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Climate Change Vulnerability, Adaptation and Public Debt Sustainability in Small Island Developing States

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Abstract

Small Island Developing States (SIDS) are a group of 39 United Nations (UN) member states and 18 dependent territories mostly located in the Caribbean and Oceania. They are among the most vulnerable countries to losses and damages from climate change globally, and they are especially exposed to tropical cyclones and sea level rise. This paper evaluates the climate change-related vulnerabilities of the SIDS. It uses data from the International Disaster Database (EM-DAT), to examine the magnitude of damages incurred over the last three decades and conducts an event study analysis to examine the fiscal impacts of large tropical cyclone disasters in the last decade. SIDS need to invest substantial resources over the long term for climate change adaption. The paper reviews the limited studies that have been conducted so far, on the potential long-term costs of effective adaptation investment programs. Using the most recent Debt Sustainability Analyses of SIDS, the paper discusses the challenges countries with high public debt levels face and whether a general program of debt relief might be a feasible way to fund the adaptation investment requirements of SIDS. Finally, the paper discusses the type of assistance that SIDS need to strengthen their resilience to climate change in a cost-effective manner, and the role development partners can play in supporting climate-resilient development.

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1. Introduction

Small island developing states (SIDS) are a group of 39 member states of the United Nations and 18 other dependent territories. Although they are a heterogenous group, most of them face similar challenges. Most are relatively small economies which are not well diversified and so are vulnerable to macroeconomic shocks. This was starkly illustrated by the economic impact of the COVID-19 pandemic; the real GDP of SIDS contracted on average by 7.4 percent in 2020, and only partially rebounded by 4.1 percent in the following year. This was mainly driven by the collapse of tourism, on which the economies of many SIDS depend.[1] Moreover, because of their geographical characteristics, many of them are much more vulnerable to climate-shocks—especially damages from tropical cyclones—than are most other Emerging Markets and Developing Economies (EMDEs). Climate change is exacerbating their vulnerability, making extreme climate-related shocks more frequent and damaging over the long term.

Alongside other socio-economic challenges, such as raising real income levels, reducing poverty and enhancing human development, most SIDS also face the urgent need to implement adaptation to climate change. Small island states must adapt to tropical cyclones, floods, droughts, rising sea levels and other extreme weather events. Investment in climate-resilient infrastructure could produce long term benefits in terms of higher GDP (Cevik, 2022). Climate change adaptation investments are, in large part, public goods and thus require public investment.[2] Moreover, because of the comparatively smaller sizes of small islands (both in terms of population and economy), it is very difficult to realize economies of scale in public investments, making such investments relatively more expensive than in larger countries. The magnitude of investments required for effective climate change adaptation, combined with the lack of economies of scale for many of these investments, unavoidably presents fiscal challenges, with most SIDS having limited fiscal space (if any) for expanding public investments.

Fiscal space in many SIDS is constrained by high public debt ratios. More than a third of the SIDS which are independent UN member states have relatively high public debt ratios (above 60 percent of GDP). In their most recent Debt Sustainability Analysis (DSA), 14 SIDS were assessed as being at high risk of debt distress, mainly because their debt ratios breach sustainability thresholds in DSA stress tests (see section 4 for more details). Consequently, some researchers and policy advocates argue that debt relief measures, alongside other reforms to the global financial architecture, are essential to restore debt sustainability and to enable SIDS to undertake the investments needed to strengthen their resilience (Fresnillio and Crotti, 2022; Rustomjee, 2017). This is the motivation for the SIDS Strengthening Resilience by Alleviating Debt (SRAD) program, which advocates for policy measures to improve climate resilience and increase fiscal space in SIDS. It focuses on debt alleviation measures such as: i)

[1] For comparison, the average unweighted real GDP of all EMDEs which are not SIDS contracted by 1.8 percent in 2020 but then increased by 6.9 percent in 2021. The source of the data is the WEO database. The data for the SIDS includes the 36 states which are UN members and which are classified as EMDEs (all SIDS except for Singapore), except Cuba and the Cook Islands for which there are no data in the WEO database.

[2] There are some types of adaptation investments which are private goods, such as strengthening privately owned buildings to make them more resilient to storms, but even these may require some form of public subsidy, either because private property owners do not have sufficient resources for the necessary investments (as may be the case for houses owned by low income households which often bear the brunt of damage from tropical cyclones) or because private property owners do not fully understand the magnitude of the risks that they face over the long term and therefore require a subsidy to incentivise them to invest optimally in adaptation.

debt swaps (for climate/nature/loss and damage); ii) insurance-based approaches to cover debt repayments while handling shocks; and iii) disaster clauses in borrowing terms to allow SIDS to prioritize recovery and defer debt servicing (principal and interest) to a later date (also called pause clauses). There are also proposals for parametric risk insurance to cover sovereign debt service payments in the event of a natural disaster, facilitated by a Global Fund to enable SIDS to pool risks as well as financing investments to strengthen their resilience (Bharadwaj, Mitchell and Karthikeyan, 2023).

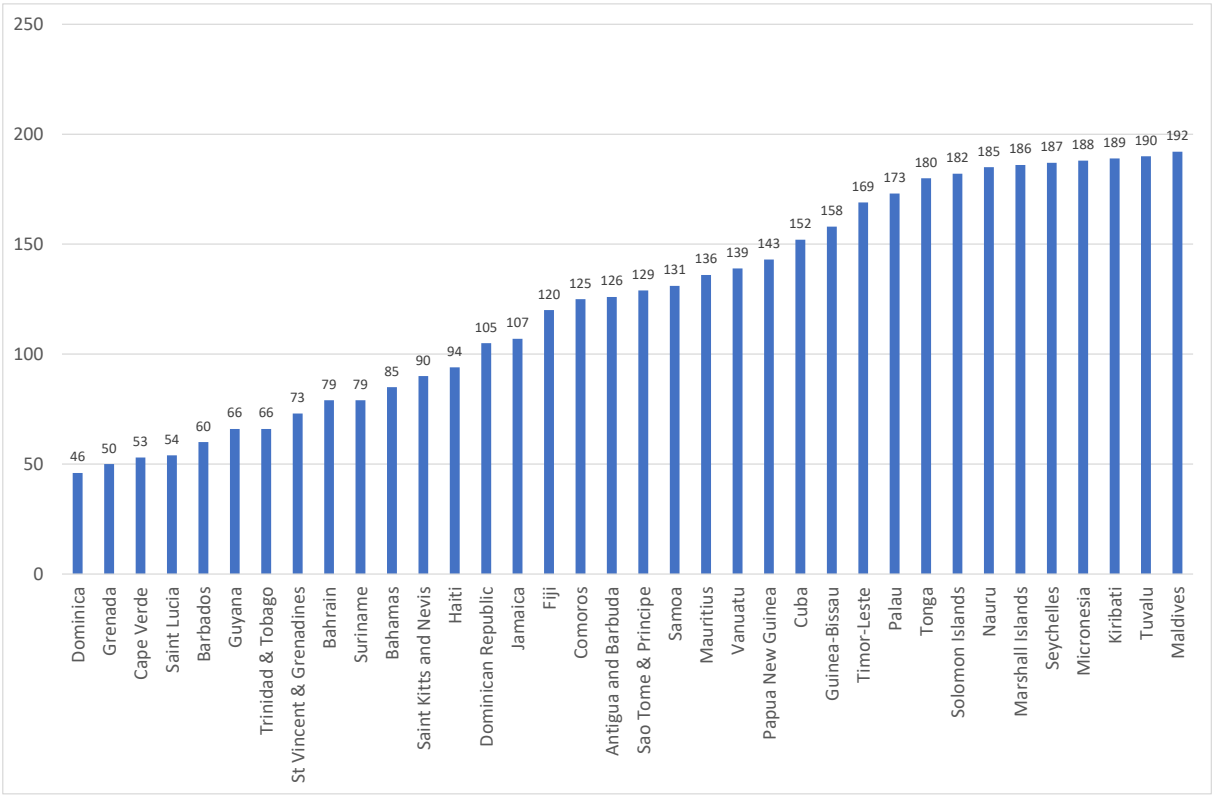
This paper evaluates the challenges SIDS face, focusing on the nexus between vulnerability to climate change, requirements for investments in adaptation and public debt, and the implications for public policy. Vulnerability to climate change and public debt are clearly linked; one of the main reasons why many SIDS are assessed as being at high risk of debt distress in their most recent DSA is their vulnerability to large climate related negative shocks. However, that does not axiomatically mean that debt relief measures are optimal policy instruments to generate the fiscal space required to strengthen the resilience of the SIDS.

The organization of the rest of this paper is as follows: Section two examines the main climate-related vulnerabilities of SIDS, using data from the international Disasters Database (EM-DAT). It also provides an event study analysis of the macro-fiscal impact of some recent large cyclone disasters which struck SIDS in the Caribbean and Oceania. Section three discusses the investment requirements of the SIDS for adaptation to climate change, drawing on existing literature. Section four examines current levels of public debt in the SIDS and their risks of public debt distress, drawing on the assessments and data in their most recent DSAs. It also briefly examines the composition of public debt, differentiating between SIDS with higher and lower debt-to-GDP ratios. Section five discusses what type of external assistance most SIDS need to help them strengthen their resilience to climate change, and whether debt relief measures offer feasible and optimal instruments to deliver this objective. Section six provides a conclusion and main messages.

2. Vulnerability to climate related natural disasters

This section examines the vulnerability of SIDS to climate change-related hazards, which is likely to increase over the long term, as the planet's climate becomes warmer. SIDS are among the most highly exposed countries in the world to hazards from climate change (Hallegatte et al, 2018). This is illustrated by their ranking in the Notre Dame Global Adaptation Index (ND-GAIN). One of the sub-indices of the overall ND-GAIN Index is exposure to climate change, which captures the physical factors external to the system that contribute to vulnerability—it is a component of vulnerability independent of the socio-economic context. Of the 192 countries ranked in this sub-index, 10 of the 19 countries in the most exposed decile are SIDS. Figure 1 shows the ranking of all of 36 EMDE SIDS which are ranked in the ND-GAIN sub-index of exposure to climate change.

Figure 1 Ranking of 36 SIDS in the ND-GAIN sub-index of Exposure to Climate Change



Note: There are a total of 192 countries ranked in this sub-index. Exposure captures the physical factors external to the system that contribute to vulnerability. It is a component of vulnerability independent of the socio-economic context. A higher ranking denotes greater exposure.

Source: ND-GAIN

Although SIDS are a heterogeneous group of countries, many of them share common factors which expose them to the hazards of climate change. Most are located geographically in tropical cyclone regions. Many also have extensive low-lying coastlines. Most also have small undiversified economies heavily dependent on a single export sector, such as tourism. Small islands are unique in that almost all of their territory is exposed to a natural hazard and their small land area means that a single disaster can have a systemic impact.

The main type of climate-related natural disasters[3] which affect most SIDS—both in terms of incidence and especially in terms of the economic damage caused—are tropical cyclones, which accounted for 95 percent of the total damages from climate-related natural disasters that SIDS in the Caribbean and Oceania suffered from 1995 to 2022 as recorded in the EM-DAT. SIDS are also affected by riverine floods and droughts, although the economic damages they cause are generally much less than those caused by tropical cyclones.[4]

[3] These are classified as meteorological (e.g. tropical cyclone, invective storm), climatological (e.g. drought, wildfire) and hydrological (e.g. landslide, riverine flood, coastal flood, flash flood) in the EM-DAT.

[4] Some SIDS are also highly exposed to geological hazards such as earthquakes and volcanic eruptions. These risks also need to be incorporated into the disaster risk planning and management of governments and the private sector.

Many SIDS are highly exposed to tropical cyclones, because of their geographical position, and are highly vulnerable because of the small size of their landmass and lack of economic diversification. The EM-DAT records 185 incidences of tropical cyclone disasters in the 16 Caribbean SIDS during the 28-year period between 1995 and 2022. It also recorded 74 incidences in the 12 SIDS in Oceania during this period.[5] The EM-DAT records total estimated damages, comprising all damages and economic losses related to the disaster, but these data pertain to less than half of the recorded tropical cyclone disasters. Table 1 shows the total damages caused by tropical cyclones and recorded in EM-DAT in the Caribbean and Oceanian SIDS from 1995 to 2022, by country and region, estimated in 2022 US dollar prices. These data must be underestimates of the actual damage caused by tropical cyclones, given the absence of data on total damages for more than half of the tropical cyclone disasters recorded by EM-DAT. It is likely that some SIDS provide more comprehensive data on damages than others; for example, data from Cuba appears to be more comprehensive than that from Haiti.[6] The data in disaster databases is unavoidably imperfect, and are subject to problems such as over or under reporting of certain hazard types and other forms of bias (Gall, 2015).

Table 1 Total Recorded Damages caused by Tropical Cyclones in SIDS in the Caribbean and Oceania; 1995-2022 (US dollar millions, 2022 prices)

Caribbean	Damages USD M.	Oceania	Damages USD M.
Cuba	18,374	Fiji	1,080
The Bahamas	8,478	Vanuatu	557
Dominican Republic	4,586	Tonga	253
Haiti	3,241	Samoa	170
Dominica	2,709		
Jamaica	2,273		
Grenada	1,387		
St Kitts and Nevis	1,193		
Antigua and Barbuda	1,167		
Belize	985		
All Caribbean SIDS	44,606	All Oceania SIDS	2,076

Source: EM-DAT

Total recorded damages from tropical cyclones suffered by SIDS in the Caribbean during 1995-2022 was USD 44 billion, while SIDS in Oceania suffered damages of USD 2 billion. in 2022

[5] Some tropical cyclones hit multiple SIDS.

[6] For most of the tropical cyclone disasters in Cuba for which deaths were reported or where there were large numbers of people affected, total damages are also recorded. But Haiti was struck by several tropical cyclone disasters which killed many people but for which no figure for damages were recorded; e.g. Hurricane Noel in 2007 which killed 90 and affected more than 100,000 people, Hurricane Gustav in 2008 which killed 85 and affected 73,000 people, Hurricane Hanna in 2008 which killed 529 and affected 48,000 people and Hurricane Laura in 2020 which killed 39 and affected 44,000 people. Jones et al (2023) discuss the problem of missing data in disaster databases and how it is handled in empirical research.

US dollar prices. The large difference between the two regions reflects not only that Caribbean SIDS suffered from more tropical cyclone disasters than SIDS in Oceania, but also that the former have economic assets exposed to tropical cyclone damage that are much greater in value than those of the latter, because the combined GDP of Caribbean SIDS is eight times larger than that of SIDS in Oceania.

Table 2 shows all the climate-related natural disasters affecting SIDS in the Caribbean and Oceania from 1995 to 2022, for which recorded total damages exceeded 10 percent of GDP. Although the larger economies in the Caribbean suffered the greatest total damages, some of the smaller islands suffered the largest losses relative to their GDP, notably Antigua and Barbuda, Dominica, Grenada, St Lucia, St. Kitts and Nevis and Vanuatu, all of which incurred losses greater than 50 percent of GDP from a single tropical cyclone disaster.

Table 2 Climate related disasters causing damages exceeding 10 percent of GDP in the Caribbean and Oceania, 1995-2022

Year	Country	Type of Disaster Event & Name	Damages as % of GDP
	The Caribbean		
1995	Antigua and Barbuda	Hurricane Luis	61
1995	St Lucia	Hurricane Luis	67
1995	Dominica	Hurricane Marylin	64
1998	Antigua and Barbuda	Hurricane Georges	14
1998	St. Kitts and Nevis	Hurricane Georges	109
1999	St. Kitts and Nevis	Hurricane Lenny	11
2000	Belize	Hurricane Keith	25
2001	Belize	Hurricane Iris	22
2004	The Bahamas	Hurricane Frances	11
2004	Grenada	Hurricane Ivan	148
2005	Guyana	Riverine flood	27
2013	St Vincent and Grenadines	Riverine flood	14
2015	Dominica	Hurricane Erika	89
2016	Haiti	Hurricane Mathew	14
2017	Antigua and Barbuda	Hurricane Irma	17
2017	Dominica	Hurricane Maria	279
2019	The Bahamas	Hurricane Dorian	26
	Oceania		
2001	Tonga	Cyclone Waka	28
2012	Samoa	Cyclone Evan	17
2014	Vanuatu	Cyclone Pam	60
2016	Fiji	Cyclone Winston	12
2020	Tonga	Cyclone Harold	23

Source: Em-Dat

World Bank (2021) reports estimates of the annual average losses (AALs) in Caribbean countries from four different types of natural disaster, made by the United Nations Office for Disaster Risk Reduction, using estimates of exposure to hazards and assumptions of asset vulnerability. Hurricanes are the largest source of risk for most Caribbean countries, with the Bahamas facing AALs from hurricanes of 4.8 percent of GDP, Antigua and Barbuda 3.8 percent of GDP and Dominica 2.7 percent of GDP. Detailed country risk profiles prepared by the World Bank for four Caribbean countries provide estimates of both the AAL and Probable Maximum Loss (PML)[7] for each country. Single family buildings are the category of asset which suffers the largest losses in each country—between 20 percent and 30 percent of AALs (World Bank, 2021, p46).

Damages caused by tropical cyclones are likely to increase over the course of the 21st century because of global warming. Walsh et al (2016) review research on tropical cyclones and climate change. They argue that, while we still lack a generally accepted theory of climate and tropical cyclone formation, there is a well-established theory of how climate affects the maximum intensity and potential intensity of tropical cyclones. In general, models predict that, with global warming over the course of the 21st century, there will be a reduction in the global numbers of tropical cyclones by 5-30 percent, but an increase in category four and five (high intensity) tropical cyclones by 0 to 25 percent and increases in maximum intensity and rainfall of tropical cyclones, although the numerical predictions are subject to a high degree of uncertainty. There is also a predicted increase in storm surges caused by the combination of sea level rises and more high intensity tropical cyclones.

The most intense tropical cyclones cause the most damage. Acevedo (2016) estimates wind speed damage elasticity for hurricanes in the Caribbean, which is between two and three depending upon whether the storm makes landfall. His findings suggests that damages have historically been underestimated. Average annual damages from storms in the Caribbean are estimated at 1.6 percent of GDP but, given the underestimation, could be as high as 5.7 percent of GDP. Acevedo also makes estimates of how much storm damages will increase with warmer temperatures. This involves three parameters: i) how much a rise in global temperature (GT) translates into a rise in sea surface temperature (SST); ii) how much a rise on SST translates into higher maximum wind speeds of tropical cyclones; and iii) the wind speed damage elasticity. In the RCP 6.0 scenario,[8] storm damages increase by between 11 and 46 percent over the course of this century, although these predictions are highly uncertain.

Some of SIDS are highly exposed to damage from sea level rises (SLR) caused by global warming. Across the globe, sea levels are already rising by an average of around 3.4 millimeters (mm) per annum, and SLR will continue as the planet gets warmer. SIDS have extensive coastal areas, some of which lie below the future high tide water level, and hence will be exposed to permanent inundation from SLR and the associated higher tides as well as episodic flooding from extreme sea level (ESL) events. Modelling indicates that the expected annual flooded area (EAFA) of all SIDS will more than triple by 2050 under all global warming scenarios and will

[7] The Probable Maximum Loss is the largest losses that might be expected to occur for a given return period. The return period is the inverse of the annual probability that a disaster will occur; i.e. the length of time over which a specific disaster would be expected to occur once.

[8] This is a Representative Concentration Pathway modelled by the Intergovernmental Panel on Climate Change (IPCC). The RCP 6.0 is an intermediate pathway in terms of the rise in global temperatures and regarded by the IPCC as the baseline scenario, in which global temperatures rise by 2.5^0 C with a range of 1.6^0C to 3.6^0 C.

rise more than six-fold by 2100 (Vousdoukas et al (2023). Kiribati is the worst affected, with a projected EAFA of between 35 and 55 percent of its total land area by 2100. Tuvalu, the Marshall Islands, the Bahamas, Micronesia and the Maldives will also be badly affected.[9] With population growth in coastal areas and economic growth, by 2100, the expected number of people exposed to annual flooding is projected to increase around 4.5 to seven times depending on the global warming scenario. Expected annual damages (EAD) will also multiply several times in real terms. The Maldives is projected to incur EAD of 12.5 percent of GDP by 2100.

Doan et al (2023) develop a methodology for estimating the numbers of people who are exposed to extreme weather events and vulnerable to suffering severe losses if these events materialise. The extreme weather events considered are drought, flood, heatwave and tropical cyclone, and an extreme event is defined in terms of a given intensity and return period; for example, an extreme weather event for a tropical cyclone is one with a windspeed of category 2 or above and a return period of 100 years. The methodology enables an estimate to be made of the total number of people exposed to each extreme weather event in each country, based on their geographical location and the probability of such an event occurring. Vulnerability is determined on the basis of income (people below or just above a poverty line) and other indicators which are known to be correlated with vulnerability to shocks such as educational attainment, access to piped water and electricity, availability of a social safety net, etc. Hence the population which is vulnerable to an extreme weather event is a subset of the total population exposed to that event. Many of the SIDS have a very large share of their population exposed to an extreme weather event. For example, Belize, the Dominican Republic, Fiji, Haiti, Jamaica, Mauritius, Samoa, St, Lucia, Tonga, Trinidad and Tobago and Vanuatu each have most or all of their total population exposed. However, the numbers of people who are categorised as vulnerable to extreme weather evets is much lower in most of the SIDS, with the exception of Haiti, because they have relatively low poverty rates and good social indicators, compared to other EMDEs. As such, although a large share of the population is exposed to extreme weather events in many SIDS, their relatively high income levels, educational attainment, etc provide the population with some resilience to these shocks.

Empirical research on the economic costs of climate related natural disasters

Researchers have used various methods to estimate the impact of tropical cyclones and other natural disasters on GDP and macro-fiscal variables, including vector autoregressions (VARs) and event studies. Acevedo (2014) used a panel VAR model to study the impact of floods and hurricanes on GDP and public debt over a 40-year period in the Caribbean. Both floods and storms have a negative impact on GDP. Floods lead to a rise in the debt-to-GDP ratio, but storms (especially severe ones) do not, possibly because they lead to increased aid inflows or debt relief measures. Storms have more pronounced effects on a sub-sample of Caribbean countries—the member states of the Eastern Caribbean Currency Union (ECCU), which are generally smaller and therefore more vulnerable to systemic damage from hurricanes. Storms reduce GDP in the ECCU countries, with severe storms having a larger impact, and both

[9] Several dependent territories are also projected to suffer extensive EAFA from SLR, especially the Turks and Caicos, Bermuda and the Cayman Islands.

moderate and severe storms increase the debt-to-GDP ratio, although only the former is statistically significant.

Cabezon et al (2016) estimated the fiscal impact of natural disasters in five Pacific Island countries using a VAR covering years between 1970 and 2013. Disasters are scaled in terms of intensity (deaths and number of people affected relative to total population). Natural disasters which cause damages and losses equivalent to one percent of GDP cause an average fall in GDP of 0.7 percent in the year of the disaster and a deterioration in the fiscal balance of 0.5 percent of GDP (also in the year of the disaster), with tax revenues falling by 0.2 percent of GDP and spending rising by 0.7 percent of GDP (the impact on the fiscal balance is mitigated by a rise in grants).

In the following analysis, we use an event study methodology to examine the impact of hurricanes which caused large damages on islands in the Pacific and the Caribbean, on GDP growth, general government revenues and expenditures, the overall fiscal balance and (where data are available) public debt. The events we study are tropical cyclones that caused the largest damages in the 2010s; hurricanes Erika and Maria in Dominica, in 2015 and 2017 respectively, hurricane Irma in Antigua and Barbuda in 2017, cyclone Evan in Samoa in 2012 and cyclone Pam in Vanuatu in 2014.[10]

The source of the data is the World Economic Outlook (WEO) database. For each tropical cyclone disaster, we compare the outturns in the affected country in the two years following the tropical cyclone with a counterfactual. The counterfactual we use is the projected outturn for these variables which was made just prior to the disaster, as shown in the applicable vintage of the WEO database. Hence, for example, the projection for outturns for Dominica before it was struck by hurricane Erika at the end of August 2015 are taken from the April 2015 WEO database. For each variable, we show the deviation of the outturn, after the disaster, from the projection made just before the disaster. As a control group, we use the similar deviations of outturns from projections for the other SIDS in the same region.[11]

For Caribbean countries, cyclone disasters all occurred towards the end of the third quarter of the calendar year. As we are using annual data, we construct outturn variables composed of one quarter of the value of the variable in the calendar year in which the disaster occurred and three quarters of the value of the variable in the following year and similarly for the subsequent year. Cyclone Evan struck Samoa in December 2012, so we examine the economic outturns in the 2013 and 2014 calendar years. Cyclone Pam struck Vanuatu in March 2015, so we construct 12-month outturns for 2015/16 and 2016/17 from the calendar year data.

Table 3.A shows the impact of hurricane Erika, which struck Dominica in August 2015 and caused damages estimated at 89 percent of GDP (table 2). Compared to pre-disaster projections, real GDP growth was slightly lower in the first 12 months after the disaster and substantially lower in the second 12 months. There was a large increase in government expenditure in both periods (a combined 30 percent of GDP) presumably to pay for the costs of repair and reconstruction, but this was more than offset by even higher government revenues and, as a result, fiscal balances improved and gross public debt fell in the first 12 months, although it was at a roughly similar level by the end of the second 12 months to that which had been

[10] We do not include hurricane Dorian in the Bahamas in 2019 or cyclone Harold in Tonga in 2020 because the impact of these disasters is likely to be masked by the negative effects of the COVID-19 pandemic.
[11] Not all of the SIDS in Oceania are included in the control group because of missing data for some countries.

projected before the disaster. The deviations in these variables were all much more pronounced than in the control group, with the exception of the changes in public debt, and both revenues and expenditures moved in the opposite direction to the control group.

Table 3. A Hurricane Erika on Dominica (August 2015): Deviations of macro-fiscal outcomes from projections made immediately prior to the disaster (percent of GDP)

	Dominica		**Other Caribbean SIDS**	
	2015/16	2016/17	2015/16	2016/17
GDP growth	-1.4	-6.2	-0.8	-1.0
Govt Revenue	26.4	23.8	-2.1	-2.3
Govt Expenditure	11.1	19.3	-2.7	-2.2
Net Lending	15.3	4.4	0.7	-0.1
Gross Public Debt	-5.1	0.6	-5.6	-5.0

The figures in the table show the difference between the outcome for each variable and the projection made just before the disaster. Net lending is equivalent to the overall fiscal balance.

Source: WEO database

Table 3. B Hurricane Maria on Dominica (September 2017): Deviations of macro-fiscal outcomes from projections made immediately prior to the disaster (percent of GDP)

	Dominica		**Other Caribbean SIDS**	
	2017/18	2018/19	2017/18	2018/19
GDP growth	-1.3	-2.9	0.1	-0.3
Govt Revenue	13.3	9.2	-2.5	-1.7
Govt Expenditure	27.5	19.6	-3.6	-2.3
Net Lending	-14.1	-10.4	1.1	0.6
Gross Public Debt	3.9	13.3	-4.6	-4.8

The figures in the table show the difference between the outcome for each variable and the projection made just before the disaster. Net lending is equivalent to the overall fiscal balance.

Source: WEO database

Table 3. C Hurricane Irma in Antigua and Barbuda (September 2017): Deviations of macro-fiscal outcomes from projections made immediately prior to the disaster (percent of GDP)

	Antigua and Barbuda		**Other Caribbean SIDS**	
	2017/18	2018/19	2017/18	2018/19
GDP growth	4.1	3.7	-0.3	-0.3
Govt Revenue	-2.1	-2.8	-1.3	-0.8
Govt Expenditure	0.9	1.3	-1.6	-0.9
Net Lending	-2.9	-4.0	0.2	0.1
Gross Public Debt	0.9	-2.2	-4.4	-3.7

The figures in the table show the difference between the outcome for each variable and the projection made just before the disaster. Net lending is equivalent to the overall fiscal balance.

Source: WEO database

Table 3.B shows the impact of Hurricane Maria, which struck Dominica in September 2017 and which caused the largest amount of damages—as a share of GDP (279 percent)—by any tropical cyclone in the Caribbean or Oceania in the last three decades. Compared to pre-disaster projections, the impact on GDP was slightly negative in the first 12 months but positive in the second. There was a huge increase in government expenditure in both periods, which when combined, amounted to almost 50 percent of GDP. Government revenues also increased, but only by about half the increase in expenditure; the difference was accounted for by larger fiscal deficits. Hence public debt also rose, although the increase in the public debt stock as a share of GDP was not as large as what would be implied by the larger fiscal deficits alone.

Table 3. C shows the impact of Hurricane Irma on Antigua and Barbuda, which struck in September 2017 and caused damages estimated at 17 percent of GDP. Real GDP growth was higher than had been projected before the disaster, but there was only a small increase in government expenditure in both of the 12-month periods following the disaster. Government revenues were lower in both periods, although by relatively moderate amounts, and there was a reduction in the fiscal balance (larger deficits) of three to four percent of GDP), but this was not reflected in higher public debt stocks, which were actually slightly lower two years after the disaster than had been projected before the disaster.

The impact of cyclone Evan on Samoa, near to the end of 2012, is shown in table 3.D. This caused damages estimated at 17 percent of GDP. Relative to pre-disaster projections, there was a small reduction in real GDP in both of the two following years and a much larger fall in government revenue, especially in 2013. Surprisingly, government expenditure also fell, almost

mirroring the fall in revenue and leaving the fiscal balance largely unchanged relative to the pre-disaster forecast.[12]

Table 3. D Cyclone Evan on Samoa (December 2012): Deviations of macro-fiscal outcomes from projections made immediately prior to the disaster (percent of GDP)

	Samoa		**Other Oceania SIDS**	
	2013	2014	2013	2014
GDP growth	-1.8	-1.6	0.2	1.0
Govt Revenue	-10.4	-6.3	2.5	3.3
Govt Expenditure	-11.0	-4.9	-3.6	0.5
Net Lending	0.6	-1.3	6.2	2.8

The figures in the table show the difference between the outcome for each variable and the projection made just before the disaster. Net lending is equivalent to the overall fiscal balance.

Source: WEO database

Table 3.E Cyclone Pam on Vanuatu (March 2015): Deviations of macro-fiscal outcomes from projections made immediately prior to the disaster (percent of GDP)

	Vanuatu		**Other Oceania SIDS**	
	2015/16	2016/17	2015/16	2016/17
GDP growth	-2.6	1.2	1.4	1.4
Govt Revenue	15.4	15.1	9.9	12.0
Govt Expenditure	18.3	11.8	0.5	3.5
Net Lending	-2.9	3.2	9.4	8.5
Gross Public Debt	13.5	17.8	-9.0	-9.0

The figures in the table show the difference between the outcome for each variable and the projection made just before the disaster. Net lending is equivalent to the overall fiscal balance.

Source: WEO database

[12] The government debt data for Samoa were not available in the 2012 WEO.

Finally, we look at the impact of Cyclone Pam on Vanuatu, shown in table 3.E. This was a large disaster, causing damage estimated at 60 percent of GDP. In terms of the damage caused as a share of GDP, it was by far the largest cyclone disaster in Oceania in the last three decades. Real GDP growth was lower than had been projected before the disaster in the first 12 months after the cyclone hit, but recovered partially in the following 12 months. There were large increases in government expenditure, cumulatively amounting to 30 percent of GDP in the 24 months after the disaster, but this was matched by higher revenue, so that over the course of the two years, the fiscal deficit was no larger than had been projected before the disaster. Despite this, government debt was almost 18 percentage points of GDP higher in 2017 than had been projected before the disaster.

Any conclusions drawn from this very limited sample of cyclone disasters must be treated as very tentative at best, but one point in particular stands out. The three large cyclone disasters—Erika, Maria and Pam—were all followed by a very large increase in government expenditure in the following 24 months. Specifically, government expenditure increased by 30, 47 and 30 percentage points of GDP respectively over the 24 months combined, relative to the pre-disaster projections. This was most likely because of the need for relief operations and repair and reconstruction. In fact, the rise in total government expenditure masked the extent of the post disaster recovery spending, because there were significant reallocations of expenditure from non-disaster related items to help fund the recovery efforts.[13] The two smaller disasters, Irma and Evan, did not lead to a large increase in total government spending.

For the three largest disasters, the increase in government expenditure was accompanied by increased government revenue, and only in one of these disasters, Maria, did the increase in government spending exceed the increase in revenue over the 24 months combined, leading to a reduction in the fiscal balance and a rise in public debt. The increase in government revenue is most likely attributable to inflows of grant aid to fund post disaster recovery expenditures, as there is no reason why other components of government revenue, such as taxes, should have risen so steeply following the disasters.

None of the cyclone disasters had a major impact on real GDP growth, with the partial exception of Erika, when growth was lower by six percentage points in the second year after the disaster. In the two other large disasters, Maria and Pam, real GDP growth was lower in the first year after the disaster but rebounded in the second year, probably because reconstruction activities boosted the economy. This finding is in accord with that of World Bank (2021), which, focusing on SIDS in the Caribbean, found that although natural disasters cause a lot of damage to infrastructure assets, especially housing, the negative impact on GDP is relatively short lived and the economy quickly rebounds. Caribbean economies have developed a high degree of economic resilience to natural disasters through a variety of mechanisms, including the preparation of disaster preparedness plans by governments and private sector firms, investments to reduce the vulnerability of productive assets to damage, and access to remittances from abroad by households to smooth consumption.

[13] In Dominica, following hurricane Erika in 2015, non-reconstruction government capital expenditures fell sharply and were depressed below pre-Erika levels for several years (Guerson, 2020, p12).

3. How much will effective climate change adaptation cost the SIDS?

Climate change adaptation comprises three pillars (Cervik, 2022). The first pillar entails investments in physical infrastructure to strengthen its resilience to climate related shocks, such as intense storms or flooding and infrastructure for which the only purpose is to prevent or reduce damage from climate change, such as a flood protection scheme. It also includes investments in soft infrastructure such as early warning systems and policy measures to help communities which are vulnerable to climate change to diversify or adapt their livelihood activities in ways which reduce vulnerability, such as changes in farming practices or relocation away from areas at severe risk of flooding.

The second pillar is the building up of fiscal buffers with which to fund recovery expenditures necessitated by the occurrence of climate related disasters without jeopardizing fiscal sustainability. Such buffers could include contingency funds and insurance cover. The third pillar entails contingency plans and other measures to enable an expeditious response to a disaster. Estimating how much individual countries need to invest in climate change adaptation is very complex. What particular investments are needed, and are cost effective, depends on country specific characteristics and the level of risks facing specific physical assets within these countries. The latter can be very difficult to estimate because of uncertainty, which characterizes the likely incidence and magnitude of future climate disasters. These uncertainties escalate as the geographic scale becomes smaller, because the vulnerabilities to climate change disasters are often very location specific (Heal and Miller, 2013).

The largest fiscal costs of adaptation, on an ongoing basis, will involve the capital investment requirements of pillar one. These investments involve three main components; making new infrastructure assets more resilient to climate change hazards, by changing the design or using stronger materials than would be the case if the assets were not exposed to climate change hazards; retrofitting existing infrastructure assets to make them more resilient to climate change hazards; and constructing new types of infrastructure to provide protection against specific types of hazards, such as coastal flood protection schemes.

There are very large differences in the estimates of the annual fiscal costs across EMDEs and SIDS and between different studies, mainly for three reasons. First, there is a large degree of heterogeneity across SIDS in terms of the specific climate change hazards to which they are exposed and the physical investments needed to counter these hazards. Second, there can be large differences in estimated costs depending on how the objective of adaptation investment is defined. One strategy involves using an efficiency criterion, in which the adaptation investments are undertaken up to the point where the marginal cost of adaptation equals the expected marginal benefit, in terms of the discounted value of expected damage averted. Essentially, this approach minimizes the sum of adaptation costs and the expected residual damages from climate change which are not averted by adaptation. A second, and generally more expensive approach in terms of public investment costs, involves undertaking sufficient adaptation investment to hold expected future damages below some pre-determined threshold, such as a small percentage of GDP.[14] These two approaches are termed the cost minimization strategy and the risk intolerance strategy in an IMF analysis (2021a). A third reason for differences in estimated adaptation costs is that a large part of these costs involves strengthening

[14] Other approaches are also possible, such as by incorporating distributional considerations so as to balance the objectives of efficiency and fairness.

infrastructure to make it more resilient to climate change, which obviously increases the unit costs on infrastructure. This implies that the adaption costs will be related to the overall infrastructure investment requirements of a country (sometimes referred to as closing the infrastructure gap) and the magnitude of these overall investment requirements differ between countries.

IMF (2021A) reports estimates of the annual adaptation costs up to 2030 in three categories: retrofitting existing physical assets to make them resilient to climate change hazards, constructing new assets so that they are resilient to these hazards and the annual investment and maintenance costs of coastal protection infrastructure for countries in the Asia Pacific region. The average total annual costs of public investment across all countries in the region are 3.3 percent of GDP, but some SIDS have much higher costs, notably Kiribati (around 25 percent of GDP), Tuvalu (15 – 20 percent of GDP), Vanuatu (almost 15 percent of GDP), Marshall Islands (5 percent of GDP), and Tonga and Timor Leste (almost 5 percent of GDP). By far the largest component of these total costs are those for the investment and maintenance of coastal protection infrastructure, which is not surprising given how vulnerable many of the SIDS in the Asia-Pacific region are to sea level rises, as discussed in section two.

World Bank (2021, table 15.2) reports estimates of annual capital investment and maintenance costs of coastal protection systems for Caribbean countries over 2020 – 2050, with lower and upper bounds. The average for all Caribbean countries for which estimates are available are between 0.4 percent and 0.9 percent of GDP, but some countries have much larger costs, notably Guyana (4.8-10.3 percent of GDP), Suriname (2.1-5.6 percent of GDP) and Dominica (1.8-4.9 percent of GDP).[15]

The Government of Grenada has prepared a disaster resilience strategy (DRS) to build resilience to climate change hazards, especially storms and sea level rise. The estimated average annual cost of implementing the DRS over 2024 to 2035 is 5.6 percent of GDP, of which 3.9 percent of GDP comprises the direct costs of physical infrastructure, 0.5 percent of GDP comprises the costs of financial resilience, including accumulating insurance cover, such as self-insurance through a public savings fund, against natural disasters and one percent of GDP comprises the costs of post disaster relief and social resilience (IMF, 2022B). Similarly, the Government of Dominica has prepared a DRS to transform the country into a disaster resilient state. The costs are estimated over a 20-year implementation period and amount to an average of 13 percent of GDP per annum for investments in physical infrastructure, one percent of GDP for the costs of financial resistance and two percent of GDP for post disaster relief and social resilience (IMF, 2021B).

Tiedemann et al (2021) focus on a sample of 25 climate vulnerable small developing states (SDS)[16] and use an input-output approach to estimate the country specific additional costs of achieving sustainable development goals (SDGs) by 2030 in five sectors. This includes three infrastructure sectors (roads, energy/electricity and water, sanitation and hygiene [WASH]) and two social sectors (health and education), taking account of country specific vulnerabilities to climate change. For the three infrastructure sectors, the estimated costs are those needed to close the gap between the level of infrastructure provision in 2019 and the SDG target for 2030 in

[15] The costs are estimated for the climate change associated with RCP 4.5. The costs as a share of GDP are expressed in terms of 2019 GDP.
[16] Of the 25 SDS countries in the sample, only two (Bhutan and Djibouti) are not SIDS.

each country, and they include the cost of making public capital more resilient to climate change. Country specific weighted average unit costs to construct and maintain infrastructure are used. The estimates incorporate higher depreciation rates in climate vulnerable SDS. To estimate the additional costs of making infrastructure climate resilient they incorporate country specific costs and other factors which vary between countries according to differences in climate vulnerability, geographic location and other structural factors.

The authors estimate that the total capital and recurrent costs of meeting the SDG targets in the three infrastructure sectors analyzed would average 3.7 percent of 2030 GDP every year until 2030, with an additional 3.0 percent of GDP of spending required in the two social sectors. Costs are higher than these averages in the lower middle-income SIDS. For the roads sector, the costs of making roads climate-resilient accounts for a median of 18 percent of total infrastructure costs, but there is wide variation between the 25th percentile (2 percent) and the 75th percentile (39 percent). They do not provide estimates of the cost of climate resilience for other types of infrastructure, acknowledging that this requires more in-depth country specific analysis. If we apply the same median estimate for the roads sector (18 percent of the capital costs of new roads), to the other sectors (power and WASH) it would imply that making infrastructure climate-resilient would cost around 0.7 percent of 2030 GDP across all three infrastructure sectors. However, this might be an underestimate, as there could be additional investments needed for infrastructure other than roads, power or WASH. For example, some SIDS may need to invest in infrastructure to protect shorelines from erosion by rising sea levels.

Hallegatte et al (2019) make estimates of the cost of strengthening the resilience of public infrastructure in power, transport and water sectors in low income countries (LICs) and lower middle income countries (LMICs). They show that the costs are very sensitive to the technical and engineering specifications required. If the specific hazards to which assets are exposed are known—so that the technical and engineering standards can be applied specifically to counter these hazards—the costs are much lower than if uniform standards are applied to the entire infrastructure network on the assumption that the specific hazards facing each asset are unknown or are too uncertain.

4. How critical is the public debt burden in the SIDS?

4.1 Public Debt Ratios and Risks of Debt Distress

The characteristics of public debt, in regard to its magnitude, composition, and threats to debt sustainability, vary widely among SIDS. Table 4 provides data for 34 of the 39 SIDS which are UN member states,[17] based on the risk evaluation in the most recent IMF/World Bank Debt Sustainability Analysis (DSA). Table 5 provides data on the size and composition of the debt and, where available, the present value of total public debt and external public debt to GDP relative to the applicable thresholds.[18] The risk rating in the DSA analysis is determined by several factors, notably the current levels of public debt relative to the applicable thresholds for

[17] The tables omit Singapore and Bahrain, which are both high income countries, Kiribati and Cook Islands because no recent DSA is available and Cuba which is not a member of the IMF/World Bank.
[18] The DSAs used as sources for the data in this paper were all conducted in 2021, 2022 or 2023.

sustainability, the projected future trajectory of the debt ratios and the vulnerability of debt ratios to shocks, as indicated in stress tests.

Table 4 Summary of Public Debt Risk Assessments for 34 SIDS

Risk Assessment	**Country**
Unsustainable	Suriname, Antigua and Barbuda
In Debt Distress	São Tomé and Príncipe, Grenada
High Risk of Debt Distress	Cabo Verde, Comoros, Dominica, Haiti, Maldives, Marshall Islands, Mauritius, Micronesia, Papua New Guinea, Samoa, St Vincent and the Grenadines, Tonga, Tuvalu
Moderate Risk of Debt Distress	Barbados, Belize, Guyana, Jamaica, St Kitts and Nevis, Solomon Islands, Timor Leste, Trinidad and Tobago, Vanuatu
Other risk assessment	
Substantial Risks	St Lucia
Elevated Risks	Bahamas
Significant Risks	Fiji
Increased Risks	Palau
Decreased Risks	Dominican Republic
With Risks	Seychelles
Sustainable	Nauru

Source: Debt Sustainability Analysis Assessments published with Article IV and other country reports on the IMF website.

Table 5 SIDS public debt ratios (% of GDP) and composition of debt (% of total public debt), 2022

Country	PPG debt/ GDP %	PV PPG debt/ GDP %	PV PPG external debt/GDP %	Composition of PPG debt %				
				External				Domestic
				Multilateral	Bilateral	Private	other	
Suriname	132.2			20	18	19	8	34
Antigua & Barbuda	91.2							46
São Tomé and Príncipe	94	74 (35)	25.3 (30)	19	29			51
Grenada	69	63.7 (55)	50.7 (40)					22
Guinea Bissau	81	65.6 (35)	26.2 (30)	41	10			49
Cabo Verde	128.8	90.7 (70)	51.3 (55)	38	14	18		29
Comoros	33.7	23.4 (55)	18.3 (40)	31	52			17
Tonga	47.6	35.2 (70)	26.7 (55)	35	48			17
Dominica	100.3	78 (55)	44.2 (40)	37.7	18		8	36
Haiti	29.4	23.3 (55)	6.5 (40)	5	40			55
Maldives	122.6							
Marshall Islands	26.2	21 (35)	21 (30)					0
Micronesia	14.6	12.5 (35)	12.5 (30)	71.3	18.1	9.4		1
Mauritius	92.4							68
Papua New Guinea	49.8	48.4 (35)	21.2 (30)					54
Samoa	51.3	38.9 (70)	30 (55)	44	42			15
Tuvalu	5	4 (35)	2.7 (30)	74				26
St Vincent and Grenadines	87.8	80 (55)	62 (40)	49	20	10		22
St Lucia	90.1			33			24	43
Bahamas	109.2							55
Fiji	88.7			24		2	4	72
Palau	90.3							1
Dominican Republic	59.2							42
Seychelles	67.9							53
Nauru	27.3							49
Belize	63.7	35.2 (70)	26.7 (55)	30	15		20	35
Guyana	22.8	19.2 (35)	6.5 (30)	29	14	1		56
Jamaica	100.3			22	5	38		35
Barbados	122.5			24	2	10		64
St Kitts and Nevis	58.4							84
Trinidad and Tobago	53.8							68
Solomon Islands	16.9	16.3 (35)	10.6 (30)	49	12			39
Timor Leste	14.7	10.3 (35)	10.3 (30)	91	9			0
Vanuatu	46.6	31.1 (55)	20.8 (40)	32	44		2	22

Notes: Figures in parentheses in the columns for the preset value (PV) of Public and Publicly Guaranteed (PPG) debt and external PPG debt are the applicable thresholds or benchmarks for each country, which are determined by its assessed debt carrying capacity.

Source: Debt Sustainability Analyses

Two of the SIDS—Suriname and Antigua and Barbuda—are assessed as having unsustainable public debt. Both countries have accumulated substantial external debt arrears (they are in default). Restoration of debt sustainability requires agreements with creditors to restructure the debt and reduce the debt burden; Suriname is currently negotiating with its creditors to do this. For these two countries, therefore, some form of substantial debt alleviation is imperative.

All other SIDS are assessed as having sustainable public debt. Two countries, São Tomé and Príncipe and Grenada, are assessed as being in debt distress because they have unresolved debt arrears to external creditors. However, these arrears are unresolved for legal and technical reasons rather than a lack of fiscal resources to repay them, and the current debt metrics of both countries are not markedly worse than those of many SIDS which are not in debt distress. The baseline projections of public debt trajectories in the DSAs for both countries indicate that the key sustainability metrics decline over the medium to long term and can be brought back below the applicable sustainability thresholds. Hence it is possible that both countries can resolve their public debt problems without debt relief.

Fourteen SIDS are assessed as being at high risk of debt distress. These countries differ very widely in respect of their current public debt metrics. Some have high levels of public debt, some moderate levels, and some low levels. Out of the 12, for which present value data are available in the DSA, only five currently breach the applicable sustainability threshold for the Public and Publicly Guaranteed (PPG) debt-to-GDP and only two breach the sustainability threshold for external PPG debt to GDP.

There are three main reasons given in the DSAs for these countries to be assessed as at high risk of debt distress (for some countries more than one reason is cited):

i) For three countries, current high levels of public debt do not decline fast enough in the baseline projections leading to prolonged breaches of debt sustainability thresholds;
ii) For four countries, public debt ratios which are currently quite low are projected to rise sharply over the medium to long term because of the need for external finance for SDGs and adaptation investments and, in two of these countries, the expected expiry of grant programs from a bilateral donor;
iii) For seven countries, vulnerability to shocks (natural disasters, macroeconomic shocks, and the materialization of contingent fiscal liabilities) is the main source of risk to debt sustainability.

In addition to the countries assessed as being at high risk of debt distress, a further three countries are assessed as being at "substantial," "elevated" or "significant" risk. In all three countries, the main reasons cited for the risk assessment are high or elevated public debt levels together with vulnerability to macroeconomic shocks and/or natural disasters. Nine SIDS are assessed as being at moderate risk of debt distress, one each is assessed as being subject to "increasing" and "decreasing" risks and one is simply assessed as being sustainable without any qualifying term about the level of risk.

What conclusions can we draw about the scale and nature of the public debt problem in SIDS? First, with two exceptions, the public debt of SIDS is not assessed as unsustainable in their latest DSAs. Second, SIDS as a group do not have higher levels of public debt as a share of GDP than other categories of EMDEs. The average level of general government debt among all

SIDS in table 4 was 61 percent of GDP in 2022, compared to the average of 65 percent of GDP for all EMDEs.[19] Nevertheless, public debt ratios vary greatly among SIDS and current high levels of public debt are identified in the DSAs as major contributors to risks of debt distress in more than a third of SIDS. However, vulnerability to macroeconomic, financial or natural disaster-induced shocks contributes to the risk of debt distress in an even larger number of SIDS, including those with low or moderate public debt ratios.

4.2 The Composition of Public Debt by Creditor

Domestic debt comprises 38 percent of total public debt on average for the 34 SIDS in table 5, and external debt 62 percent, although domestic debt is generally larger as a share of total debt for those SIDS with the highest levels of public debt. Domestic debt is mostly held by local financial institutions, especially banks and public provident funds, although for most SIDS, there are no comprehensive data showing a breakdown of domestic debt by type of creditor.

Table 6 Composition of Public Debt by Creditor; averages for 21 SIDS (% of total)

Category (number of countries)	***PPG debt to GDP (%)***	***Share of total PPG debt by type and creditor (%)***			
		Multilateral debt	Official bilateral debt	Private and other external debt	Domestic debt
Full sample (21)	65	38	20	8	34
PPG debt above 60% of GDP (11)	99	31	12	15	43
PPG debt below 60% of GDP (10)	28	46	28	1	25

All data are means.

Source: DSAs

For external debt, there are only data in the DSAs on the breakdown by type of creditor for 21 SIDS. Table 6 shows the breakdown of public debt into external and domestic and, for external debt, by type of creditor, for these SIDS. These countries are divided into two categories in the

[19] Data from the IMF World Economic Outlook database, April 2023. The average for the SIDS excludes Palau because there are no data on this indicator for Palau in the WEO database. The PPG debt shown in table 5 (which is taken from IMF country reports) is slightly higher than general government debt because it includes government guarantees. The average PPG debt to GDP in 2022 for the 34 SIDS shown in table 5 was 67 percent. There are no data on PPG debt to GDP in the WEO database.

table: Those with public debt to GDP ratios above 60 percent in 2022 (11 countries), and those with public debt to GDP ratios below 60 percent (10 countries).

For the 21 SIDS, multilateral debt comprises 38 percent of total public debt, bilateral official debt comprises almost 20 percent, private and other debt[20] comprises 8 percent. For this sample, domestic debt comprises 34 percent of total public debt. There are however, marked differences in the composition of debt between the higher and lower debt categories of SIDS. For the higher debt SIDS, domestic debt comprises a much larger share of total debt (43 percent) than it does for the lower debt SIDS (25 percent). Private external debt comprises 15 percent of total debt for the higher debt SIDS but is negligible for the lower debt SIDS. In contrast, for the lower debt SIDS, official (multilateral and bilateral) external debt comprises much larger shares of public debt than is the case for the higher debt SIDS, for the former it comprises almost three quarters of their total debt whereas for the latter it is 43 percent.

[20] This includes arrears which are not classified by creditor and some non-commercial private debt.

5. What type of external assistance would most benefit SIDS?

The specific challenges facing SIDS, which are discussed in sections two to four of this paper, have clear implications for the type of external assistance that they need from their development partners and, in particular, international and regional development banks. For most SIDS, their main challenges related to climate change are twofold: they need to increase public investment in climate change adaptation, and they need access to substantial emergency funds to fund relief and recovery operations and reconstruction in the event that they are hit by a substantial natural disaster.

As discussed in section three, SIDS need to invest resources in adaptation, which will involve both specific adaptation projects (such as building flood protection infrastructure) and making other types of infrastructure, such as roads and power transmission systems, more resilient to potential damage from natural disasters such as tropical cyclones. They also need to invest in soft infrastructure such as early warning and response systems and disaster relief planning, and access to a social safety net. Strengthening resilience will also require adapting jobs and key economic sectors (such as tourism or agriculture) to climate impacts, as well as building community resilience. Most of these adaptation investments are national public goods and cannot therefore be implemented on a commercial basis by private investors and will thus have to be funded through government budgets.

How much fiscal resources each country needs to allocate to climate change adaptation investment will need to be carefully assessed by their governments. As noted by Hallegatte et al (2019), there are potentially large returns to generating information which will allow for the design of strengthening infrastructure assets to be tailored to the specific risks facing each asset, rather than applying uniform standards to make them more resilient to climate change. Clearly, the fiscal costs of adaptation will vary between SIDS depending on their exposure to climate change related threats, as discussed in section three. For some of the smaller SIDS, these costs will be very large as a share of their GDP. For many SIDS, financing the requisite investments in adaptation to protect themselves against major climate risks will not be possible unless they receive substantial external support, especially as SIDS also need to expand public investment to achieve other SDGs in circumstances where fiscal space is limited.

Given that many SIDS already have high levels of public debt and that adaptation investments do not generally expand the economy's tax base,[21] financing adaptation investments with commercial debt would exacerbate the risks of future debt distress. Hence SIDS require concessional finance, and ideally grants, to fund their adaptation investment expenditures.

Major exogenous shocks, such as natural disasters, have substantial negative fiscal impacts. Tax revenues are reduced because of disruption to the economy and the government has to fund both emergency assistance for the affected population and repair damaged public infrastructure, as discussed in section two. Unless the fiscal costs are fully funded with grant aid from donors, fiscal deficits and borrowing requirements will rise, and even if this rise is only temporary it will increase the public debt burden, creating the potential for debt distress, or forcing the government to impose socially damaging cuts to public spending to constrain the increase in

[21] This is because, unlike many other types of public investment, such as road construction, adaptation investments are largely designed to prevent future damage rather than to enhance the economy's productive capacity. Nevertheless, over the long term, investment in adaptation can involve significant benefits for the budget in terms of saving future expenditures on repair or replacement of assets damaged or destroyed by natural disasters.

public borrowing. Consequently, SIDS require access to non-debt creating contingent funds which can be disbursed quickly in the event of a disaster, and which match the need for the incremental fiscal funding arising from the disaster.

Relying on commercial insurance to fund the fiscal needs arising from natural disasters is unlikely to be optimal for SIDS. It is usually expensive, with the cost, in terms of premiums, between 1.5 times and twice the expected payout from claims (Guerson, 2020; Ando et al, 2022). In addition, commercial disaster insurance for governments generally entails parametric triggers[22] for the payout of insurance which is not well correlated with fiscal costs for disasters with small or moderate fiscal costs. For these reasons, Guerson (2020) recommends that governments accumulate savings funds from budget resources which would hold resources equivalent to 6 to 12 percent of GDP and would be used to fund the fiscal costs of small and moderate natural disasters. These funds would need to be governed by strong institutional safeguards to prevent them from being used for purposes other than that for which they are intended.[23] The savings funds should be complemented by governments contracting contingent finance (i.e. lines of credit which would be made available in the event of a disaster) and insurance cover for larger natural disasters from commercial insurance funds such as the Caribbean Catastrophe Insurance Facility, possibly supplemented by issuing catastrophe (CAT) bonds.[24] Although commercial insurance is expensive, it could be justified on grounds of risk aversion, given the very large costs of major natural disasters. Development partners could support SIDS in funding insurance premiums for commercial insurance against substantial disasters.[25]

Finally, if SIDS are to scale up public investment in adaptation in an efficient manner, many of them will require technical assistance (TA) to build technical capacity to prepare long term adaptation strategies and strengthen their capacities for public investment management, budget planning and fiscal risk analysis. This is because planning efficient adaptation investments and evaluating projects is likely to be much more complex than would be the case for other public investment projects. One reason for this is that the benefits of adaptation are uncertain; they

[22] A parametric trigger pertains to a major physical feature of a catastrophe, such as the magnitude of an earthquake on the Richter scale, information on which is usually readily available. It is possible to base insurance contracts on the magnitude of losses incurred by the insured, but the verification costs are much larger and the time required for verification is longer (Ando et al, 2022).

[23] Whether it is realistic, financially and politically in a fiscally constrained country, to hold such a substantial amount of budget resources in a savings fund, for use only if a natural disaster occurs, must be doubtful.

[24] Catastrophe bonds (CAT bonds) are securities, usually short to medium term, in which the repayment of principal and coupon is linked to the occurrence of a catastrophic event. The proceeds of the bond issue are held in a special purpose vehicle (SPV) and invested in safe and liquid assets (rather than being spent by the issuer as would be the case for a normal bond). If the catastrophic event occurs, all or part of the proceeds are transferred to the issuer; if it does not occur, the proceeds (plus interest) are paid to the bond investors as scheduled. The CAT bond therefore provides insurance to the issuer against the risk of a specified catastrophic event, with the risk transferred to the investors in the bonds. Traditionally CAT bonds have been issued by insurance and reinsurance companies as a form of reinsurance against the liabilities they would face from catastrophic events, but in recent years a number of sovereigns have issued CAT bonds, including some EMDEs and at least one SIDS; Jamaica in 2021. The World Bank provides SPV services for sovereign CAT bonds (Ando et al, 2022).

[25] Burns et al (2021) use the World Bank's macrostructural model MFMod, adapted to take account of hurricane damages to the capital stock, to analyse and compare alternative risk management strategies for hurricanes in Jamaica. They compare four risk management strategies; adaptation investment to strengthen infrastructure, purchasing commercial insurance from the private sector, establishing a budget contingency fund and creating fiscal space through debt reduction, and a baseline of no risk management. The economic gains from adaptation investment are greatest when it is targeted at small shocks but dissipate as shocks get larger. Purchasing insurance from the private sector is more costly than either establishing a budget contingency fund or freeing up fiscal space.

occur over the long term and depend on the probability and magnitude of potential climate-related shocks, which is largely unknown. It is not axiomatic that all adaptation investments are beneficial; their cost must be weighed against expected benefits. While the former is relatively easy to estimate, the latter is not. Furthermore, the benefits are likely to be manifested through multiple channels (e.g. avoidance of loss of life and injury, damage to buildings) all of which need to be understood and factored into the cost-benefit analysis of adaptation projects.

6. Is public debt alleviation the best way to help SIDS strengthen resilience to climate shocks?

As noted in the introduction, debt alleviation measures have been proposed as a necessary component of support for SIDS to strengthen their resilience to the risks they face from global warming. Specific debt alleviation measures include debt swaps and pause clauses in debt contracts, which allow the debtor to suspend debt service payments if it suffers from a pre-specified exogenous shock such as a natural disaster.

The primary purpose of sovereign debt relief schemes is to reduce public debt which is unsustainable to a sustainable level. The rationale for this is that an unsustainable debt burden has a negative externality; it is a deterrent to private investment, because the future returns to private investments might be appropriated to pay holders of public debt (through rationing of foreign exchange or increases in the tax burden, for example). Reducing the public debt to sustainable levels removes this negative externality and, therefore, entails an unambiguous pareto improvement (Knoll, 2013). But most SIDS do not have unsustainable sovereign debt and their creditors expect to be paid in full. Consequently, the main rationale for debt alleviation does not apply to most SIDS. However, even if public debt is sustainable, empirical research indicates that very high levels of public debt can still depress economic growth for prolonged periods. This research also finds that the relationship between public debt levels and economic growth is non linear; public debt becomes a serious impediment to economic growth at levels above approximately 90 percent of GDP (Reinhart et al, 2012).[26]Nearly a third of the SIDS have nominal public debt which is either close to, or above, 90 percent of GDP (table 5) and thus are at risk of incurring lower growth because of their "debt overhangs". Reducing public debt levels would improve the growth prospects of these countries, but as discussed below, debt alleviation measures are not necessarily a feasible way to achieve this objective.

The argument that debt alleviation would free up fiscal space for public investment in climate change adaptation is much less compelling because there are other financial instruments available which can expand the fiscal space of SIDS, such as various forms of official development assistance (ODA). The case for debt relief as an instrument to expand fiscal space, therefore, it has to be evaluated in comparison to other potentially available instruments which could deliver the same objective.

[26] Reinhart et al's results were challenged by Herndon et al (2014) who argued that the data (pertaining to 20 advanced economies) actually show that public debt levels above 90 percent of GDP do not consistently reduce GDP growth rates and that the relationship between public debt and economic growth varies across countries and time. However, even if some advanced economies can incur larger public debt ratios without risking damaging their economic growth, this is less likely to be the case for EMDEs, which face much tighter financing constraints in both domestic and external financial markets.

For the two SIDS whose public debt is currently unsustainable, and which have accumulated substantial debt arrears (Suriname and Antigua and Barbuda), debt alleviation involving a significant reduction of both the present value of the debt and the gross financing needs is essential to restore debt sustainability. With the exception of these two countries, however, debt alleviation measures are neither likely to be either very feasible on a widespread basis among SIDS nor would they be particularly effective or efficient instruments for providing the assistance that SIDS require.

The main reason why debt relief is not a very feasible instrument to expand fiscal space in SIDS is that the major creditors are not institutions which are willing or able to provide financial assistance through debt relief. Because, with the exception of Suriname and Antigua and Barbuda, SIDS are not in default on their debts,[27] their creditors have not written down the value of these debts on their balance sheets. As such, providing debt relief—such as a debt swap or write off—would directly reduce the value of the creditors' assets, thereby reducing their net worth.[28] The composition of SIDS public debt examined in section four indicates how problematic this could be for a generalized program of debt relief, although it is possible that some bilateral donors might offer debt swaps to individual debtors

More than 40 percent of total public debt of the more highly indebted SIDS is domestic debt. If the domestic debtors had to provide debt relief, it could undermine the financial soundness of domestic financial institutions and would create contingent fiscal liabilities. The latter is clearly the case for debts held by public provident funds or central banks, where debt relief would simply involve the creation of quasi-fiscal deficits. Furthermore, if domestic creditors had to accept losses on their claims on the government, it would undermine the domestic debt market and make it more costly for the government to issue debt in the future. As the issuance of domestic debt such as treasury bills, plays an important role in budget management, debt alleviation measures applied to domestic debt would be counterproductive from the fiscal standpoint as well as for the wider development of domestic financial markets.

For SIDS with higher levels of public debt, almost a third of their debt is owed to multilateral creditors such as the World Bank and regional development banks. It would be very difficult for these creditors to offer debt relief for debts which are not in default and are expected to be repaid in full, because this would undermine their investment-grade credit ratings and thus their ability to mobilize finance cheaply on international debt markets, which is crucial to their business models.[29] That only leaves the bilateral official creditors and external private creditors as possible sources of debt alleviation. Yet, the latter are largely profit oriented financial institutions who have no incentive to willingly offer debt relief on debts which they have no reason to believe will not be repaid in full, and a unilateral default on these debts would invite legal action by the creditors which the debtors are unlikely to be able to defeat. As such only

[27] São Tomé and Príncipe and Grenada have accumulated arrears to individual creditors, but this is for technical and legal reasons specific to these debts and does not affect the rest of their debt liabilities.

[28]. This is not necessarily the case if the debtor has defaulted, because the default will normally cause the creditor to write down the value of its asset on its balance sheet in recognition of the expected loss (or make a provision against the loss). In addition, where debts involve tradeable securities, a default will usually mean that these securities will trade at a discount on the market.

[29] Although the direct quantitative impact of any debt relief measures given to SIDS on the balance sheets of the multilateral creditors would be minor, given that loans to SIDS are only a small part of their overall loan portfolios (with the exception of the Caribbean Development Bank), the precedent it would set would create an expectation that similar debt relief could be extended to much larger debtors.

official bilateral creditors provide a feasible source of debt relief and for SIDS with higher levels of debt, debts to official bilateral creditors comprise only 12 percent of total public debt on average. Moreover, the bilateral creditors may be reluctant to provide debt relief if no other category of creditor is doing so. For these reasons, efforts to secure debt alleviation on existing debts are unlikely to be feasible or generate significant amounts of debt alleviation for most SIDS, and especially for those with higher levels of debt.[30]

In addition to the practical difficulties of securing tangible debt relief from multiple creditors with different commercial and institutional objectives, efforts by SIDS governments to campaign for debt relief could undermine their own perceived creditworthiness on credit markets and thereby raise the risk premiums that they have to pay to mobilize commercial debt. As such, campaigns for generalized debt relief by countries whose public debt is sustainable could actually worsen fiscal space, by raising borrowing costs on new debt while failing to obtain any relief on existing debt.

Given that the DSAs identify vulnerability to exogenous shocks as posing a major threat of debt distress in many SIDS, the insertion of pause clauses into debt contracts might be valuable for SIDS. The World Bank's Climate Resilient Debt Clause (CRDC) is an example of such a clause. This offers eligible debtors of the World Bank, including the SIDS and other small state economies, the option of deferring scheduled principal and/or interest payments on IBRD and IDA credits for up to two years, in the event of their being struck by a natural disaster which exceeds pre-defined trigger thresholds. The fee charged to the borrower to include the CRDC in a debt contract is five basis points per annum of the disbursed and outstanding loan amount.

7. Conclusions and Main Messages

Most SIDS are vulnerable to climate induced disasters, especially tropical cyclones, and are highly exposed to major losses and damages from such disasters because of the small size of their territory and of their geographic location. The EM-DAT database records 185 episodes of tropical cyclone disasters among Caribbean SIDS and 74 among SIDS in Oceania from 1995 to 2022. These disasters caused USD 45 billion in damages in the Caribbean and USD 2 billion in Oceania (in 2022 prices). These figures are almost certainly underestimates because there are no recorded damages in the database for some large disasters. In 22 of the tropical cyclone disasters, recorded damages exceeded 10 percent of GDP: for three of these disasters, the damages exceeded 100 percent of GDP and for a further five, damages were between 50 percent

[30] The practical difficulties of implementing effective debt alleviation measures are illustrated by the experience of Jamaica (Schmid, 2016). With public debt to GDP of 140 percent in 2010, Jamaica undertook two programs of debt restructuring, in 2010 and 2013, but neither reduced the debt burden significantly. There were two reasons for this. First, the debt restructurings were restricted to domestic government securities, which comprised around 55 percent of the public debt stock in January 2010, but omitted external bonds held by international investors which comprised almost 30 percent of the debt stock. The latter were omitted because the bonds lacked collective action clauses which could have allowed a haircut to be imposed on all bondholders without costly and time consuming legal disputes with individual bond holders. Second, the amount of debt relief which the restructuring of domestic government securities provided was relatively small – it was limited to a reduction in the interest rate and an extension of maturities – but did not involve a write down in the nominal value of the debt (although there was a significant reduction in the PV of the debt) because that would have risked financial fragility among domestic financial institutions – banks, broker dealers and insurance companies – which held the securities. On average, the holdings of government securities by domestic commercial banks amounted to 112 percent of their capital in 2010, so any substantial write down of the face value of the debt would have depleted the banks' capital.

and 100 percent of GDP. Scientific research into the impact of global warming on tropical cyclones indicates that there is likely to be an increase in high intensity cyclones, which cause the most damage, during the course of the 21st century, although by how much they will increase is uncertain. Some SIDS are also highly exposed to sea level rise and several SIDS, mainly, but not only, in Oceania are projected to incur the loss of a substantial part of their land area to inundation by sea water during the course of this century.

The main fiscal impact of substantial tropical cyclone disasters (which cause large losses in relation to GDP) during the 2010s was a very steep increase in government expenditure, mainly to fund recovery, repair and rebuilding of damaged assets. This was often accompanied by increased grant inflows, which mitigated the adverse impact on public borrowing, although in some cases, there were larger fiscal deficits and higher public borrowing. In some countries, non-disaster related government expenditures were suppressed following disasters to free up budget resources for disaster related expenditures, which obviously could create longer term fiscal pressures.

Because of their vulnerabilities to climate induced disasters, SIDS need to invest in adaptation, and particularly, in strengthening public infrastructure, to make it more resilient to natural disasters, building specific infrastructure, such as fortifying coastal defense systems, to protect their populations and economic assets from damage as well as social and economic resilience to climate change. How much this will cost depends on the specific vulnerabilities and exposure of each SIDS. For some SIDS with disaster resilience strategies, the estimated annual costs of implementing comprehensive adaptation strategies are very high as a share of their GDP. There are likely to be high returns to investing in enhancing the understanding of the specific risks facing individual capital assets so that the technical and engineering design of adaptation investments can be tailored to these risks. The first step in strengthening resilience of SIDS to climate change should be the preparation of rigorous and carefully-costed adaptation strategies, based on a comprehensive analysis of the risks to which they are exposed, and the potential costs if these risks materialize. The governments of Grenada and Dominica have already prepared Disaster Resilience Strategies which set out long term programs of capital investments for adaptation alongside other measures such as accumulating insurance funds; these are examples which other SIDS should consider implementing.

The public debt burden of SIDS is heterogeneous but, with two exceptions, Antigua and Barbuda and Suriname, is not assessed as being unsustainable in the most recent DSA undertaken by the IMF/World Bank. Two other SIDS are assessed as being in debt distress, but this is for legal and technical reasons rather than lack of fiscal resources—because they have unresolved bilateral arrears.

More than a third of SIDS which are independent UN member states have relatively high public debt ratios. Seven SIDS for which PV data are available in the DSAs breached the applicable threshold or benchmark for the PV of PPG debt to GDP in 2022, although only two of these countries also breached the threshold for external PPG debt to GDP. Fourteen SIDS were assessed in the DSAs as being at high risk of sovereign debt distress and three more are assessed as having substantial, elevated or significant risks. Although high levels of public debt which are projected to be above the applicable thresholds for prolonged periods is a major source of risk for three of the SIDS at high risk of debt distress, a more common reason is their

vulnerability to macroeconomic shocks and natural disasters, which in DSA stress tests lead to sustainability thresholds being breached.

The composition of PPG debt varies considerably among SIDS. For the 21 SIDS for which a detailed breakdown is available, 34 percent of total debt on average comprises domestic debt (mostly held by local financial institutions), 30 percent is multilateral external debt, 20 percent bilateral official debt and 8 percent is external debt held by the private sector. However, the more highly indebted SIDS—those with nominal PPG debt above 60 percent of GDP in 2022—had higher levels of domestic debt (43 percent of the total) and external private sector debt (15 percent) and less multilateral and official bilateral debt.

The types of external assistance that would be most beneficial to SIDS in helping them overcome the challenges posed by climate change are threefold.

i) Scaling up the provision of concessional finance to support public investment in adaptation projects, mainly physical infrastructure to provide protection against natural disasters, strengthening infrastructure to make it more resilient to disasters and measures to strengthen social and economic resilience.
ii) Providing non-debt creating insurance instruments to protect the fiscal sustainability of SIDS which are afflicted with major exogenous shocks and allow them to undertake the necessary public expenditures to protect public welfare and repair damaged infrastructure.
iii) Provision of technical assistance to strengthen the capacity of SIDS in designing long term adaptation and resilience strategies, public investment management, long term fiscal planning and fiscal risk analysis.

A general program of debt relief measures is not a feasible or efficient way to mobilize resources to strengthen resilience in SIDS, although debt relief measures are necessary to restore public debt sustainability in the two SIDS whose public debt is currently unsustainable (Antigua and Barbuda and Suriname). Because all of the other SIDS have not defaulted on their public debts, their creditors expect to be repaid in full, and most will not willingly offer debt relief which would erode the value of their assets and thus their net worth. Furthermore, forcing the holders of domestic debts to provide debt relief would create quasi-fiscal deficits (where the creditors are public sector financial institutions) or contingent fiscal liabilities (where the creditors are local commercial banks). The multilateral and regional development banks cannot offer debt relief without damaging their own business models.

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