available to SDS. This support is provided both through MDBs and climate funds. The ***Global Facility for Disaster Risk Reduction and Recovery (GFDRR),*** for example, targets the most disaster-prone countries and provides grants in support of building resilience and enabling recovery. Through its ***Small Island States Resilience Initiative (SISRI),*** technical assistance supports small island states to build pipelines of resilient investments to withstand climate change impacts.

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