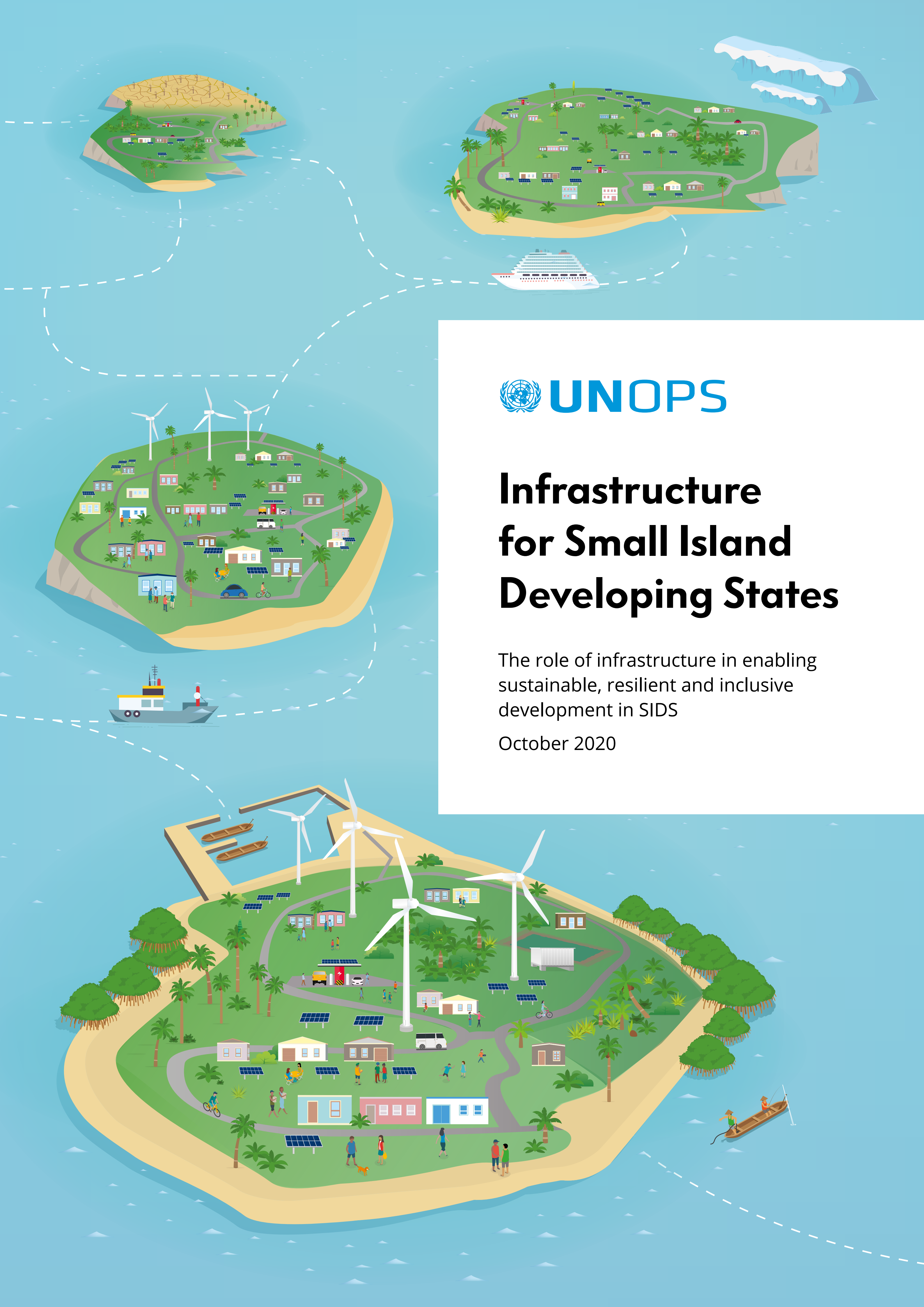

UNOPS

Infrastructure for Small Island Developing States

The role of infrastructure in enabling sustainable, resilient and inclusive development in SIDS

October 2020

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Table of contents

Foreword

Ms. Grete Faremo
Under-Secretary-General
and UNOPS Executive Director

Small Island Developing States (SIDS) face a unique set of development and environmental challenges. They are among the most vulnerable countries to the climate crisis, facing greater risks to their economies, livelihoods and food security. The COVID-19 crisis has further compounded these challenges, threatening lives and livelihoods in SIDS and across the world.

Their generally small size, remote locations, and their vulnerability to environmental threats can hinder SIDS' efforts to achieve sustainable development. But innovative infrastructure solutions offer opportunities to overcome these challenges and deliver on the 2030 Agenda.

This report highlights some of these innovative solutions. It calls for a holistic understanding of infrastructure systems, and argues for an urgent need to make evidence-based decisions. With limited resources and mounting needs, it is crucial that investment in infrastructure systems yields long-term development gains for all.

UNOPS has been working hard to support SIDS with better access to water and waste management, marine protection, renewable energy and health procurement. We provide infrastructure expertise. Over the past year, UNOPS has worked closely with the SIDS to prepare, respond to and recover from impacts of the COVID-19 crisis.

The report highlights some examples of this work, from helping build a more resilient Haiti in the wake of extreme weather events and natural disasters, to contributing to stronger healthcare services in Trinidad and Tobago, and working to prevent freshwater contamination in Cabo Verde. As the report shows, gender mainstreaming has been a key part of our work, so that infrastructure projects work to reduce gender inequality and empower women.

It also illustrates UNOPS work to strengthen national long-term infrastructure planning, which is key to promoting sustainability, resilience and inclusiveness in SIDS. Together with the University of Oxford, UNOPS supported the government of Saint Lucia to establish a vision for their future infrastructure, responding both to national priorities and international development commitments.

To support the achievement of the recommendations of the report, innovative financing will be crucial. This too is an area where UNOPS is committed to supporting SIDS, for example by mobilising public and private funding resources to create affordable housing in Antigua and Barbuda.

Sustainable, resilient, and inclusive infrastructure is key to SIDS' efforts to respond to their challenges. UNOPS is committed to supporting SIDS in building a better future for all.

Ms. Fekitamoeloa Katoa 'Utoikamanu
Under-Secretary-General and High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS)

Infrastructure is a prerequisite for sustainable development.

From transport to power generation, from information and communications technology to the movement of water and waste, the march of progress requires the movement of things.

For Small Island Developing States (SIDS), the planning, delivery and management of infrastructure systems can be challenging because of their small size, large ocean areas and relative isolation, although some are close to their major markets such as the Caribbean countries. But for the same reason, their realisation promotes trade, fosters inclusive economic growth and job creation, improves education and health outcomes and ultimately reduces poverty and inequality.

SIDS, however, face many challenges of mobilising the necessary investment and resources for the development and maintenance of infrastructure.

By their very definition, small islands suffer limited economies of scale and some are a long distance are from markets. Insularity when met with vulnerability to climate change and natural disasters and limited public resources equals prohibitively high infrastructure costs.

COVID-19 has shed some light on key issues for infrastructure development, including in SIDS.

The pandemic has laid bare the truth of the digital divide, which has severely tested the resilience of the education and health sectors, as well as the overall economy. These impacts are evident in SIDS as a whole and within the more vulnerable segments of their populations.

That greater digital access and broadband connectivity is a prerequisite for modern resilient societies, especially in the face of new and emerging challenges, should no longer be in doubt. To "Build Back Better" in SIDS, we must therefore prioritise sustainable and resilient infrastructure to enhance resilience.

This report highlights the importance of foreign aid and investments, directly coordinated with governments and citizens, to build resilient infrastructure and local capacity in SIDS. In particular, SIDS need greater technical capacity to prepare viable bankable infrastructure project proposals so as to attract the necessary investments. Regulatory and policy reforms are also critical to foster an environment supportive of greater public and private investments in infrastructure.

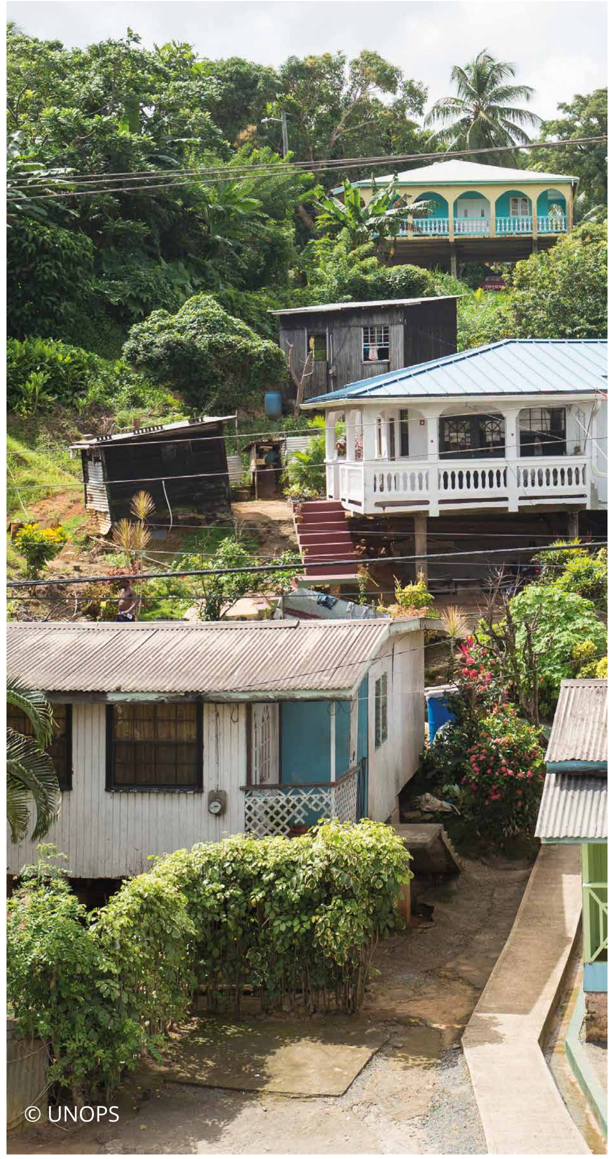
The need for infrastructure financing is even more urgent as SIDS suffer deep economic and financial shocks due to the ongoing COVID-19 crisis. OHRLLS will continue to work with UNOPS on these efforts toward resilient and sustainable infrastructure in SIDS.

Executive summary

The distinct characteristics of Small Island Developing States (SIDS), including their smallness, geographic remoteness and vulnerability to environmental threats, pose particular challenges to their development. The small landmass and population of SIDS constrain their domestic technical and institutional capacity, prevent economies of scale and cause land competition. The remoteness of SIDS, reflected in their poor connectivity and high transportation costs, hinders competitiveness and reduces their participation in international markets. Furthermore, 90 per cent of SIDS are located in the tropics, which increases their exposure to extreme weather events and results in significant human, economic and social losses when a hazard occurs.

Sustainable, resilient and inclusive infrastructure plays a key role in addressing these challenges and presents opportunities to harness the unique resources inherent to SIDS. Given infrastructure's potential to influence the achievement of up to 92 per cent of all the targets of the Sustainable Development Goals (SDGs), infrastructure can help SIDS achieve the 2030 Agenda. Infrastructure can also enable equal access to services for women, girls and vulnerable and marginalized groups, helping reduce inequalities such as the gender gap in SIDS. Through a sectoral analysis, this paper identifies specific infrastructure opportunities to innovatively maximize SIDS' resources to tackle their challenges. Table 1 highlights some of the proposed infrastructure solutions.

Sector-specific solutions rooted in evidence can enable SIDS to overcome their challenges and accelerate progress along their development path. For that to occur, infrastructure development should take into account SIDS' particular contexts, vulnerabilities and needs, as well as international best practices. Key cross-cutting actions, including integrated infrastructure planning, adopting appropriate international standards and promoting inter-island cooperation, are essential to reap long-term benefits from infrastructure investments.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It is paramount that SIDS governments delineate specific plans and the type of external support required to achieve their development targets. UNOPS is committed to assisting SIDS through an evidence-based approach to infrastructure. To date, UNOPS has provided direct implementation and technical advisory services on a wide variety of strategic topics to help governments attain their development goals. For example, UNOPS has aided upstream planning and asset assessment to support the creation of strategies that meet specific needs in alignment with global agendas and international commitments. As SIDS and global bodies embark on awareness campaigns and initiatives to combat climate change, the implementation of sustainable, resilient and inclusive infrastructure must be equally championed.

Table 1: Infrastructure solutions to overcome challenges and harness opportunities in SIDS

	Smallness	Remoteness	Vulnerability to environmental threats
Transport	Efficient inter-island shipping services can enable the pooling of resources among islands to yield economies of scale	Expansion of existing airports, ports and inter-island routes can improve access to core services and facilitate knowledge transfer	Coastal protection measures can safeguard airports, seaports and roads from sea level rise and storm surges
Energy	Offshore wind farms and rooftop installation of solar panels can reduce land competition	Solar mini-grids and micro-hydropower systems can increase electricity access in hard-to-reach areas	Underground energy transmission systems can limit exposure to certain hazards
Digital communications	Submarine fibre-optic cables can lower wholesale costs and improve service delivery	Space-based technology can serve remote communities and reduces the need for large infrastructure assets	Geographic information systems can create hazard risk maps to guide infrastructure implementation
Water	Integrated water resource management can facilitate water reuse and lessen groundwater abstraction	Innovative water capture technology can reduce the need for pipe networks in remote areas	Rainwater harvesting systems can provide freshwater supply in times of drought
Wastewater	Decentralized natural self-treatment systems can circumvent constraints imposed by small domestic markets	Multilateral agreements defining effluent limitations for domestic sewage can encourage proper wastewater management	Stormwater diversion canals and floodgates can minimize the risk of flooding
Solid waste	Sanitary landfill sites can prevent contamination in densely populated communities	Recycling plants can circumvent high costs of waste exports	Sea dikes and seawalls can prevent the flow of waste into the sea
Buildings	Building upgrades can enable existing structures to provide additional services	Development of local industries for construction materials can decrease dependence on imports	Deep foundations and steeply pitched roofs can increase buildings' resilience

Introduction

About 65 million people and 20 per cent of global biodiversity suffer from the damaging impacts of climate change in SIDS.[1] The threat SIDS face is disproportionately greater than their contribution to climate change, considering they are responsible for less than 1 per cent of global greenhouse gas emissions.[2,3] In addition to this, challenges related to their small size and geographical remoteness have hindered sustainable development in these countries.

Infrastructure systems can address these challenges due to their impact on the society, the economy and the environment, by innovatively harnessing the unique resources inherent to SIDS. Sustainable, resilient and inclusive infrastructure presents opportunities to unlock potential in SIDS and bridge their development divide with the rest of the world. Incorporating new solutions and tools in the planning, delivery and management of infrastructure systems will support SIDS in reducing their vulnerability to hazards while also optimizing their economic productivity.

Known for their sandy beaches and tourist destinations, SIDS are an integral part of the global economy. They are the trading partners of many countries and are leading the way in conservation efforts for oceans – which make up 70 per cent of our planet – and developing some of the world's largest marine protected areas.[4]

However, many SIDS are encumbered with poverty, gender inequality, unemployment, food insecurity and debt, among other challenges. These arise due to a combination of factors, including SIDS' small land area, remoteness and vulnerability to environmental threats. SIDS' small landmass restricts land use, constraining agricultural production, resource extraction and infrastructure development. The islands' remoteness further exacerbates these restrictions. Many SIDS depend on imports to meet the gaps in local supply, and their distance from other countries leads to high logistics costs.

Furthermore, despite $4.1 billion of foreign direct investment and $4.2 billion of official development assistance (ODA) in 2017, development efforts in SIDS have been hindered by the recurrence of hazards, both natural and caused by human activity.[5,6,i] Using data from 1950 to 2014, a study by the International Monetary Fund found that, on average, SIDS as a group are hit by seven natural hazards annually, with rising intensity in recent years. This results in the loss of lives and livelihoods, affecting approximately 10 per cent of the SIDS population and reaching economic losses of nearly 13 per cent of their gross domestic product (GDP).[7,ii] This is alarming, particularly in comparison to larger states, where a hazard impacts about 1 per cent of the population and 1 per cent of the GDP.[8,iii]

The effects of hazard events have put some countries' existence at risk; the first complete migration of an island population is already underway in Carteret Islands in Papua New Guinea, while the Maldives is exploring alternatives (e.g., population relocation, construction of protective structures or building an artificial island) to protect those living on smaller lower-lying islands.[9,10,11,12] In particular, these challenges impact men and women differently, as gender gaps manifest in many spheres, including land and property ownership, wages and job opportunities.[13]

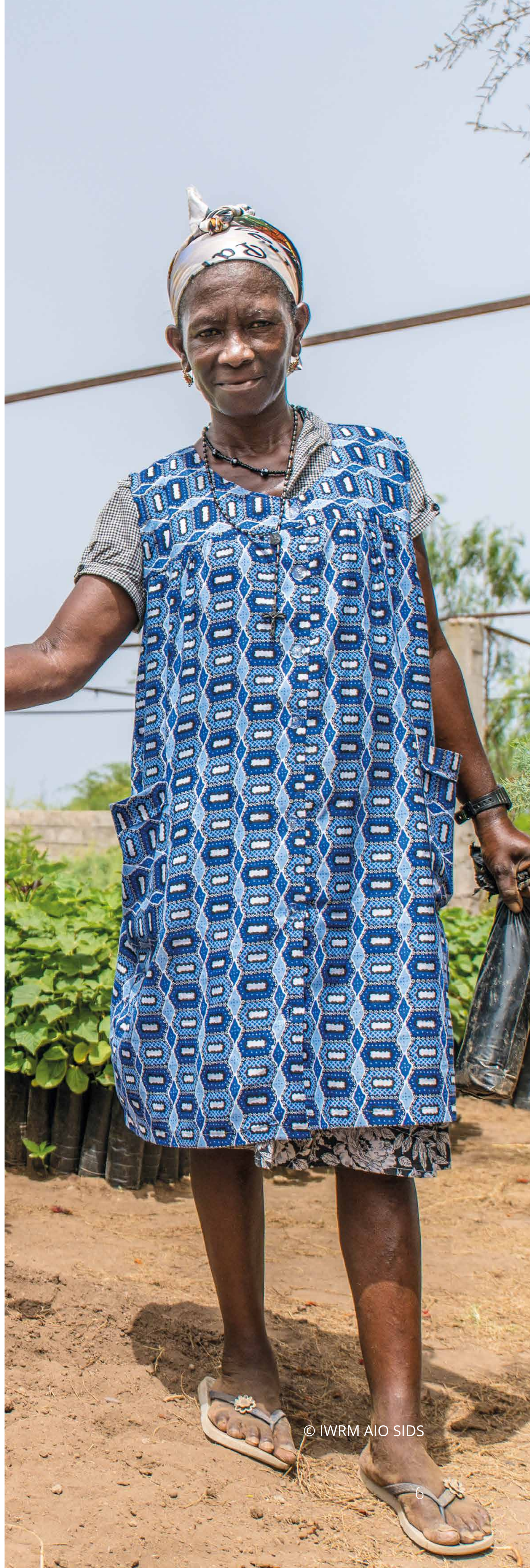
The COVID-19 pandemic provides further evidence of the importance of disaster risk reduction to protect SIDS populations and help them cope with the unfolding consequences of emerging crises. While the long-term implications of COVID-19 remain uncertain, the pandemic had an immediate devastating impact on the economies of SIDS due to their reliance on tourism. Travel restriction measures are expected to contract the tourism sector by 20 to 30 per cent in 2020.[14] It is estimated that a 25 per cent decline in tourism receipts will result in a $7.4 billion or 7.3 per cent fall in GDP for SIDS. This loss can be significantly higher in some SIDS, reaching 16 per cent in the Maldives and Seychelles.[15] Given that women constitute up to 63 per cent of the workforce in the tourism sector in some SIDS, the decline in tourism threatens their source of livelihood and risks worsening the gender gap.[16,17]

In view of the challenges SIDS face, it is paramount that foreign aid and investments are directly coordinated with governments and citizens to build local capacity and resilience. Infrastructure plays a crucial role in achieving this goal, given that it is the bedrock of the provision and support of essential services in all sectors of an economy, addressing the needs of the population, particularly women, girls and vulnerable and marginalized groups. Research reveals that infrastructure systems influence the achievement of up to 92 per cent of all the targets of the SDGs.[18] Moreover, sustainable, resilient and inclusive infrastructure will significantly impact SIDS' performance in global trade, regional and international connectivity, tourism and agriculture while protecting the lives and livelihoods of SIDS communities.[19] For this reason, incorporating concerns of sustainability, resilience and inclusiveness into the infrastructure life cycle can secure economic and social progress and ensure environmental preservation in SIDS. Failure to do so can exacerbate the challenges SIDS face and lead to major social, economic and environmental losses.

On this premise, the time is now for concrete action by SIDS governments, their development partners, the private sector and civil society to tackle these issues. It is paramount that SIDS delineate specific plans and the type of external support required to achieve their adaptation and mitigation targets. UNOPS is committed to supporting SIDS governments and key stakeholders by promoting an understanding of the infrastructure-related challenges and opportunities that can facilitate sustainable, resilient and inclusive development in SIDS.

In addition, UNOPS has developed – and is currently implementing – a series of methodologies and tools to help governments assess and improve their capacity to plan, deliver and manage infrastructure systems. These tools use an evidence-based approach to infrastructure development and are designed to incorporate all end users' needs into the infrastructure life cycle to ensure lasting benefits. This report builds on UNOPS experience working in SIDS. It provides a sectoral analysis of island states' infrastructure challenges and indicates potential actions to address them. It further explores cross-cutting approaches that can enable SIDS to reap the benefits of their unique geographic location through evidence-based infrastructure development.

i. The Cook Islands, Niue and Singapore are excluded.
ii. Bhutan, Djibouti, Montenegro, and Swaziland are included.
iii. Bhutan, Djibouti, Montenegro, and Swaziland are included.



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Background

The United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) recognizes 58 countries as SIDS, of which 38 are UN members and 9 are further categorized as Least Developed Countries (LDCs).[20] However, the United Nations Conference on Trade and Development (UNCTAD) acknowledges only 28 SIDS for analytical purposes, of which 7 are also LDCs *(see Figure 1)*.[21] This report uses the UN-OHRLLS definition unless indicated otherwise.

SIDS are geographically located in the Caribbean, the Pacific Ocean, and the Atlantic, Indian Ocean, Mediterranean and South China Sea (AIMS) *(see Figure 1)*. Their combined population is about 65 million.[22] Though similar in many ways, standards of living differ among island states. Some SIDS have more than 40 per cent of the population living below the poverty line of $1.25 a day, while for others, it is less than 2 per cent.[23] Additionally, the average annual GDP growth rate of SIDS is estimated to be 3.09 per cent as of 2018.[24]

Tourism, agriculture and fisheries make significant contributions to SIDS' GDP; for instance, gross revenues from marine and coastal tourism in the Caribbean were approximately $57 billion in 2017.[25,26] These three sectors are highly climate-sensitive; thus, climate change represents a serious threat to sustainable development in SIDS. The increased frequency and intensity of natural hazards deplete resources for livelihood and economic activities in island states.

Over the past decades, various international frameworks have been established in recognition of the particular constraints to sustainable development in SIDS *(see Figure 2)*.

In 1994, the Barbados Programme of Action (BPOA) identified priority areas in SIDS and set out specific actions to address them.[27] It was followed by the Mauritius Strategy in 2005, which added new thematic areas to the ones included in the BPOA and further indicated measures to build resilience in SIDS.[28]

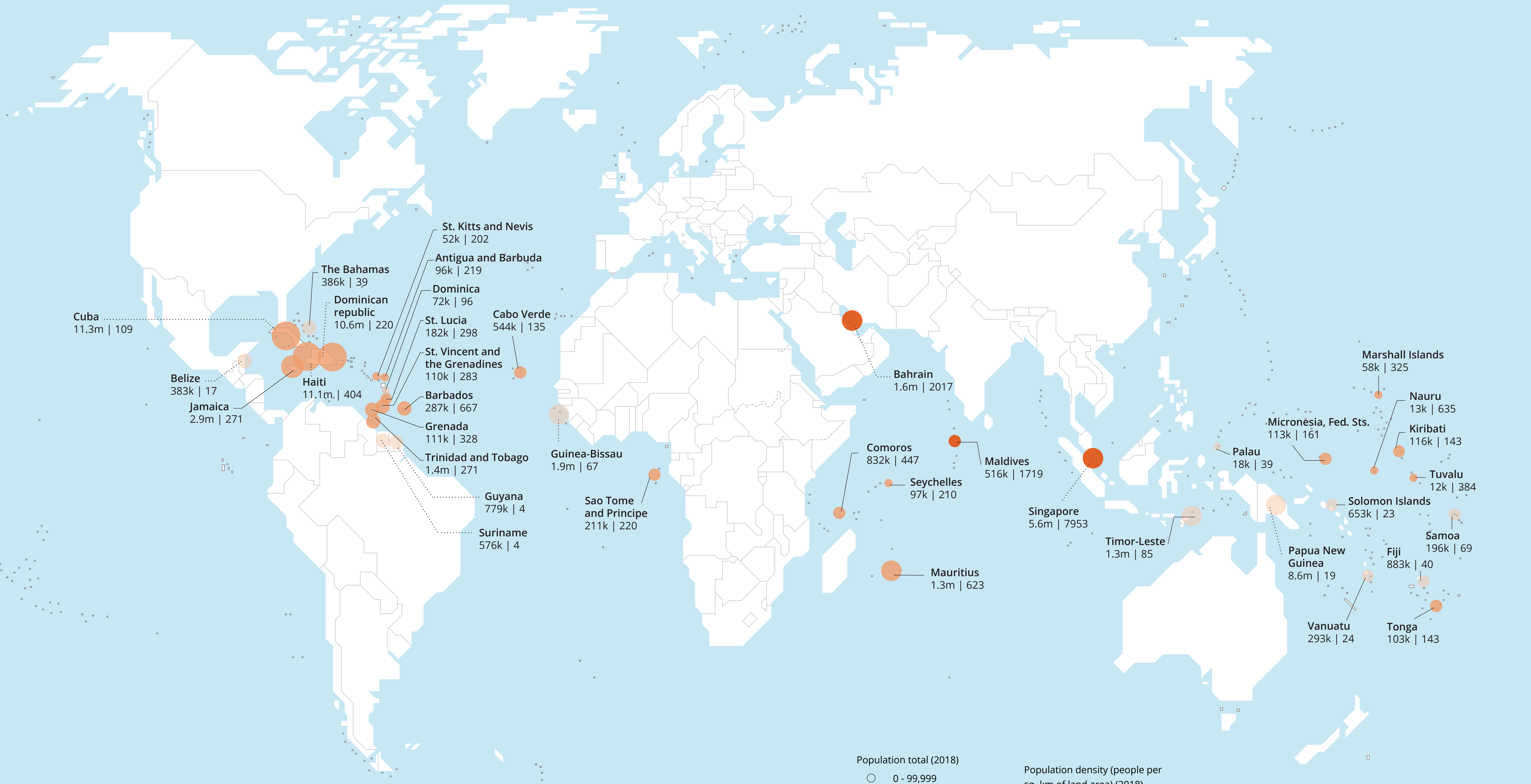
In line with this, the SIDS Accelerated Modalities of Action (or SAMOA Pathway), adopted during the Third International Conference on Small Island Developing States in 2014, has engendered efforts to curb climate change impacts through risk reduction and risk management strategies at national and regional levels. Some of these strategies include the Pacific Resilience Project Phase II for the Republic of the Marshall Islands, Ensuring Climate Resilient Water Supplies in the Comoros Islands, the Pacific Islands Renewable Energy Investment Programme and Blue Halo Curaçao (sustainable ocean policies and a marine spatial plan).[29]

SIDS are also involved in other global agendas such as the Sustainable Development Goals, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction. The SDGs highlight desirable targets across the economic, environmental and societal dimensions of development in a country. The Paris Agreement focuses on reducing climate change and its impacts through mitigation and adaptation. The Sendai Framework emphasizes strategies to reduce economic losses and mortality in the event of hazards.

SIDS have made encouraging progress in public awareness, research and policy development regarding climate change adaptation.[30] Forty SIDS are signatories to the Paris Agreement and have set various adaptation and mitigation targets to meet their nationally determined contributions.[31] For example, the Republic of the Marshall Islands aims to reduce its greenhouse gas emissions to 32 per cent below 2010 levels by 2025 and 45 per cent by 2030; a key aspect of their strategy is reducing their fossil fuel consumption in electricity and transport services, opting for renewable energy and making energy efficiency improvements.[32] However, precise plans on how SIDS intend to achieve their adaptation and mitigation targets have not been fully laid out. This causes difficulty determining in detail the type of support each country requires from the international community, whether financial, related to technology transfer or capacity building.[33]

Integrated processes and long-term infrastructure planning are required to promote sustainability, resilience and inclusiveness in SIDS. They also benefit effective gender mainstreaming in national infrastructure development, potentially reducing long-term inequalities.

Figure 1: Population and population density of countries that are recognized as SIDS by UN-OHRLLS and UNCTAD (2018)



Source: World Bank, 'Population density (people per sq. km of land area)', <https://data.worldbank.org/indicator/EN.POP.DNST>, accessed 21 September 2020; World Bank, 'Population, total', <https://data.worldbank.org/indicator/SP.POP.TOTL>, accessed 21 September 2020. No data available for the Anguilla, Cook Islands, Guadeloupe, Martinique, Montserrat and Niue. Latest data available for the Curaçao and Sint Maarten is from 2017.

"This map is for illustrative purposes and does not imply the expression of any opinion on the part of UNOPS concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries."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Generally, infrastructure development in SIDS has met financial and technical constraints related to SIDS' smallness, remoteness and vulnerability to environmental threats. SIDS have a shortage of highly skilled professionals and incur costs for foreign experts and imported technological equipment.[34] Hence, they rely on various financing mechanisms such as grants, loans, development aid, public-private partnerships and government revenue to promote sustainable, resilient and inclusive infrastructure development.[35]

SIDS also depend heavily on ODA to achieve their development targets.[36] Despite increases in the global volume of ODA over the past decade,[37] flows to SIDS fell from 2016 to 2018.[38] In addition, there have been disparities between the call for the volume of ODA flows to be needs-based and the income level of ODA recipients among SIDS. For instance, from 2002 to 2011, SIDS with the lowest GDP per capita received the lowest net ODA per capita.[39]

Furthermore, the bulk of finance for climate and disaster resilience in many SIDS is granted by a handful of donors, with only five providers accounting for 61 per cent of all ODA flows from 2011 to 2014[40]. A country may rely on a single donor for the largest share of disaster resilience financing, making it susceptible to the shifting priorities of the dominant donor(s) or their considerable influence over national development agendas.[41]

Nevertheless, between 2003 and 2018, climate funds financed 255 projects in 38 SIDS, at a cost of approximately $1.7 billion, with 54 per cent of funds directed towards adaptation efforts *(see Figure 3)*. Over that period, Pacific Islands had the largest amount of approved finance from multilateral climate funds, totalling 47 per cent, while Caribbean islands received 34 per cent and the AIMS region got 19 per cent.[43]

Remittances are also an important source of external flows to SIDS due to their high emigration rate. Remittances represented 7.5 per cent of SIDS' GDP on average from 2006 to 2013.[44] The repatriation of guest workers and massive job losses resulting from the COVID-19 pandemic is putting this source of financing at greater risk. International remittances to SIDS are expected to fall by approximately 20 per cent due to COVID-19, which will have a dire impact on these countries' economies.[45] In light of the pandemic's impact, greater mobilization of funds domestically and globally from both private and public sectors is crucial to meet the infrastructure and development needs of SIDS.[46]

Figure 2: Timeline of frameworks established in recognition of SIDS' particular constraints

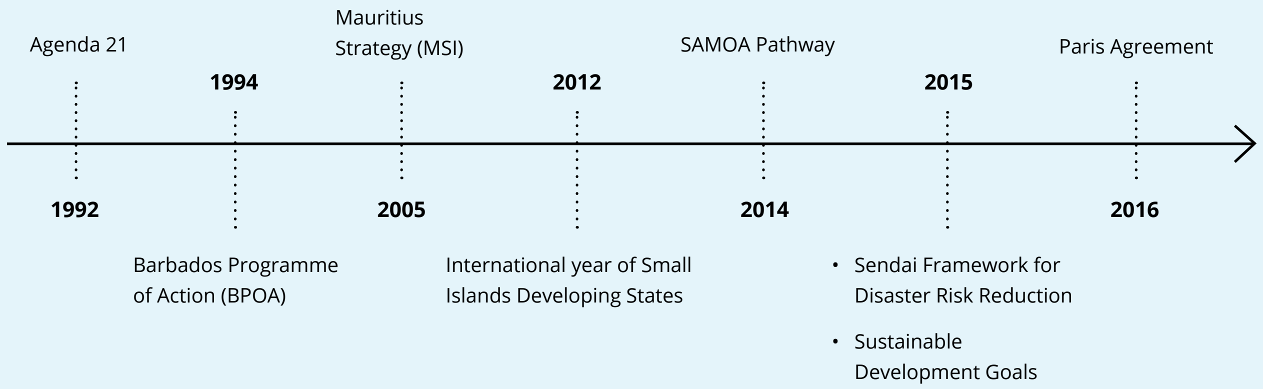
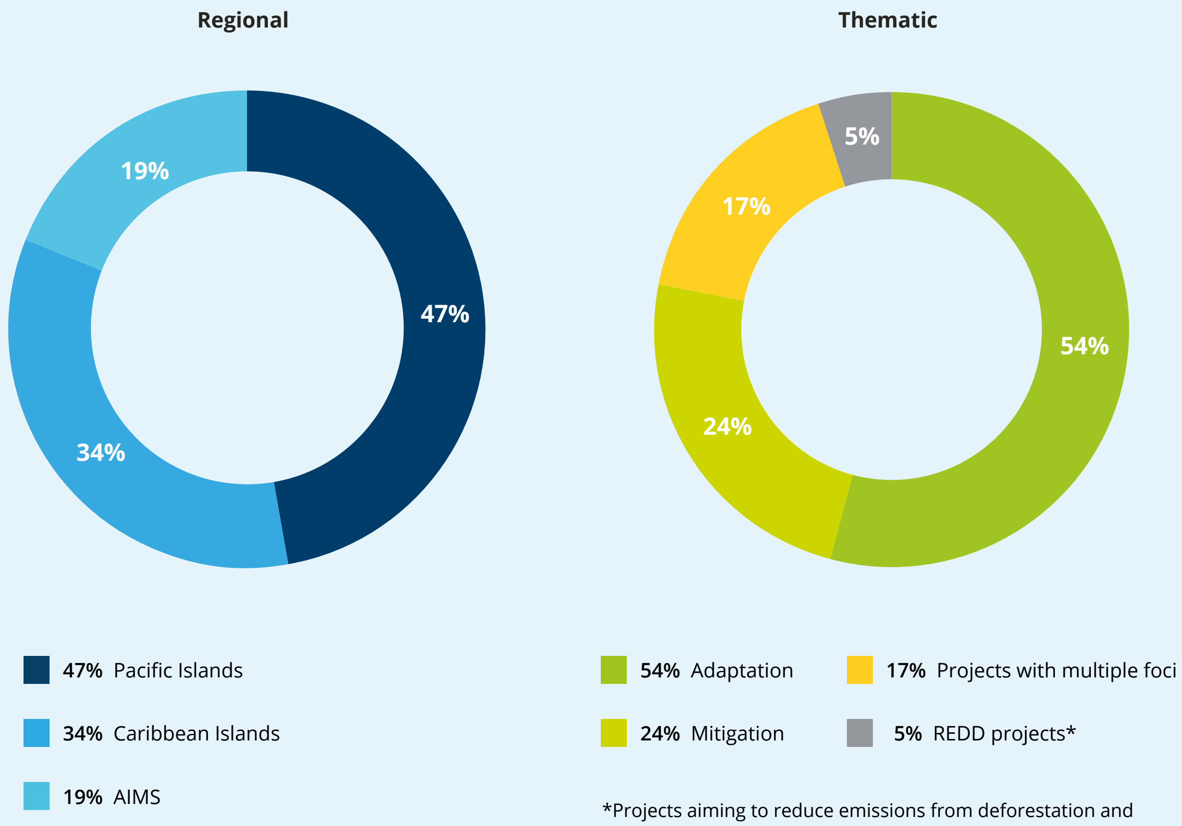


Figure 3: Regional and thematic distribution of approved finance from multilateral climate funds (2013-2018)



*Projects aiming to reduce emissions from deforestation and forest degradation, aligned with the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries.

Source: Overseas Development Institute and Heinrich Böll Stiftung [42]

Challenges

As highlighted in the introduction, SIDS encounter significant development challenges. Their unique characteristics can hinder their efforts to achieve sustainable development but can also present opportunities to harness new technologies and innovative solutions to realize the vision of the 2030 Agenda. This section will explore SIDS' challenges related to (i) smallness, (ii) remoteness and (iii) vulnerability to environmental threats.

Smallness

Many SIDS are not only small but are themselves made up of several small islands.[47] Therefore, they are often constrained by their land area, small populations (yet high population densities), small domestic markets and low technical and institutional capacity.[48] These features lead to a narrow resource base, food insecurity, import dependence, a narrow range of exports and a lack of economies of scale and competition. [49,50]

The population size of SIDS varies from less than 20,000 in the Pacific Island states of Palau, Nauru and Tuvalu to over 10 million in Cuba, the Dominican Republic and Haiti (2019) *(see Figure 1)*.[51]

With land sizes ranging from less than 1,000 square km to 28,000 square km, SIDS face intense pressure from competing land uses for agriculture, residential and infrastructure development, industrial production, tourism and waste disposal.[52,53] This pressure is further compounded by a high population density; 22 SIDS are among the top 50 countries with the world's highest population densities *(see Figure 1)*.[54] This situation leads to the overuse of resources and their premature depletion to meet high demand.[55] SIDS' small land area also magnifies the effects of natural hazards, since the impact of a given disaster covers relatively more of a small country and significantly exhausts its natural capital and resources to respond.[56,57]

Finally, SIDS' small landmass curbs their ability to meet their populations' needs by reducing opportunities for agricultural production and resource extraction.[58] Consequently, most SIDS are forced to rely heavily on imports of food and oil, among many other goods, exposing them to price volatility.[59] Due to their small populations, SIDS also have a smaller skilled labour force that is further diminished by high brain-drain rates of 50 per cent on average and up to 75 per cent in some cases (according to 2013 estimates).[60] The small population size also means small domestic markets, reducing opportunities for economies of scale. Combined with lower domestic capital stock and constrained production and innovation, these challenges make competitiveness difficult to achieve.[61] There are also gender gaps in the workforce; for instance, only one in four women participates in Samoa's labour force.[62] This creates a barrier to the improvement of women's socio-economic conditions and promotes the feminization of poverty in some islands.[63]

Remoteness

Many SIDS are remote, typically located at significant distances from other countries and major shipping routes and networks. For example, the average Pacific Island country is 11,500 km away from any other country.[64] This distance results in poor connectivity of people and freight, which bears upon international trade, productivity and innovation in SIDS. Time delays and infrequency of shipping services also cause uncertainties in trade.[65] In addition, distance and expensive means of transportation constrain inter-island connectivity, deterring coordination and leading to lost opportunities to build economies of scale. High transportation costs also affect imports and exports, hindering SIDS' access to international markets and limiting their ability to become a significant part of the global supply chain.[66]

The average number of foreign markets reached by SIDS is 43, which is lower than all other country groups and half of the world average *(see Figure 4)*.[67]

This lack of diversification reduces SIDS' competitiveness and ability to take part in global patterns of specialization, thus rendering them less attractive for foreign direct investment.[69,70] At the domestic level, these factors contribute to local producers becoming monopolists that set uncompetitive prices to the disadvantage of the SIDS populations.[71,72] When it comes to infrastructure, higher transportation and import costs can discourage its construction, operation and maintenance, especially in remote areas.

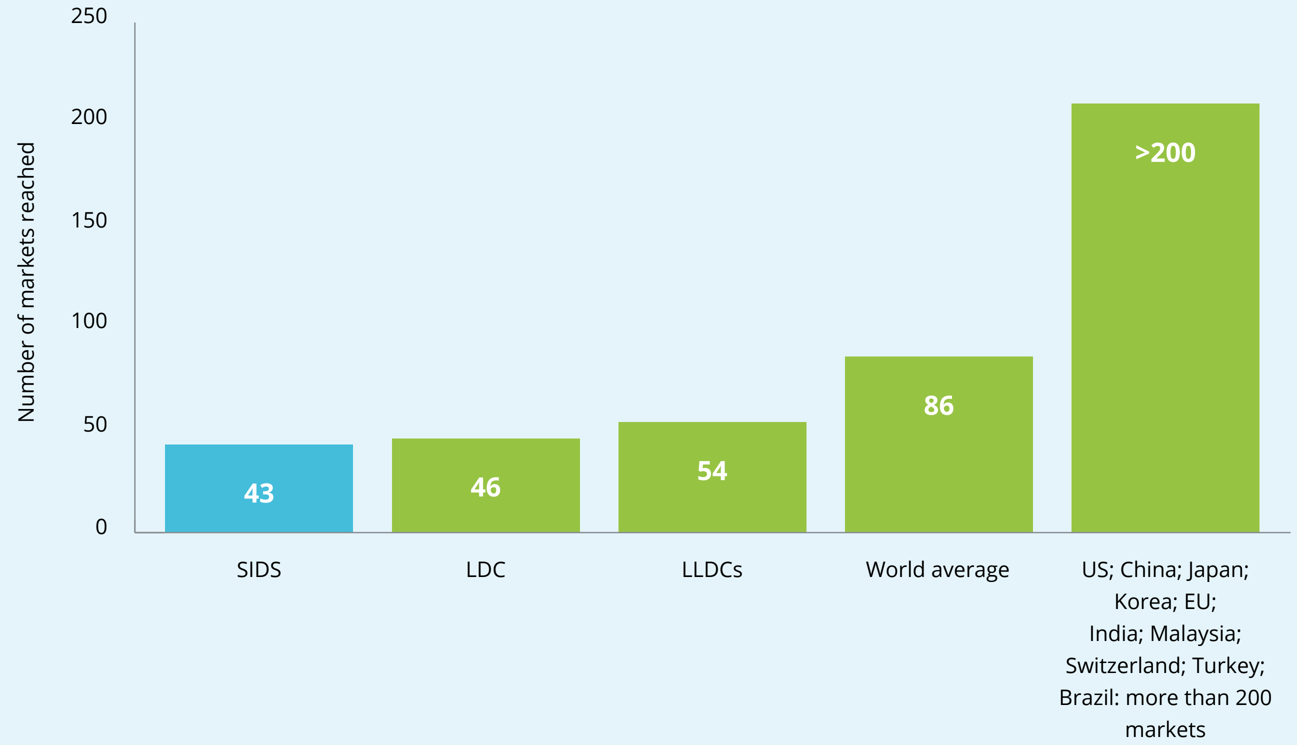
Furthermore, remoteness from the international community and major knowledge centres reduces technology flows and poses challenges in advancing innovation and economic growth. Remoteness diminishes the scope of knowledge sharing and available resources, inhibiting the evolution and application of research and development that can generate revenue to boost SIDS economies.[73] In particular, women are disproportionately affected by SIDS' distance from major knowledge centres, with research indicating that women in the Pacific islands are more reluctant than men to leave their families in pursuit of tertiary education abroad.[74] This can negatively impact women's access to education and exacerbate the gender gap in SIDS. Moreover, remoteness has significant economic and social implications in the aftermath of natural hazards. The cost of aid delivery is high, and it takes a long time for disaster relief and reconstruction materials to reach affected islands, prolonging efforts towards economic recovery.[75]

Vulnerability to environmental threats

Natural hazards represent the greatest challenge to SIDS' drive towards sustainable development. Ninety per cent of SIDS are positioned in tropical areas, where they are at high risk of experiencing extreme weather events, which have a significant impact on SIDS economies and the well-being of their populations. Due to their geographic location, many Caribbean and Pacific SIDS are also exposed to earthquakes, volcanic eruptions and tsunamis, as they lie along tectonically active margins or volcanic hotspots.[76]

These events can have dire consequences for SIDS populations, as evident from the 7.0 magnitude earthquake that hit Haiti in 2010. The earthquake resulted in the loss of 220,000 lives, 300,000 people sustaining injuries, and around 1.5 million individuals losing their homes.[77] Its impact on critical infrastructure and public services led to the greatest humanitarian crisis in the country's history. It was estimated that damages to the country's infrastructure (including homes, offices, public buildings, etc.) exceeded Haiti's annual GDP and could cause a decline in the country's income per capita by an average of 28 percentage points over a 10-year horizon.[78,79] Moreover, consecutive environmental shocks have challenged recovery efforts since 2010, including Hurricanes Isaac and Sandy in 2012, El Niño conditions in 2015 to 2016 and the category 4 Hurricane Matthew in 2016.[80]

Figure 4: Export diversification by markets reached (2017)



Source: WTO Secretariat calculation based on the WTO IDB and UN COMTRADE[68]

Hazard events affect women, men, girls and boys differently due to structural gender inequalities. As recognized by the Report of the Secretary-General E/CN.6/2014/13, women are more vulnerable to disasters, evidenced by the higher number of women's deaths in comparison to men's in the aftermath of hazard events.[81] Gender inequalities also translate to different post-hazard survival strategies among men and women, where men have access to more resources, livelihood assets and opportunities. As such, women are at a higher risk of engaging in prostitution or transactional sex and becoming targets of rape, sexual exploitation and other forms of gender-based violence.[82] For this reason, SIDS' vulnerability to environmental threats can also compromise women's safety, reinforce gender inequality and impact efforts to address gender gaps.

SIDS' vulnerability to environmental threats is further aggravated by climate change, given that it has led to a rise in the frequency and intensity of extreme weather events such as heatwaves, droughts, hurricanes, cyclones, high winds and heavy rains. These events can produce cascading effects such as flooding, storm surges and wildfires, which result in, inter alia, water and food insecurity, increased mortality, and destruction of infrastructure.[83,84,85] Low-lying SIDS are particularly affected by rising sea levels; for example, the Maldives is at risk of inundation if a one metre rise in sea level occurs.[86]

The high atmospheric concentrations of greenhouse gases over the years have led to negative environmental outcomes, such as global warming (and a consequent increase in sea temperatures) and ocean acidification. Both effects threaten coral reef ecosystems and negatively impact the tourism, fishery and seafood industries, which are core contributors to SIDS economies, especially in the poorer islands.[87,88] For instance, in 2013, the Caribbean tourism sector contributed $49 billion to the region's economy and directly sustained 1.1 million jobs. SIDS economies are therefore threatened, as the aftermath of climate hazards is characterized by fewer tourist arrivals, reduction in public sector jobs and unemployment in the formal and informal sectors (e.g., for farmers, fish vendors and fishers).[89]

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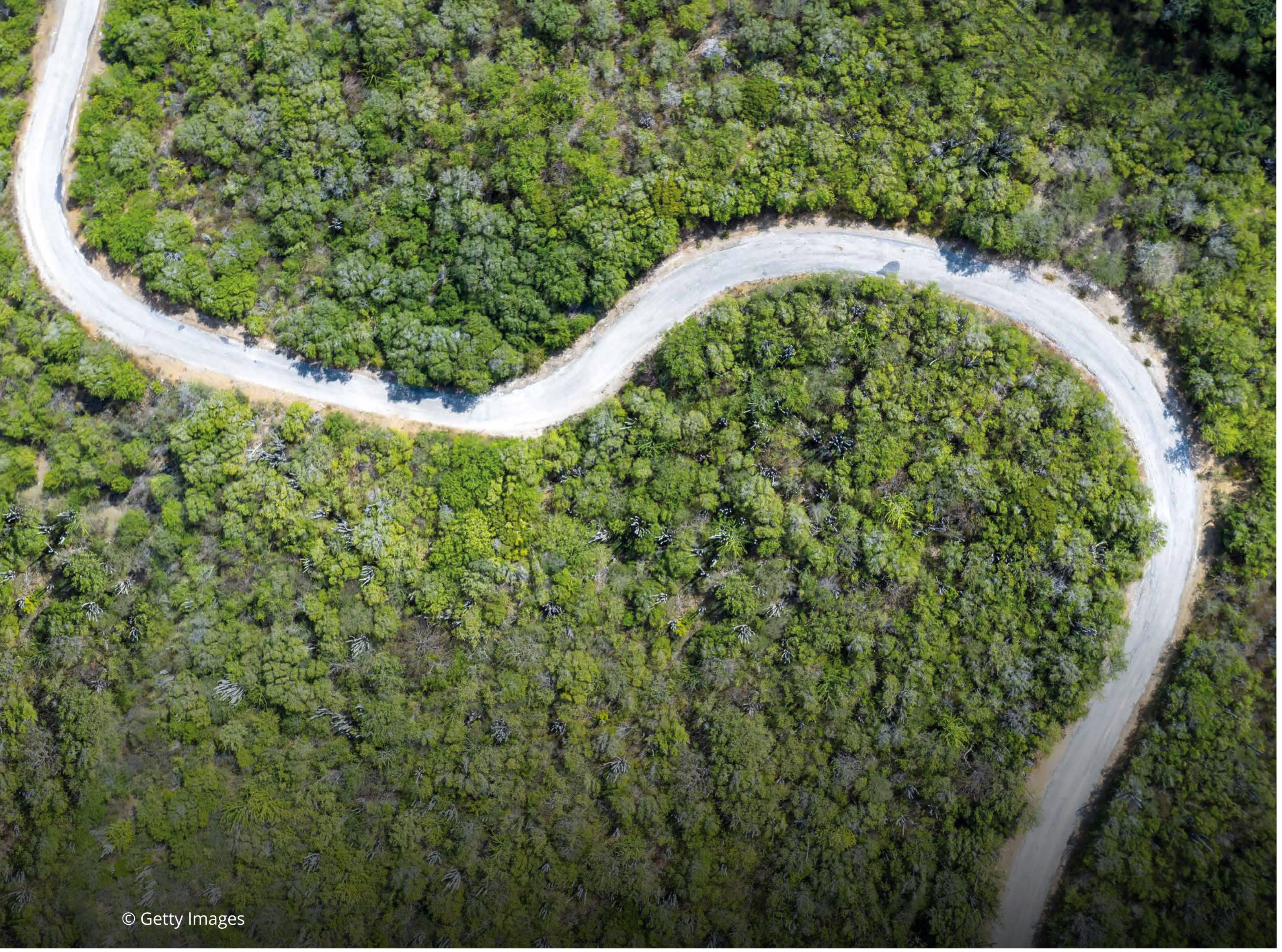
Harnessing infrastructure opportunities in SIDS

Infrastructure sectors, including transportation, energy, water, wastewater, solid waste, digital communications and buildings, provide essential services that underpin SIDS' ability to develop sustainably and achieve the SDGs. These sectors, with the exception of buildings, operate as a grid of connected assets that provide and support essential services. They are referred to as networked infrastructure systems. Networked systems support the functioning of non-networked infrastructure systems, such as buildings. The challenges SIDS face impact each infrastructure sector in a specific way. This section examines how SIDS' smallness, remoteness and vulnerability to environmental threats affect each infrastructure sector. It also presents opportunities to overcome these barriers and support SIDS' development objectives.

Transportation

The transportation sector is a critical component of public infrastructure, enabling the movement of goods, services and individuals within a territory. By doing so, transportation systems facilitate communities' access to core services such as health, education, security and justice. Improved mobility by transportation networks also contributes to economic development, as businesses, workforce and goods can easily transit across territories. Due to its ability to connect individuals - particularly women, girls and disadvantaged and marginalized groups - to services, goods and opportunities, the transportation sector plays a major role in countries' achievement of the SDGs, influencing 45 per cent of all SDG targets.[90] In the context of SIDS, transport infrastructure has high economic relevance for trade and mobility within islands as well as externally. Flights and cruises are crucial for tourism activities, which account for almost 50 per cent of SIDS' GDP.[91] This section examines how the challenges faced by SIDS impact



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transport networks. It also outlines opportunities to overcome those challenges in the context of the transport sector.

Smallness

The size of islands has an impact on transportation, especially maritime transport for export activities. The small land area of SIDS results in a narrow resource base for agriculture and manufacturing, leading to low export volumes, while SIDS' dependence on the import of goods brings about trade imbalances. The small domestic markets generate low volumes of trade for which SIDS use small cargo vessels that are often not fully loaded on the export leg of their journey. Together, this trade imbalance and use of small cargos translate into higher freight costs, as small vessels are less fuel-efficient per unit carried, and small ports have higher operating costs per ton of cargo. [92]

Inter-island shipping services and supporting infrastructure (e.g., harbours, marinas, wharves and jetties) can facilitate better coordination among islands by promoting efficient, reliable and affordable transportation of goods and people to and from islands. This enables the pooling of resources to yield economies of scale in the production and expansion of exports for larger cargo volumes.[93] The Central Pacific Shipping Commission is an example of such coordination involving Kiribati, the Marshall Islands, Nauru and Tuvalu. Improved berthing facilities are also required, given competing uses for cargo and tourist cruise ships. Separation of freight and passenger services is desirable for safety, amenity and aesthetic purposes. This has been done in Marigot Bay in Saint Lucia, where several berths are exclusively reserved for tourism. [94]

Remoteness

Maritime transport accounts for more than 80 per cent of merchandise trade by volume in SIDS, while air transport is predominantly for passengers, tourists and domestic inter-island operations.[95]

Despite the economic importance of transport infrastructure, most SIDS are equipped with a single airport, one major port and a small number of arterial roads.[96] Consequently, many SIDS have been unable to adequately participate in international markets.

SIDS limited participation in global markets is partially due to their geographic remoteness, which excludes them from the main maritime and air routes, resulting in high transportation costs and low business competitiveness. Infrequent shipping journeys and unreliable schedules create further challenges to trade and represent a key area for improvement in SIDS' economic performance.[97] Moreover, given that travel costs are a key factor in choosing holiday destinations, SIDS with direct flight links, such as Seychelles, have more tourist arrivals by air than other less connected islands.[98]

The construction or expansion of airports and ports, though requiring large upfront capital investments, has the potential to yield long-term benefits by generating revenue and increasing competitiveness in SIDS. Beyond this, better transport networks, including inter-island routes, bring better access to education, health services, technology and other social benefits.[99] Gender-responsive transport infrastructure that recognizes gender-differentiated travel patterns and needs can play a pivotal role in addressing gender inequalities and improving women's and girls' safety and security when trying to access social and economic opportunities.[100]

Vulnerability to environmental threats

The structural integrity of transport infrastructure is a major issue in SIDS. The World Bank notes that while climate risk impacts almost all aspects of life in SIDS, transport is disproportionately affected, resulting in massive economic losses. This occurs because many transport assets are located close to or on the coastline and typically rank among a country's most valuable assets.[101] For example, the 2016 Tropical Cyclone Winston in Fiji extensively damaged roads, bridges, ports and airports. Transportation was the largest networked infrastructure to suffer damages, with losses in the sector estimated at $60.2 million.[102,iv] Seismic events such as landslides and earthquakes also have adverse effects on transport assets, exemplified by the 2020 earthquake in Puerto Rico, which cracked and lifted roads and damaged bridges, among other impacts.[103] Given the limited amount of transport infrastructure in SIDS, damages to the existing infrastructure can stall relief efforts and economic recovery.

As a consequence, disaster risk mapping is highly important in planning transport infrastructure and upgrading existing assets to build resilience against natural hazards. Transport assets, including roads, bridges, berths, mooring facilities, runways and parking aprons, should be designed and constructed using standards that take into consideration the expected wind, temperature, rainfall, sea-level and wave conditions that climate change entails. A study across four SIDS (Belize, Fiji, Saint Lucia and Tonga) showed that raising standards for critical road assets, improving road maintenance and developing other resilient transport policies can reduce future asset losses by 9 to 24 per cent and well-being losses by 16 to 27 per cent.[104]

Ensuring the resilience of transport infrastructure will also facilitate the movement of large numbers to safety during warnings of impending hazards, the rescue of victims of hazards and the delivery of relief items. This will prevent a repetition of the incident in Puerto Rico after Hurricane Maria, where containers full of relief supplies sat undistributed at ports due to blocked roads, non-functional cell towers and a shortage of truckers.[105] Air transport is particularly critical post-hazard, as it is more resilient than other transportation and is often the fastest and most feasible mode of reaching affected locations.[106]

A number of SIDS have been proactive in building resilience into their transportation sectors. Examples include the execution of a climate vulnerability assessment in Jamaica to inform revised national transport policy and the Pacific Aviation Investment Programme, which aims to rehabilitate the Port Vila airport in Vanuatu and install a modern Automatic Dependent Surveillance-Broadcast system.[107,108] In addition, sea defences can effectively protect transport infrastructure. In the Maldives, breakwaters and revetments were constructed and investments were made in coral reef protection to safeguard airports and seaports from sea level rise and storm surges.[109]

iv. 129.5 million Fijian dollars (F$2.15 = US$1; exchange rate on February 22, 2016).

Enhancing road transportation in Curaçao

Country: Curaçao

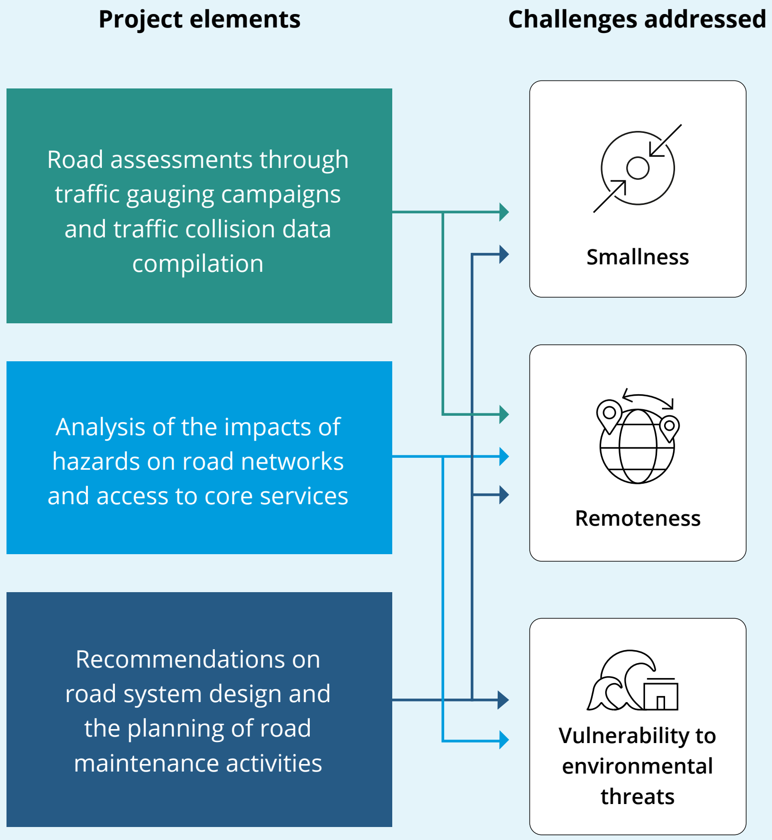
Partners: Government of Curaçao and the University of Oxford (ITRC-Mistral)

Duration: 2016–2019

To support the government of Curaçao in improving road safety and connectivity, UNOPS performed road infrastructure assessments and impact forecasting. Findings from the assessments guided evidence-based decisions on the improvement of intra-island connectivity and road safety, enhancing the accessibility of remote communities to larger cities, markets and services. Safer transport infrastructure directly benefits the achievement of SDG 3 by helping reduce the number of deaths and injuries from road traffic accidents. Likewise, better-connected transport infrastructure can also contribute to the attainment of SDG 5 by enabling access to political, economic and social opportunities for vulnerable road users, including women.

To reduce Curaçao's vulnerability to environmental threats, UNOPS analysed the impact of hazards on road infrastructure and accessibility to essential services. Based on this analysis, UNOPS provided recommendations for road system design and the planning of road maintenance activities to enhance the system's resilience to future shocks and avoid the high costs of infrastructure reconstruction and rehabilitation. Given that the functioning of markets relies on effective connectivity, improved transportation infrastructure benefits Curaçao's participation in inter-island logistics and shipping services, helping it overcome the constraints imposed by smallness. It also positively impacts a series of SDGs, including SDG 8, by facilitating long-term access to employment opportunities and fostering economic activity.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Curaçao's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Energy

Energy is an essential service that facilitates economic activities and supports the provision of almost all other critical services to society. Not surprisingly, the energy sector plays a crucial role in countries' achievement of the SDGs, directly influencing 43 per cent of all SDG targets.[110] In SIDS, energy supply typically relies on imported fossil fuels, particularly diesel, which is very expensive and exacerbates affordability issues, especially in rural areas.[111] Consequently, many SIDS experience partial energy access. This section probes these issues and highlights infrastructure solutions.

Smallness

The spread of the SIDS populations over many small islands hinders the achievement of 100 per cent energy access due to a lack of economies of scale and increased unit costs in electricity provision.[112] Although SIDS are deficient in fossil fuel energy resources, opportunities abound in the use of renewable energy sources – particularly solar energy - which are ubiquitous, including on small or dispersed islands.

Some islands, especially those of volcanic origins, have great potential for geothermal development, while those with exposed windward coasts in the tropics can harness wind energy.[113,114] However, the lack of appropriate technologies and technical capacity in SIDS have been barriers to the adoption of renewable energy.[115] Furthermore, low electricity demand on islands due to their small populations makes it difficult to attract investment capital for the high upfront expenditure of renewable infrastructure development.[116] In addition, SIDS' smallness raises concerns over inadequate space to install solar panels and wind farms, which can aggravate deforestation and add to competing land uses.[117]

In spite of this, some estimates suggest savings of 3.3 per cent of the annual GDP on average by switching to renewable sources; in less developed islands, savings can be up to 30 per cent of the GDP.[118] A study in Fiji showed that although the initial cost of diesel generators is relatively cheap compared to solar energy and other renewables, over their lifetimes, generators incur more running costs from the importation and transportation of diesel.[119] In contrast, renewables can have low and predictable operating costs and require little downtime for maintenance.

Moreover, innovations involving offshore wind farms and the installation of solar panels on rooftops and expansive ocean space help bypass space limitations in SIDS.[120] As estimated by the Scaling-Up Renewable Energy Programme in Low Income Countries, rooftop spaces of individual households and public buildings could help meet as much as 30 to 80 per cent of the electricity demand in some islands.[121] This has been successfully done in Villa College in the Maldives with a 186-kilowatt grid-connected rooftop solar panel system that reduced electricity costs by 42 per cent.[122] Also, geothermal plants generate a significant amount of power from a relatively small area.[123,124] The adoption of renewable energy also provides health benefits by reducing air pollution, which disproportionately affects women and girls in low-income rural households who rely on combustible fuels to carry out domestic activities.[125]

Remoteness

The average Pacific Island is in the top 10 per cent of the world's most remote countries, while the average Caribbean island is in the top 55 per cent. With many islands situated at remote locations, SIDS face high fuel transportation costs. They are also vulnerable to fluctuations in global oil prices, making SIDS' fuel imports and cost of energy services among the highest in the world. On average, island states spend over $67 million on oil per day.[126] This makes up a significant percentage of public expenditure (such as 15.4 per cent of the GDP in the Solomon Islands and 27.9 per cent of the GDP in Palau), increasing SIDS' dependence on development banks and exacerbating their indebtedness.[127] Despite this huge fiscal burden, as of 2017, 18 per cent of the SIDS population did not have access to electricity, with significant disparities between the rural or remote (39 per cent) and urban (5 per cent) areas.[128] Lack of access increases the time poverty of rural women and girls who bear the responsibility of collecting biomass fuels such as wood to meet household energy needs.[129] Caribbean SIDS are better off than African and Pacific SIDS, with over 80 per cent of their populations having access to electricity (with the exception of Haiti).[130,131]

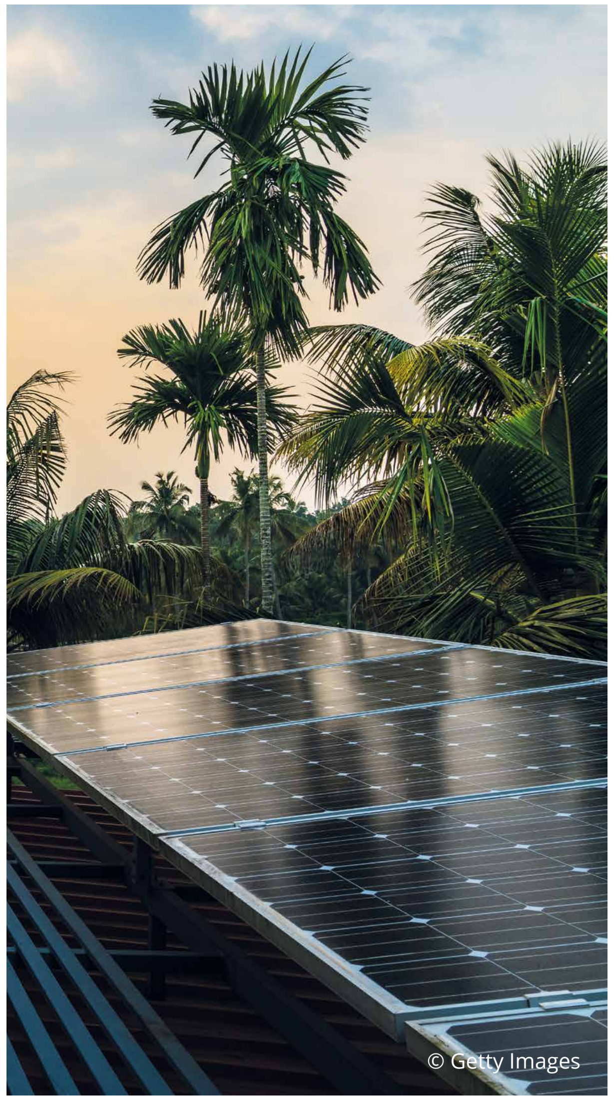
Efforts to increase electricity access in SIDS have been met with challenges. For instance, 11 Pacific Island countries are made up of hundreds of islands scattered across an area equivalent to 15 per cent of the globe's surface, which makes connecting to large grids more difficult. Meanwhile, using smaller grids is more expensive.[132,133] Improvements in electricity access have been slow in countries where the access gap is largest, making the need for renewable energy solutions more pressing.[134]

Remoteness allows for high wind speeds in some SIDS, due to the flat surface of open seawater that surrounds islands, and this could be harnessed as wind energy for electricity provision.[135] In addition, decentralized electricity generation systems such as solar mini-grids and micro-hydropower systems are also economically and environmentally viable alternatives for remote islands. Geothermal energy is a promising option for Pacific Islands in particular, as eight islands are located along active tectonic margins.[136] Other solutions, such as biogas and wave energy, should also be explored further.

Vulnerability to environmental threats

The energy sector typically suffers extensive damage during hazard events, given that many islands have above-ground transmission and distribution systems. For example, the British Virgin Islands recorded a decimation of 90 per cent of their power lines (12,000 poles, 400 miles of conductor cable, 2,200 pole-mounted transformers) and 3,500 street lights during Hurricane Irma.[137] Additional damage to power plants resulted in a loss of power generation capacity, plunging the country into darkness that lasted six months in certain communities.[138] Furthermore, hazards can prevent ship docking and damage seaports, which impedes the importation of fossil fuels and brings uncertainties regarding electricity supply in islands during or following crises.[139]

These impacts emphasize the need to diversify SIDS' energy sources and increase the share of renewable energy. A study by the National Renewable Energy Laboratory, analysing 50,000 solar energy systems installed between 2009 and 2013, revealed that solar panel systems designed durably could successfully resist shocks from hurricanes and hail.[140] This was further proven by the resilience of the solar power systems in Antigua. Climate adaptation measures were incorporated in the design, mounting and structuring of the solar power racking systems and solar panels, allowing them to withstand the 275 km/hour winds brought about by Hurricane Irma.[141,142] Furthermore, if found cost-effective, energy transmission systems can also be placed underground to reduce their exposure to extreme weather events and avoid high replacement costs.



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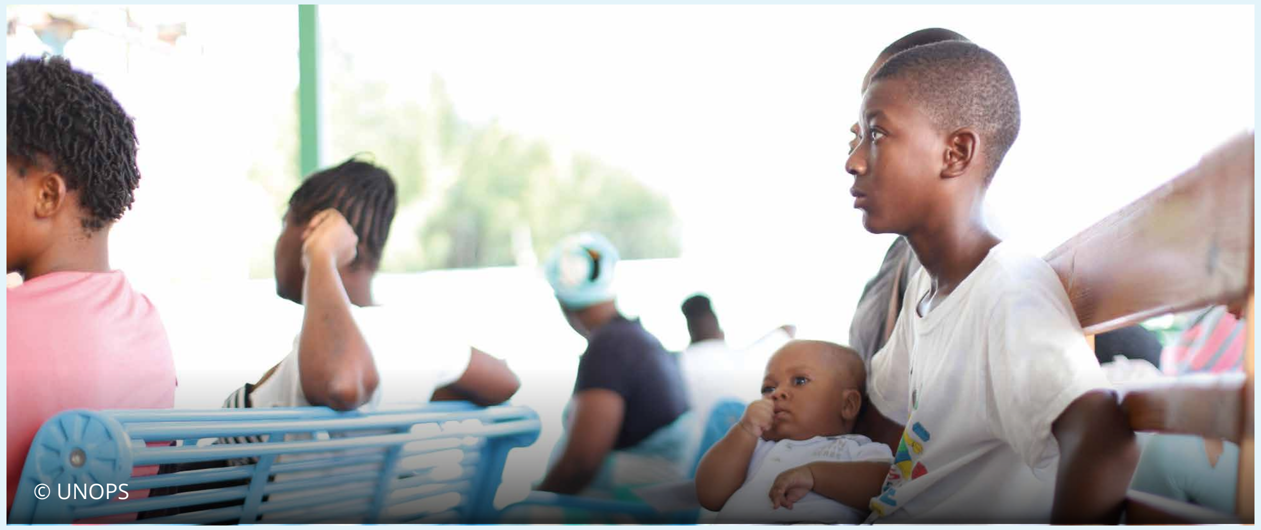
By using resilient solutions, including transitioning to renewable energy, SIDS can ensure the continuity of public service provision, as facilities such as hospitals, schools and government offices will always be powered.

Geothermal installations are also highly resilient against extreme weather events. Despite the higher upfront investments associated with geothermal energy (e.g., to install drilling and pump systems), geothermal installations can operate continuously (at up to 98 per cent capacity) and consistently throughout the year.[143] In addition, the ability of breakwaters to reflect and dissipate waves can lessen the impact of hazards and forms an important part of the research on harnessing wave energy.[144] An additional benefit of renewable energy is that it can reduce fossil fuel consumption and greenhouse gas emissions.[145] Ta'u Island in American Samoa has set an example by supplying 100 per cent of its power needs from 1.4 megawatts of solar microgrids.[146]

CASE STUDY / Energy



Enabling reliable health services for the people of Gonaïves

Country: Haiti

Partners: Governments of Mexico and Haiti

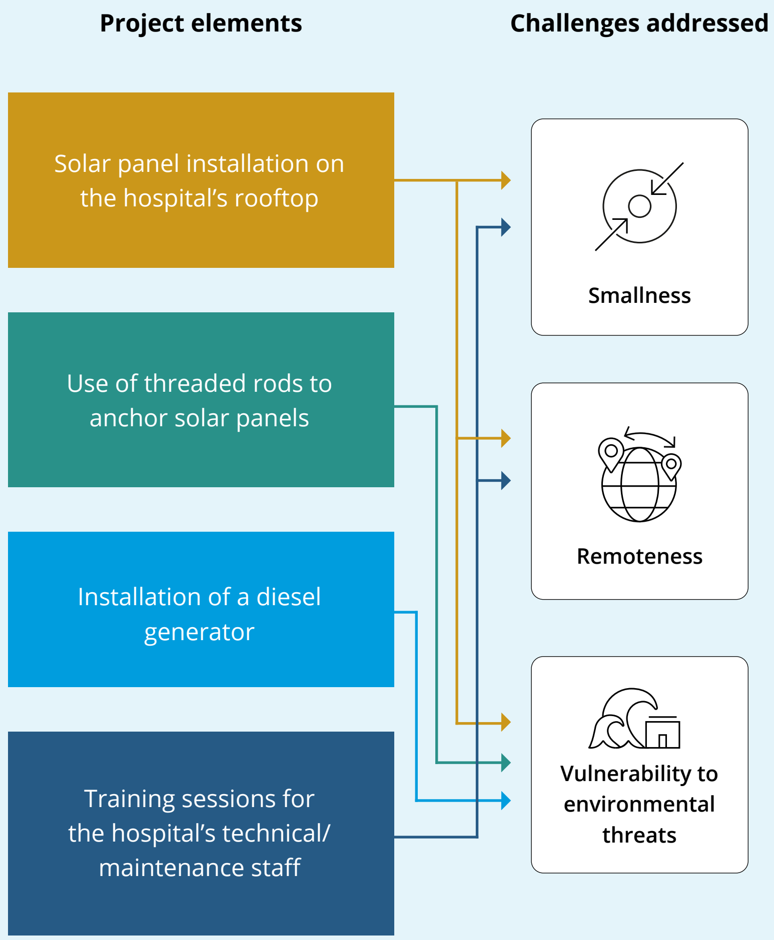
Duration: 2014–2016

In response to the destruction caused by Hurricane Jeanne in 2004, UNOPS supported the reconstruction of the Providence Hospital in the Gonaïves commune of Haiti. Reconstruction efforts included the installation of a hybrid energy system comprising a solar panel system and diesel generator. Local energy provision significantly reduced the hospital's dependency on diesel, which incurred higher costs from transportation and importation to remote locations. It also contributed to the development of a renewable energy market in the commune, which can help overcome the limitations imposed by a lack of economies of scale in small domestic markets. As a result, the solar panel installation directly benefited the achievement of SDG 7 by fostering access to affordable and reliable energy services.

Anchoring the solar panels with threaded rods (which can withstand category 4 hurricanes) and installing a backup diesel generator ensures that the hospital can remain operational, even in the aftermath of environmental shocks. This enables the functioning of critical departments, such as emergency and surgery, supporting the achievement of SDG 3 by facilitating continued access to essential healthcare services.

Training the hospital's technical and maintenance staff increased expertise in the small domestic market of Haiti, which benefited the long-term operation of the hybrid energy system and contributed to the attainment of SDG 13 by promoting awareness-raising and improving capacity on climate change adaptation and impact reduction.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Haiti's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

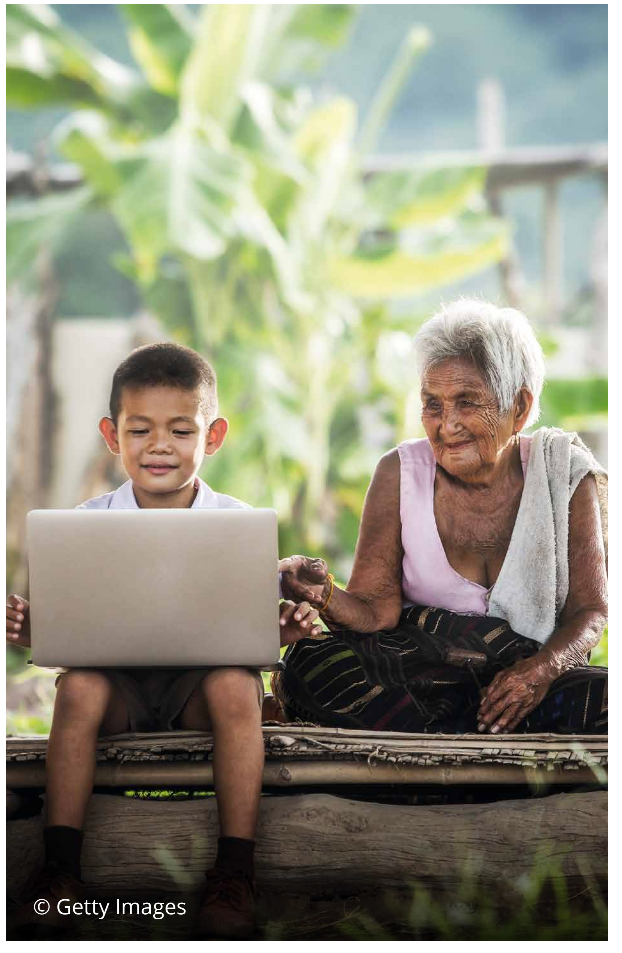
Digital communications

Digital communication infrastructure refers to communication networks (including terrestrial, satellite and wireless transmission systems) upon which broadcasting and telecommunication services rely. Digital communications is a core component of countries' social well-being and economic performance, given that many sectors such as health, transport, tourism and education rely heavily on information and communication technologies.[147] Moreover, digital communications have greatly influenced social connectivity over the years, increasing access to information and a variety of services worldwide. For example, the growing use of mobile phones and digital devices, as well as the widespread use of social media, can enable the timely dissemination of critical information, such as early warnings of imminent environmental threats. Digital communications also foster new channels for women's empowerment through distance learning and employment in online service-based industries. Digital communications are thus critical to promote sustainable development, especially because they directly influence 48 per cent of all SDG targets.[148]

Telecommunication companies are often among the major contributors to government revenue in small islands through taxes, employment opportunities and tourism facilitation.[149] Mobile connectivity has significantly improved over the past few years due to its strategic role in SIDS economies. Consequently, over 90 per cent of households have access to a mobile phone in more than half of all the SIDS, while mobile phone availability in households remains below 75 per cent in just six of the SIDS.[150] This section provides insight into the challenges and opportunities in achieving cost-effective and widespread digital communication services in SIDS.

Smallness

SIDS' small landmass and domestic markets make it difficult to attract investments to the digital communication sector. SIDS' small markets (made up of small populations often scattered across different islands) and restricted economic activity are limiting factors to the development of a competitive and effectively regulated communications sector. Several islands struggle to promote key sectoral reforms (such as the provision of subsidies, enactment of telecommunication laws and the



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creation of independent regulatory agencies that foster a desirable, predictable and stable operating environment), which contributes to the lack of competition between service providers in those markets.[151] Consequently, access to broadband connectivity in SIDS is constrained by low service availability and the high prices of these services, even in major urban areas. Indeed, the penetration of fixed broadband connectivity (wired or wireless) in SIDS is considerably low, at an average of 9.3 subscriptions per 100 people in 2017.[152]

Digital communication infrastructure in the form of submarine fibre-optic cable networks may provide a low-cost means to international fibre connectivity for SIDS communities. Submarine cable connection can lower wholesale costs and therefore encourage new service providers to operate in the country, increasing competitiveness and promoting higher quality service delivery. A significant number of submarine cables are currently being built in proximity to islands that have no connectivity, but the cables were not designed to enable access to neighbouring islands. Improved engagement and coordination by the international community can lead to the development of cable networks with branching points (that can be connected to SIDS' networks for a relatively low additional cost).[153] This is an attractive solution for island states, given that landing fees for submarine cables are quite low, and the method has successfully been adopted in the Eastern Caribbean.[154]

Remoteness

Beyond the low population density and lack of economies of scale, island remoteness adds another layer of complexity to the establishment of effective digital communication services in SIDS. High connectivity costs are linked to the difficulty of crossing the open sea to connect remote and rural island communities to internet services.[155] Although a lack of digital skills in island communities influences the pace of technology adoption, research indicates that the cost of broadband services has a bigger impact on internet usage than years of schooling (and therefore, pre-existing skills).[156] For that reason, lowering connectivity costs in SIDS, notably for remote islands, will play a critical role in enabling communities to use essential services such as online early warning systems for hazards and real-time weather information.[157] Moreover, digital communication can help close the skills gap in remote communities by granting access to online education in the form of distance learning, therefore promoting skills development and capacity building. The provision of online channels can also encourage women's participation in public forums and decision-making processes.[158]

The key to improving digital communication service provision in SIDS lies with technological innovation. For instance, emerging satellite systems (such as the O3b[v] service) can lower service costs and increase bandwidth coverage and quality in remote areas.[159] The use of space-based technology can also reduce the need for large infrastructure assets, making it a convenient solution for remote islands that cannot bear the high costs of transporting materials and tools for infrastructure development. For example, a single satellite dish could serve a remote community and allow it to pick up broadcast signals sent from a satellite instead of relying on a series of constructed transmission and relay towers.[160] In the context of SIDS, telecommunication operators would be able to connect their remote networks even with no terrestrial infrastructure and therefore provide greater coverage at lower costs. Several island states have already adopted or are in the process of implementing O3b links, including Palau, Papua New Guinea, the Solomon Islands and Timor-Leste.[161]

Vulnerability to environmental threats

SIDS' vulnerability to environmental shocks puts their digital communication infrastructure under greater exposure and risk of collapse. This threat is particularly alarming for SIDS, given that ICT services are a major contributor to island states' GDP, with telecommunication operators being some of the largest companies operating in SIDS and representing leading sources of employment and government tax revenues.[162] Moreover, digital communication also plays a central role in the assessment of natural hazards and in immediate responses following shocks.[163] For example, digital communication infrastructure enables access to data such as those found in satellite imagery and geographic information systems, which can inform plans to reduce vulnerabilities and promote resilience in SIDS. Despite the importance of the digital communications sector to SIDS economies, several islands rely on sparse and highly vulnerable telecommunications infrastructure. For example, in 2014, several Pacific Islands had a single satellite antenna for international services, exposing telecommunication services to high risk of disruption due to shock events.[164]

To prevent this, coastal structures such as seawalls may protect base stations, local switches and transmission cables located near coastal areas from landslides. Besides this, using satellite imagery and geographic information systems to create hazard risk maps is critical to ensure that SIDS' sparse communication assets are located in safer areas.[165,166] In Haiti, for instance, multi-hazard risk models were used after the 2010 earthquake to identify the intensity as well as the spatio-temporal distribution of potential environmental hazards.[167] This assessment informed reconstruction operations by identifying zones that were most exposed to natural hazards (where construction was prohibited) and provided recommendations for future earthquake standards for all public buildings and major infrastructure systems.[168]

v. O3b stands for the 'other 3 billion', which at the time of its launch roughly represented the number of people in the world without broadband access.

Supporting Haiti's reconstruction and resilience

Country: Haiti

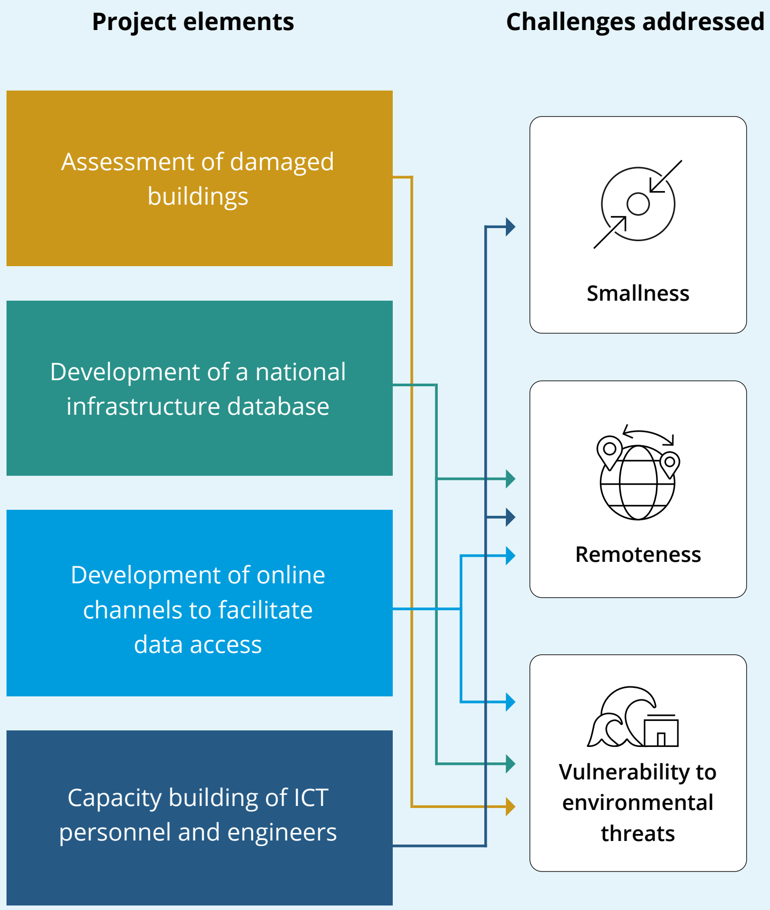
Partners: Government of Haiti and the United Nations Office for the Coordination of Humanitarian Affairs

Duration: 2010–2011

In response to the destruction caused by the 2010 earthquake, UNOPS supported the government of Haiti in post-disaster recovery, conducting assessments of building damage and repairs. Findings were stored in a comprehensive national infrastructure database, enabling evidence-based decisions on resilient infrastructure development and avoiding future high costs of reconstruction and rehabilitation due to Haiti's reliance on importing construction materials from distant locations. The database also contributes to the attainment of SDG 10, as evidence-based strategies and plans are more likely to attract development assistance and foreign investments to the country.

Making the database available via online channels enabled public access to national data, notably in remote locations, also benefiting the achievement of SDG 16. Using such channels to share studies, maps and guidelines for repairs and construction facilitates the development of resilient infrastructure, which reduces Haiti's vulnerability to environmental shocks. It also positively impacts SDG 17, as the use of information and communications technology supported coordination and knowledge sharing among implementing partners working in the country. Capacity-building sessions ensured long-term usage of this technology and helped increase the pool of skilled workers in Haiti's small domestic market, reducing the country's dependence on foreign experts.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Haiti's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Water

The water sector provides safe and quality freshwater to meet the needs of the local population and the environment. Growing populations, over-exploitation and unequal distribution of water put pressure on water resources. This can lead to water scarcity and insecurity. SDG 6 recognizes the importance of achieving universal and equitable access to safe and affordable drinking water for all. Target 6.4 specifically highlights the need for increased water-use efficiency as well as sustainable withdrawals and supply of freshwater to address the growing issue of water scarcity.[169] Beyond SDG 6, the provision of freshwater also impacts other aspects of sustainable development, such as health, education and poverty. In accordance with this, water-related services influence 37 per cent of all SDG targets.[170]

Unfortunately, SIDS face various challenges in the effective provision of water services. Increased urbanization, population expansion and highly polluting economic activities such as tourism put pressure on water supplies and increase the risk of water insecurity in SIDS.[171,172] Islands' vulnerability to environmental threats can also lead to contamination of freshwater supplies, directly impacting the health and well-being of populations and possibly jeopardizing continued habitation in some islands.[173] This section explores some of the main challenges SIDS face in providing freshwater as well as potential opportunities to address them.

Smallness

Many islands are dependent on thin groundwater lenses floating on saltwater, small rivers, lakes and rainwater for freshwater.[174] Due to their small size, limited natural storage and competing land uses, SIDS are often unable to maintain extensive surface or underground water repositories, leaving the islands exposed to droughts and water insecurity.[175] In the Pacific Islands, for instance, only 52 per cent of the population had access to improved drinking water in 2016.[176] Water scarcity also impacts food security since agricultural activities, which already suffer from spatial limitations and competing land uses, primarily rely on freshwater availability. Inadequate freshwater provision negatively impacts women's and girls' participation in productive or educational activities. In Comoros, for instance, women spend two and a half hours per day on average fetching water.[177]

The creation and implementation of Integrated Water Resource Management (IWRM) plans can help SIDS overcome the challenges imposed by their smallness. IWRM is a process that seeks to overcome the traditional fragmented approach to water management by making a clear distinction between resource management and water service delivery. This approach allows decision-makers to consider multiple viewpoints on how water should be managed so that all potential sources of water are considered and actions identified to obtain the most out of a limited resource. Only after this process should more expensive and energy-intensive options, such as desalination, be considered. This approach is being used by a Global Environment Facility-funded project to support six SIDS by enhancing their capacity to plan and manage their aquatic resources sustainably, for the protection and utilization of groundwater and surface water for improved water service delivery.[178]

Remoteness

The often prohibitive costs of infrastructure development, operation and maintenance in remote areas make it difficult for SIDS to develop appropriate drinking water treatment and distribution systems. Lack of proper maintenance can also lead to water losses. For example, according to 2016 government estimates, Trinidad and Tobago had lost 48 per cent of its water due to leakages and illegal connections.[179,180] The cost of improving existing water facilities or building new infrastructure makes universal coverage a distant reality for many island states. In the Pacific region, for example, it has been estimated that island states would need to invest approximately $83 million in drinking water treatment on a yearly basis to achieve universal coverage by 2030.[181] Chemicals used in water treatment processes are not readily available in SIDS, which leads to additional costs from importation.[182] Furthermore, remoteness limits access to personnel with high levels of technical expertise and impedes the adoption of certain technology used in water infrastructure, such as desalination.

Nevertheless, SIDS' unique location and climate also provide opportunities for innovative decentralized water capture solutions. For example, innovative water capture technology such as rooftop panels that pull moisture from the air is being used to provide clean drinking water in the University Hospital of the West Indies in Kingston, Jamaica.[183] This is done through a system that collects water vapour from the air onto a hygroscopic material in solar photovoltaic panels and later condenses it into water, which is mineralized with magnesium and calcium to achieve the ideal quality.[184] Although costly, this solution provides a decentralized alternative for freshwater supply. This technology is particularly relevant for remote locations, as it circumvents the prohibitive costs of laying distribution pipes and developing large treatment plants. Moreover, increasing the use of new and innovative technologies can foster research and development, making these innovations more accessible and cost-effective.[185]

Vulnerability to environmental threats

SIDS' freshwater resources are significantly vulnerable to natural hazards. Hurricanes, storm surges and floods increase the risk of freshwater contamination and damage to water infrastructure.[186] Droughts, in particular, deplete groundwater reserves due to over-abstraction, which contributes to saline water intrusion and, in turn, leads to reduced groundwater quality. Furthermore, considering that a significant share of SIDS communities lives in areas less than five to ten metres above sea level, climate change-induced sea level rise can lead to seawater intrusion from coastal flooding, which affects the quality of water reserves in these communities.[187] These challenges to water security have put certain SIDS, such as Comoros and Mauritius, at risk of becoming water-stressed or water-scarce by 2025.[188]

To tackle the environmental threats posed by climate change, water infrastructure facilities such as dams, desalination plants, and rainwater harvesting and storage facilities have become increasingly vital for island governments. In Kiribati, for instance, the World Bank-funded Kiribati Adaptation Program saw the installation of rainwater harvesting systems and safe storage facilities in suitable buildings (such as communal buildings, health centres, churches and schools) to enable local communities to access safe water in times of drought.[189] In addition, the programme invested in the construction of coastal structures such as seawalls to prevent shoreline flooding due to storm surges and waves, ensuring that core infrastructure (such as communal buildings with rainwater harvesting systems) is protected.[190,191]

Given women's active role in fetching water for their households, it is critical that they be involved in decision-making for adaptation initiatives regarding the provision and management of water infrastructure.[192]

Enhancing water security and climate resilience in the Maldives

Country: Maldives

Partners: United States Agency for International Development

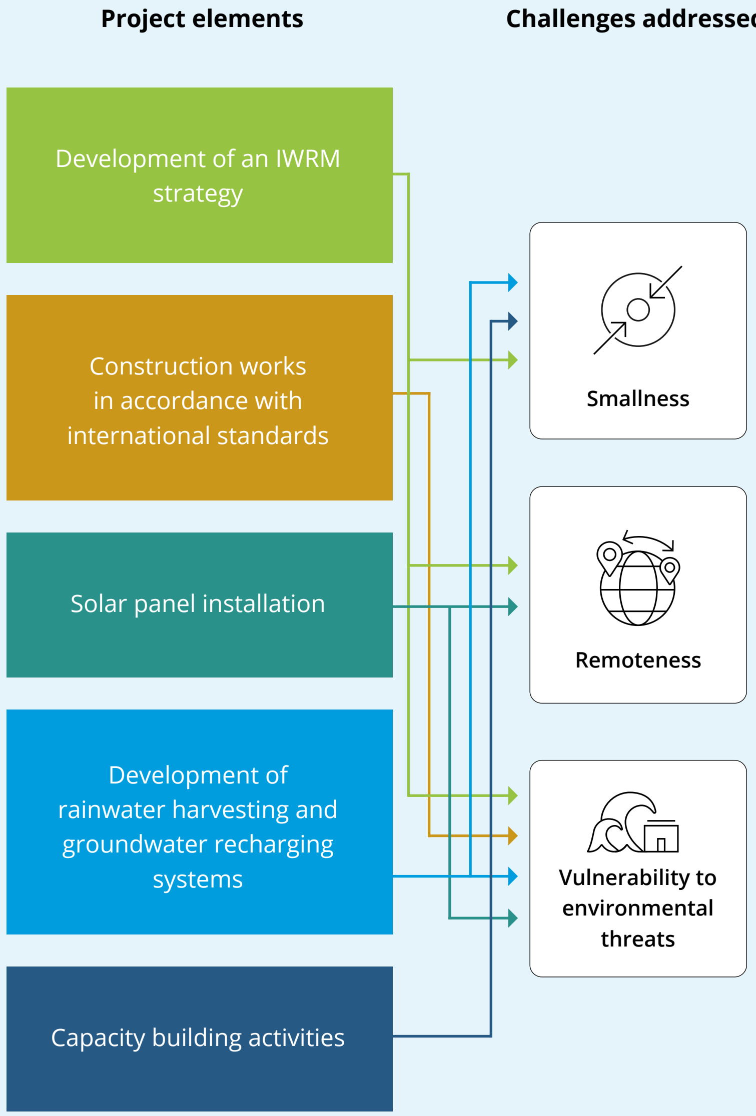
Duration: 2014–2018

In an effort to increase the availability and quality of drinking water in the island of Hinnavaru in the Maldives, UNOPS developed an IWRM strategy for the island. The strategy included the development of a desalination plant, which was designed and constructed in accordance with international building codes as well as national standards to ensure the quality and resilience of the IWRM system. Resilient water infrastructure promoted the well-being of residents and supported the achievement of SDG 9 by fostering more affordable and long-term access to water resources. Construction works also included the installation of a solar power system to decrease the facility's dependence on expensive imported diesel, which incurred higher costs from transportation. Solar power helps reduce operating costs of the plant and ensures continued operation even if environmental shocks occur.

In addition, UNOPS developed rainwater harvesting and groundwater recharging systems that help overcome the island's small size by avoiding resource overuse and enhancing Maldives' underground water repositories. This fostered sustainable water management in Hinnavaru, directly contributing to the attainment of SDG 6 and reducing local communities' exposure to water insecurity.

Training sessions on operation and maintenance were provided for local workers, increasing knowledge and the pool of skilled workers in the small local market, as proposed by SDG 4, and ensuring long-term sustainability of the infrastructure system.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed the Maldives' challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Wastewater

The wastewater treatment sector refers to the conversion of wastewater (originating from domestic, industrial, commercial or agricultural activities) into clean water that can be discharged into the environment or used in irrigation and industrial activities. The provision of effective wastewater treatment is key to sustainable development, given that water-related services can influence 37 per cent of all SDG targets.[193] Target 3 under SDG 6 specifically recognizes the need to reduce the proportion of untreated wastewater globally and eliminate the dumping of hazardous substances in water-related ecosystems.[194]

SIDS face various challenges in the provision of effective wastewater treatment services. This negatively impacts their populations and natural resources that are critical for their tourism-based economies.[195] For example, it is estimated that 85 per cent of the wastewater discharged into the Caribbean Sea is completely untreated, which has largely contributed to the loss of about 80 per cent of the living coral in the Caribbean over the past 20 years.[196] This section explores how the challenges SIDS face affect the provision of adequate wastewater treatment services as well as the potential actions to address these challenges.

Smallness

The growth of populations has heightened the demand for sanitation services in many island states. Sanitation coverage in SIDS is often inequitable, leaving rural populations or more remote locations with poor facilities. The small populations in these communities create a disincentive for the commitment of significant financial resources to wastewater infrastructure. In the Pacific Islands, for instance, rural areas have been neglected in terms of sanitation investments, with over 60 per cent of the population using inadequate facilities and 15 per cent practising open defecation in 2015.[197] Lack of adequate facilities creates difficulties for women in relation to proper menstrual hygiene management, pregnancy and birth. Inadequate wastewater infrastructure can also enable gender-based violence when women and girls seek privacy in secluded locations outdoors to defecate.[198]

In addition, locations that have improved sanitation, for example through sewer collection and conveyance systems, can still face environmental and health issues when operating without proper final wastewater treatment. For instance, poorly maintained and inappropriately sized septic tanks in the Pacific Islands have led to the deterioration of groundwater quality, which further compounds the issue of water insecurity.[199] Likewise, public sewerage systems that discharge untreated sewage into water bodies will likely harm the biodiversity of fragile ecosystems, such as coral reefs, on which SIDS tourism activities largely rely. Lack of adequate investment in wastewater treatment, among other factors, impedes the proper operation and maintenance of existing infrastructure systems.

Innovative wastewater treatment solutions that incur lower operation costs or require less maintenance can help SIDS overcome the constraints imposed by smaller economies of scale. For example, decentralized natural self-treatment systems (e.g., septic tanks, anaerobic upflow filters, recirculating sand filters, stabilization ponds and wetlands) can be an environmentally friendly alternative. These require less maintenance due to their capacity for self-adjustment, therefore circumventing some of the constraints imposed by small domestic markets lacking the necessary chemicals, components or skilled labour to operate and maintain wastewater treatment solutions.[200] In Tuvalu, the implementation of eco-sanitation, an innovative waterless solution, allowed households to reduce their use of freshwater for toilet flushing by approximately 30 per cent and eliminate their sewage load to groundwater and coastal waters. This solution also enabled the generation of organic matter that can enrich soils for agricultural production.[201] Simplified sewerage is another cost-effective method for the collection and conveyance of wastewater. This method involves laying sewer pipes at shallow gradients and therefore requires less excavation. Some estimates state that simplified sewerage can be up to 80 per cent less expensive than conventional gravity sewerage.[202]

Remoteness

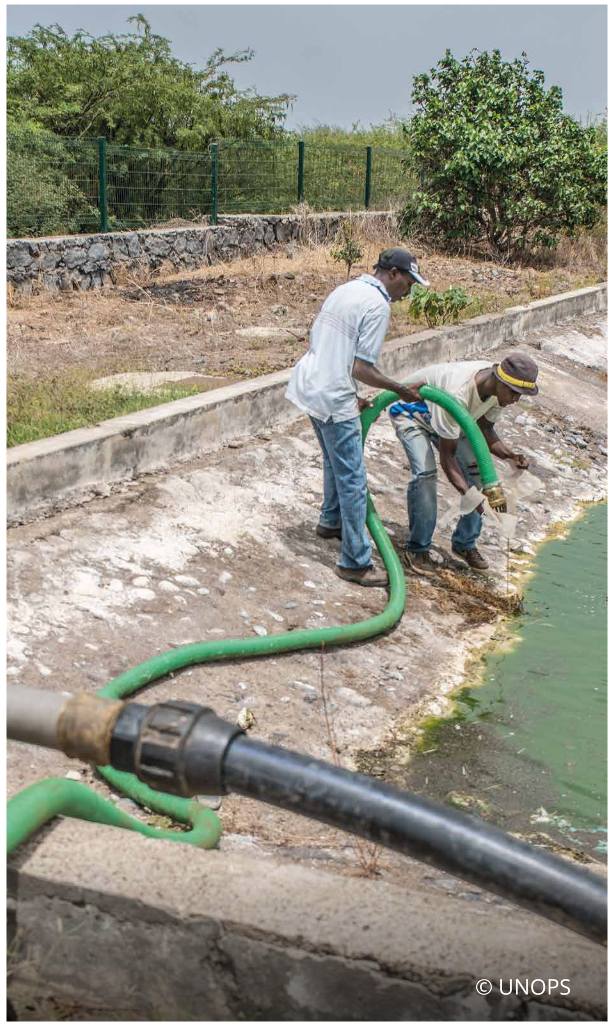
The remoteness of SIDS poses particular challenges to sustainable water management due to the difficulties of establishing wastewater treatment infrastructure in distant territories. Only one third of the SIDS population reports having sewer connections, and just 59 per cent of wastewater is undergoing secondary water treatment. Yet, improvements to water treatment infrastructure remain a distant reality for several island states.[203] This is because infrastructure improvements require significant resource allocation, especially due to the higher transaction costs of infrastructure development, operation and maintenance in remote areas.

It has been estimated that states in the Pacific region would need to invest approximately $80 million in wastewater treatment on a yearly basis to achieve universal coverage by 2030.[204] This is due to the constraints imposed by the size and remoteness of SIDS economies, which lead to higher costs in acquiring consumable materials (e.g., chlorine and other imported chemicals used in wastewater treatment) and developing and implementing the appropriate governance mechanisms (e.g., codes and standards, quality control regulations, and monitoring and evaluation activities). Training and retaining the human resources needed to operate and maintain wastewater treatment systems (e.g., chemists and technical experts) can also be challenging in remote areas.

Regional cooperation in the form of multilateral agreements can help SIDS create a supportive enabling environment for wastewater management. This can be done by establishing common obligations, frameworks and agreed standards that can be incorporated into national governance mechanisms for wastewater treatment. For instance, the Land-Based Sources Protocol, concerning the sources of marine pollution and adopted by Caribbean nations at the Cartagena Convention, advanced the adoption of codified standards and innovative wastewater treatment solutions.[205] The protocol introduces regional standards and practices for the prevention, reduction and control of marine pollution, including specific regional effluent limitations for domestic sewage. It marks an important step in the Caribbean islands' commitment to reducing wastewater pollution.[206]

Vulnerability to environmental threats

Environmental hazards put additional pressure on SIDS' wastewater infrastructure due to their capacity to damage already fragile systems. The US Virgin Islands' experiences with Hurricanes Irma and Maria illustrate the potential damage environmental hazards can do to wastewater pump stations and sewer pipes. Due to the hurricanes, wastewater treatment plants lost power and could not operate, leading to raw sewage discharges into streets and water bodies, contaminating water reservoirs and other areas.[207] Pump stations and water treatment facilities that were still operational during the storms were later affected by flooding and storm debris, which blocked sewer lines and caused manholes to overflow.[208]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Protecting sewage conveyance systems is critical to avoid water contamination and the interruption of wastewater treatment services following environmental shocks. Storm water diversion canals and floodgates, for instance, may minimize post-hazard floodings in SIDS by containing and redirecting water flow. Likewise, green solutions such as riparian vegetation may reduce flood velocity and help spread rainwater into wetland systems, removing some of the energy and sediments carried in the water.[209] Moreover, well-established and strong trees can act as debris barriers and reduce cyclonic wind damage.[210] In Suriname, for example, permeable dams built with wallaba poles and bamboo fillings are enabling the growth of mangroves that can protect the hinterland against cyclone damages such as flooding and erosion.[211]

Preventing freshwater contamination in Cabo Verde

Country: Cabo Verde

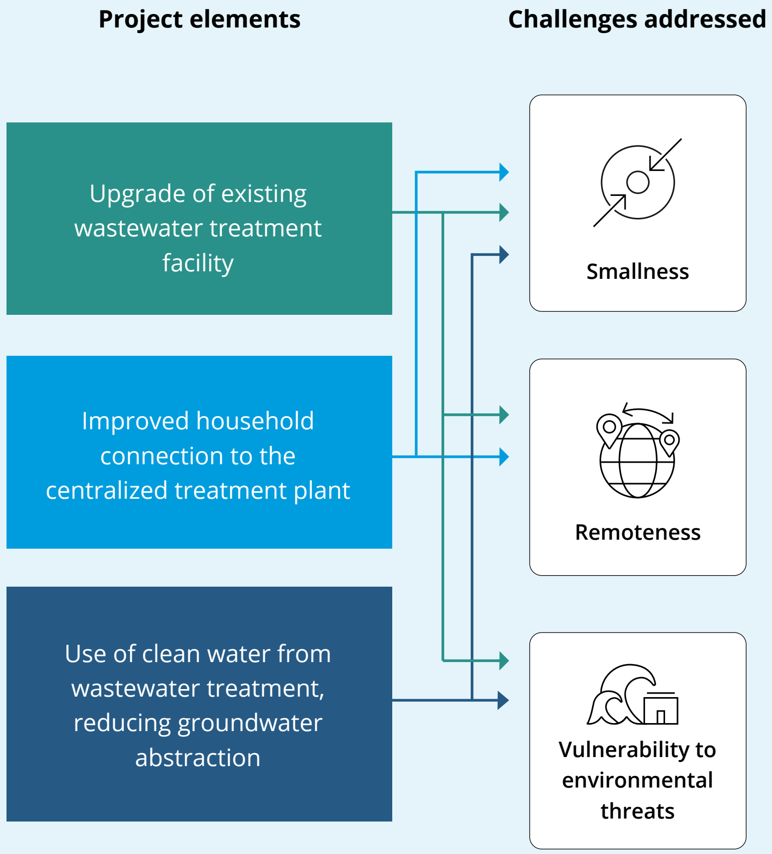
Partners: Global Environment Facility and the United Nations Development Programme

Duration: 2012–2018

In Cabo Verde, UNOPS supported an IWRM initiative to improve access to wastewater treatment and protect freshwater sources in the municipality of Tarrafal. Lack of access to sanitation services led Tarrafal residents to build small septic tanks, which resulted in wastewater leakages into the aquifer due to improper maintenance. In response, hundreds of homes were connected to Tarrafal's treatment plant, which alleviated the disproportionately high financial costs of tank maintenance in the small markets of remote SIDS. The treatment plant was upgraded to cope with the additional flow of wastewater. In this case, upgrading existing infrastructure provided a cost-effective solution to increase access to treatment services and simultaneously addressed the challenge of smallness by preventing land competition. Connecting homes to a central plant promotes access to adequate sanitation, directly benefiting the achievement of SDG 6. It also supports the attainment of SDG 15 by preventing the contamination of freshwater ecosystems.

The IWRM initiative also provided access to alternative water sources (i.e., treated wastewater), which contributed to crop productivity while curbing groundwater abstraction, therefore reducing the risk of drought. This use of resilient agricultural practices supports the achievement of SDG 2 by encouraging sustainable food production that strengthens adaptation to climate change.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Cabo Verde's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Solid waste

Solid waste management (SWM) refers to the collection, disposal and treatment of various types of solid waste (e.g., industrial, commercial, domestic and agricultural waste, among others). The solid waste sector plays an important role in sustainable development, influencing 21 per cent of all SDG targets.[212] This is due to the impact SWM systems have on the environment and on quality of life, particularly for those at risk of exposure to contamination. About 50 per cent of the solid waste produced in SIDS is organic; the rest includes chemicals, plastic, paper, metal, glass, textile and electronic waste.[213] Most of the current SWM approaches in SIDS involve waste disposal by landfilling, illegal dumping and backyard burning, which are detrimental to the health of communities and the environment.[214] Improper solid waste management, such as the practice of open burning, leads to soil degradation and other negative environmental and economic impacts. This section sheds light on the challenges and opportunities in enhancing SWM in SIDS.

Smallness

The implementation of sustainable SWM in SIDS is constrained by their small land mass and low technical capacity. SIDS are disproportionately exposed to the accumulation of waste when considering their consumption levels and population size.[215] The rate of solid waste generation in SIDS is high and aggravated by heavy packaging materials from imports and cruise ship offloading. The large number of annual tourist visits to some of the islands accounted for an average of 2.3 kg of waste per person per day in 2019, which was 48 per cent more than the average waste generation rate in member countries of the Organisation for Economic Co-operation and Development (OECD) in the same year.[216] Competing land uses challenge the development of the waste management infrastructure needed to process the variety and volume of waste generated. Moreover, inadequate local technical capacity leads to the importation of SWM technologies and the sourcing of foreign experts in the construction and maintenance of SWM infrastructure, which require significant financial commitments.[217]

Furthermore, the small ports in most SIDS do not have the adequate infrastructure needed to handle the extremely high amounts of waste generated by tourism. For example, in the wider Caribbean Sea, 795,000 litres of sewage, 3.8 million litres of grey

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water, 500 litres of hazardous waste, 95,000 litres of oily bilge water and eight tons of garbage are generated in a one-week voyage on a middle-size cruise ship with 3,500 passengers.[218] These sources of acute pollution negatively impact the ocean economy and ecosystem by harming biodiversity and other natural resources.[219] Pollution also has negative health impacts for SIDS populations through the spread of infections to swimmers, through seafood consumption or the accumulation of harmful substances in the environment, which can lead to contamination.[220]

Proper SWM requires the construction and maintenance of sanitary landfills, waste collection and transfer stations, composting and recycling plants, incinerators (including waste to energy plants), as well as collection and transport infrastructure (such as wide road networks for ease of access for waste collection vehicles). Incinerators are useful to overcome land constraints, considering they can reduce the volume of solid waste by up to 90 per cent, as is being done in Bermuda.[221] Additionally, when incineration is completed in a waste to energy plant, the energy generated in the process can be used to offset some of the financial constraints of SWM in SIDS and contribute to energy resources. However, the operation of these plants requires complex control measures to capture the by-products of incineration (toxic ash and dioxins), which can make this option inconceivable in many contexts.[222] If space allows, sanitary landfills are a viable solution, provided that extensive site preparation is carried out comprising fencing, full leachate and gas control, compaction and daily cover to protect users,

the local community and the environment from contamination.[223]

In addition, given that organic waste is a significant component of solid waste in SIDS, centralized and small-scale composting facilities are promising solutions for SWM. The by-products of the composting process (biogas/methane, nutrient-rich digestate and compost) can supplement energy requirements and be used as natural fertilizer to improve agricultural outputs.[224] This technology is being used by a number of farmers in Mauritius; however, the untapped potential of this solution represents more than 700 times the amount of biogas currently produced in the country.[225]

Remoteness

In many SIDS, waste is dispersed over distant locations in small amounts, which makes waste collection and transfer difficult and expensive to operate.[226] This is further exacerbated by SIDS' low technological capacity and lack of economies of scale for waste management facilities.[227] In a bid to overcome these constraints, some islands like Puerto Rico have started exporting waste overseas.[228] Nevertheless, the remoteness of the islands brings about high shipping costs and, in some cases, high export taxes on recyclable waste.[229] Some countries' regulations on the acceptance of hazardous waste for disposal (such as lead-acid batteries) can also be restrictive for some islands.[230]

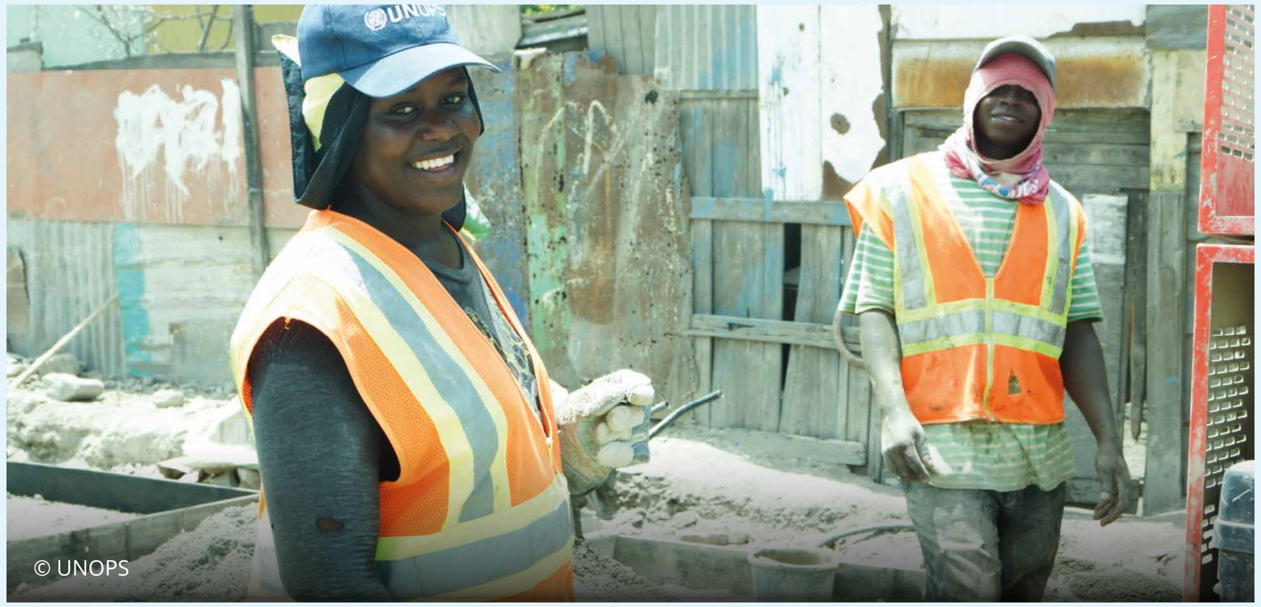
Therefore, some SIDS have started directing efforts towards domestic SWM. Examples include small-scale recycling of paper, cardboard, plastics and crushed glass in the Cook Islands, green waste composting and commercial-scale scrap metals recycling in Fiji, and an autoclaving facility in Jamaica.[231,232] Unfortunately, this covers only a small fraction of the total waste generated in these countries, and there are doubts regarding the long-term sustainability of these initiatives.[233] Moreover, small-sized domestic economies and agricultural/industrial sectors are often unable to consistently sustain high levels of material reuse, which limits local markets for recycled materials and compost products.[234] Sufficient plans for these materials are needed before countries commit significant investments to these SWM technologies.

Societal norms, especially gender roles, influence how households participate in waste management. Given women's active role in waste collection and disposal in their households, they should be involved in waste management decisions and awareness campaigns. The waste management system in Tonga improved through the participation of women's community groups in gathering waste collection fees in each village and forwarding the funds to the Waste Management Authority.[235] Increased collaboration among islands is also a promising alternative in overcoming the geographical limitations to SWM. The Moana Taka Partnership between 21 Pacific Island countries is a successful example of how collaboration can attract external funding for sustainable shipping solutions and foster public-private partnerships for the export and treatment of recyclable waste.[236]

Vulnerability to environmental threats

In 2013, it was estimated that Caribbean island nations produced 275,000 tons of daily waste that ended up in open-air dumps, local waterways or drainage channels.[237] Natural hazards tend to aggravate this situation, as the destruction of properties creates more debris beyond the capacity of landfill facilities. Shocks also damage sewer lines, which leads to raw sewage being discharged into streets. This results in a dual problem, as seen in the US Virgin Islands when Hurricanes Maria and Irma created 850,000 tons of debris and damaged the solid waste processing facilities needed to dispose of the debris.[238] Furthermore, storms and flooding events often sweep waste from open-air dumps and rivers into the sea. Littered waste also clogs drainage channels, which reduces outlets for storm water runoff, worsening the impact of rainfall events by causing flooding and pools of polluted stagnant water. These issues pose serious health risks and affect the livelihoods of low-income groups, especially those that rely on fishing.[239]

To address these challenges, infrastructure assets should be built to resilient standards, enabling them to withstand shocks. This can prevent hazard events from creating debris and alleviate pressure on SWM infrastructure. In addition, it is important that SWM facilities are connected to appropriate transport infrastructure to facilitate the collection, treatment and disposal of waste. The Deglos Sanitary Landfill and Vieux Fort Waste Transfer Facility in Saint Lucia are examples of resilient SWM plants that have successfully provided services for waste collection, waste disposal, oil waste disposal and recycling for 20 years.[240] Moreover, storm surge barriers, sea dikes and seawalls can protect low-lying areas from flooding, preventing the flow of waste into the sea.[241] Similarly, windbreaks can help reduce the amount of waste in landfills being blown into drainage systems and water bodies.



Rehabilitation of Riverton Road in Jamaica

Country: Jamaica

Partners: Governments of Jamaica and Mexico

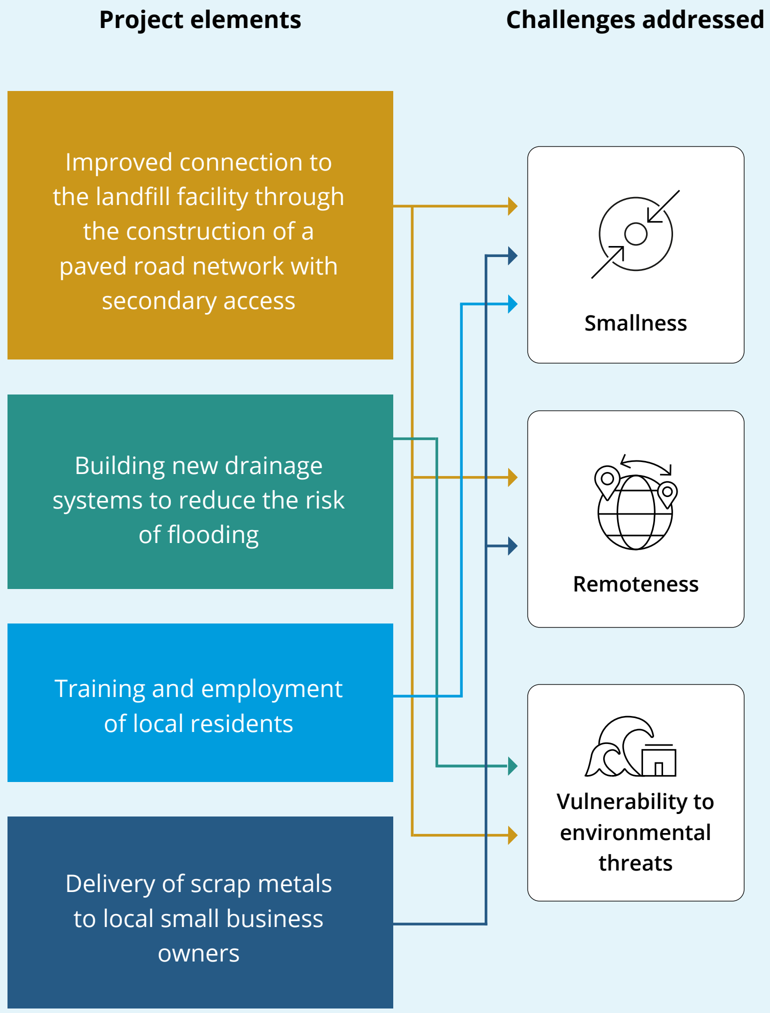
Duration: 2015–2016

UNOPS supported the government of Jamaica in addressing challenges related to poor road conditions and drainage systems that hindered effective solid waste management. UNOPS designed and constructed roads to improve connections from the developed urban centre of Kingston to the largest landfill facility in the country. Improving overall connectivity directly supported the achievement of SDG 11, as the improved waste management system reduces the adverse environmental impact from activities in urban areas.

The road network also included a functioning drainage system with connections to existing canals and a secondary access road to facilitate evacuation during emergencies. These features enhanced the country's resilience to climate shocks and also supported the achievement of SDG 14 by reducing the risk of marine pollution during floods.

Improved connection to the landfill site also enabled the delivery of scrap metals to local business owners for income generating activities. This circumvents the high costs of shipping recyclables overseas and supports the development of a local recycling trade in the small market of Jamaica. It also contributed to the attainment of SDG 12 by reducing waste generation through recycling.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Jamaica's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Buildings

For the purpose of the present analysis, 'buildings' refers to several types of single infrastructure assets that support the delivery of public services. These include hospitals, schools, industrial facilities, community centres and government buildings. The services delivered by buildings are critical to the achievement of sustainable development. These services include but are not limited to education, healthcare and the rule of law. Inclusive infrastructure can also facilitate vulnerable and marginalized groups' access to core services. Accordingly, non-networked infrastructure can influence 80 per cent of all SDG targets.[242] In the context of SIDS, the construction, operation and maintenance of buildings face particular challenges related to the size of the domestic markets, shortage of construction materials and vulnerability to environmental hazards. This section explores the challenges and opportunities related to the buildings sector in SIDS.

Smallness

Several SIDS have gaps in core non-networked infrastructure services due to the small size of their domestic markets, which reduces the scope of revenue generating activities and challenges infrastructure development financing. In addition, as explored in the previous sections, the lack of services provided by networked systems (e.g., electricity, water and wastewater) also limits the functioning of buildings located in smaller areas, contributing to the gap in non-networked infrastructure service provision. Consequently, some SIDS experience shortfalls in critical infrastructure services such as healthcare and increasingly rely on international medical travel, an industry that is volatile to external shocks.[243,vi] SIDS that are made up of several small islands also struggle to provide public services in smaller and remote locations, where infrastructure development costs are even more prohibitive. For example, while several of the smaller islands that make up the Turks and Caicos Islands lack pharmacies, police stations and magistrate courts, these services are available on larger islands such as Grand Turk and Providenciales.[244,245]

Education services are also constrained by a small student population, particularly in tertiary and vocational education. As a result, most SIDS have few or no nationally-based universities as well as technical and vocational education and training facilities.[246, 247] Due to this, many students opt for tertiary education in regional institutions or abroad and stay there to work after obtaining their degrees. Consequently, a university graduate from SIDS is nearly four times more likely to emigrate from his or her country when compared to a graduate from an LDC.[248] This has reduced the pool of experts and professionals in SIDS, which hinders service provision, innovation and competitiveness.

Investments in building upgrades can help SIDS overcome the shortage of networked infrastructure systems by enabling the use of existing structures to provide additional services. On-site energy and water generation, for instance, may offset the gaps in service provision from networked infrastructure systems and enable buildings to operate in a sustainable way. The provision of separate sanitation facilities for women and men can also promote access and use of the building infrastructure by women and girls. In the sparsely populated Ragged Island in southern Bahamas, reconstruction efforts (in response to the destruction caused by Hurricane Irma) prompted the upgrade of public buildings. These upgrades involved the installation of solar panels on the rooftops of buildings such as the Anatol Rodgers High School and the Thomas A. Robinson National Stadium.[249] The energy produced by these systems feeds into a national grid, enabling not only the educational services of the buildings but also the local provision of reliable and affordable electricity.[250]

Moreover, coordination among islands can be effective in meeting infrastructure deficits in areas that are hindered by a lack of economies of scale due to SIDS' small populations. The University of the West Indies, for example, is a result of cooperation among English speaking countries in the Caribbean to provide quality education services within the region, overcoming the limitations imposed by small domestic markets. The university has principal campuses in Antigua and Barbuda, Barbados, Jamaica, and Trinidad and Tobago, which improves access to tertiary education for students from the islands and creates economies of scale.[251]

Remoteness

The unavailability of adequate construction materials is a challenge to the construction and maintenance of buildings in SIDS. For example, construction aggregates in Pacific Islands are almost entirely made up of reef carbonates, with more than 50 to 70 per cent coral gravel, skeletal sands and sea salts, which results in poor engineering properties.[252] This leads to the importation of construction materials despite the associated higher costs due to the islands' remoteness.[253] To offset these costs, some islanders engage in illegal sand mining from beaches and river beds for local supply, thus exacerbating coastal erosion.[254]

The development of local industries in mineral-rich SIDS may prevent illegal sand mining and coastal erosion while also generating revenue. An initiative by the African, Caribbean and Pacific Group of States (ACP), the ACP-EU Development Minerals Programme, aims to promote this change. For instance, estimates indicate that Jamaica could generate up to $7 billion annually through increased production of limestone and its value-added items for the local and export markets.[255] This would boost the country's domestic economy, create employment opportunities and reduce dependence on imports.

Changes in infrastructure design and construction practices can also promote the replacement of imported construction supplies with locally manufactured (e.g., lime or cement stabilized soil/sand blocks) or locally sourced materials (e.g., sand, limestone/coral, bamboo and wood). When grounded on sustainable practices and the appropriate codes and standards, these changes can contribute to the local economy and communities' resilience.[256] The government of Mauritius, for instance, successfully eliminated beach sand mining by partnering with construction companies to develop an alternative basalt rock sand industry. This initiative was implemented along with a total ban on beach sand mining, and compensation was offered to those whose livelihoods were affected by the restrictions.[257]

Vulnerability to environmental threats

An estimated 90 per cent of disasters in the world are water-related; as a result, areas along the coastline in SIDS are highly susceptible to the most common types of hazard.[258] Despite this, many SIDS construct buildings and other supporting infrastructure along the coast. For example, 80 per cent of the built environment in Seychelles and 90 per cent in Dominica are located on the coast.[259] Consequently, environmental hazards have catastrophic impacts on exposed buildings, contributing to the loss of lives and livelihoods in SIDS. For instance, Hurricane Dorian, which struck the Bahamas in 2019, caused severe damage to about 21,000 houses. Roofs were removed, and walls collapsed in shops, hotels and other commercial buildings. Schools and hospitals were flooded, and police stations and churches also suffered structural damages.[260]

These events reveal the failures of poor infrastructure development, which, rather than preserving lives and livelihoods, added to significant damage costs. Many buildings are deficient with respect to structural, non-structural and functional safety, which hampers their resilience to climate-induced pressures and other shocks and affects their ability to provide services when they are needed the most.[261] As a consequence, human casualties increase pressure on fragile hospitals and community health centres.

To address these issues, the Global Facility for Disaster Reduction and Recovery established the Small Island States Resilience Initiative to enable knowledge sharing among islands on institutional, operational and technical aspects of building resilience in SIDS. Following the creation of this initiative, and as part of a safer schools programme, Tonga adopted building codes that can withstand wind conditions of category 3 to 5 storms. This initiative also assessed the effectiveness of building codes to localized tsunami models, with a plan to extend the assessments to all hazard types.[262] Measures to enforce adherence to building codes can further contribute to enhancing infrastructure resilience in SIDS.

In addition, the Pan American Health Organization launched the SMART Hospital Initiative in the Caribbean region to ensure hospitals continue to function during disasters.[263] Resilience is built into the structural and operational aspects of these hospitals by incorporating features such as deep foundations, steeply pitched roofs, hurricane shutters, sunshades, wall insulation, thermal bridge breaking frames, auxiliary downpipes and flood levees coupled with green technologies like solar heaters.[264] Moreover, properly designed and constructed protective structures, such as tetrapods, can safeguard buildings located in coastal areas. Albeit expensive, this solution can protect buildings from the impact of flooding and large waves, ultimately protecting development gains in the long-term.[265]

vi. Based on an analysis of 14 SIDS.

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A new parliament to support democracy in Grenada

Country: Grenada

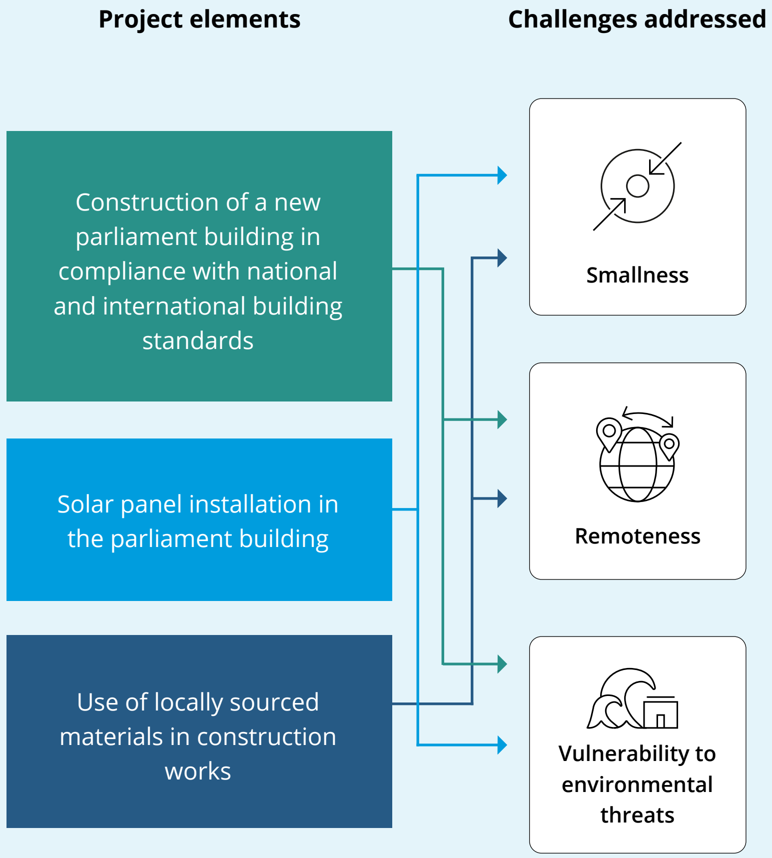
Partners: Governments of Australia, Grenada, Mexico and the United Arab Emirates

Duration: 2016–2018

In an effort to rebuild Grenada's House of Parliament, destroyed by Hurricane Ivan in 2004, UNOPS provided technical support to the national government, including design reviews, due-diligence activities and project management oversight. The new parliament building was designed and constructed to the highest international standards and in compliance with national wind and earthquake standards. These measures ensure the new structure will withstand the impacts of future climatic events and save costs associated with post-hazard reconstruction. The building design also increases access for vulnerable groups such as people with disabilities. The resilience and accessibility of public buildings are critical to the exercise of participatory democracy in Grenada, supporting the achievement of SDGs 5 and 16.

Green building considerations were also included in the project design, such as the installation of solar panels for energy generation and the use of locally sourced materials. Decentralized electricity supply from solar panels prevents disruptions in operations during and after hazards and contributes to the development of a local renewable energy market in Grenada. Using locally sourced materials benefited the domestic market and circumvented the high importation and transportation costs of bringing foreign materials to the country. The use of local materials in public buildings also contributes to making Grenada's capital more sustainable, supporting the achievement of SDG 11.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Grenada's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Cross-cutting approaches for long-term benefits

As previously explored, investments in infrastructure systems can support SIDS in overcoming the challenges they face and facilitate their progress towards the achievement of the SDGs. Infrastructure development should take into account SIDS' individual contexts, vulnerabilities and needs as well as international best practices. This section outlines key cross-cutting approaches to be considered, in order to facilitate successful infrastructure investments.

Integrated planning

Given the complementary nature of infrastructure systems, infrastructure projects should not be planned in isolation. Infrastructure planning should take into consideration the way infrastructure systems influence each other and the opportunities this presents to optimize resource allocation and stakeholder benefits. Presently, a common approach to infrastructure development in SIDS is the implementation of projects by government ministries based on their individual annual targets. This silo-based approach prioritizes immediate results over long-term strategic infrastructure planning, even if the latter yields more robust and efficient outcomes.

By shifting the focus to integrated planning, SIDS can develop comprehensive national infrastructure plans that take into account the life cycle of assets and the ways in which systems influence each other. This approach, coupled with a long-term view (beyond annual or political cycles), can foster significant development outcomes and lead to a more equitable society. For example, mainstreaming gender throughout the infrastructure life cycle ensures the individual needs of women, men, girls and boys are adequately met. In addition, spatial planning is a key element of infrastructure development in SIDS, given their unique exposure to environmental hazards and seismic events. Spatial planning entails hazard mapping and vulnerability assessments of the built environment to promote evidence-based decisions. Integrated infrastructure planning and front-loading spatial planning could guide the implementation of more strategic and sustainable infrastructure projects, which can lead to long-lasting and far-reaching development impacts.

Improved standards and enforcement mechanisms

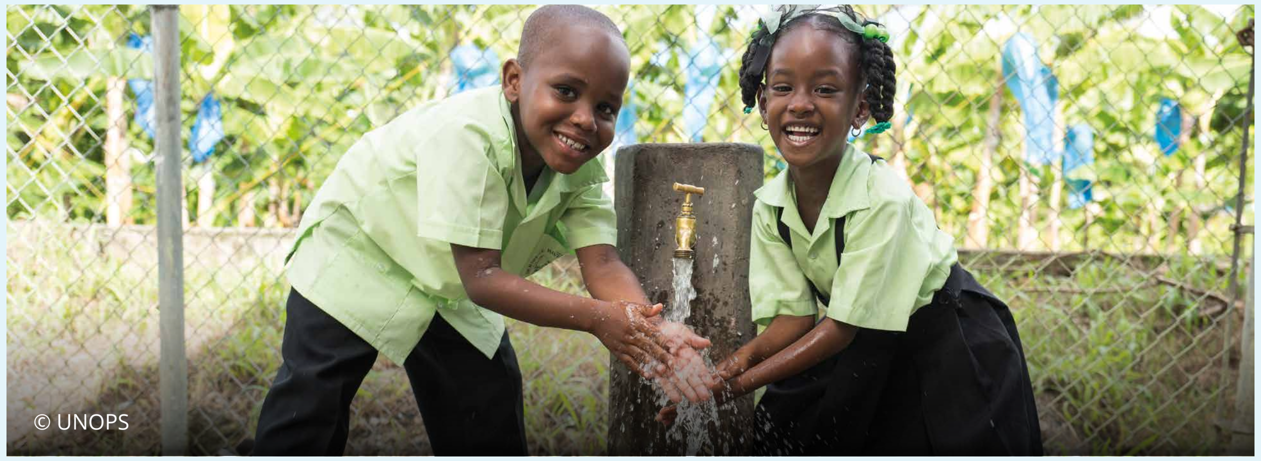
SIDS should ensure the adoption of appropriate international standards and enforcement mechanisms related to infrastructure sustainability and resilience. These standards should be adapted to the specific context in every country and be consistently applied throughout the infrastructure life cycle. This will help mitigate economic and social losses associated with hazard events and curb asset vulnerability in SIDS. The use of standardized technical information, criteria and processes, including frameworks for implementation and enforcement, should guide the design of new infrastructure.

Mechanisms that ensure codes and standards related to all hazard types are systematically applied should be put in place. Institutionalizing these processes will allow SIDS governments to incorporate resilience into infrastructure systems, helping them to anticipate, absorb, adapt to and recover from shocks and stresses and to employ sustainable practices (e.g., use of locally sourced materials). This will ultimately protect populations and economies and secure development gains.[266]

Inter-island cooperation

Collaborative efforts among SIDS increase access to human and financial resources, which can lead to improved infrastructure development. Joint initiatives such as the pooling of technical experts across islands can foster knowledge sharing and innovative approaches to infrastructure development. This is also a cost- and time-effective way to improve the replicability of successful projects on various islands. From a donor perspective, coordination among islands can reduce barriers to the allocation of greater volumes of assistance through the promotion of joint infrastructure investments (or coordination of development aid) in specific locations.[267]

Inter-island cooperation can also lead to economic benefits such as increasing economies of scale, resulting in higher export volumes and competitiveness of SIDS in international markets.[268] To date, collaboration among SIDS governments has produced significant benefits during post-disaster relief efforts and, increasingly, international trade. Expanding the scope of their cooperation to progressively encompass infrastructure development may reduce dependence on foreign countries in the long run and advance the achievement of sustainable development in SIDS.



Fostering evidence-based infrastructure in Saint Lucia

Country: Saint Lucia

Partners: Government of Saint Lucia and the University of Oxford (ITRC-Mistral)

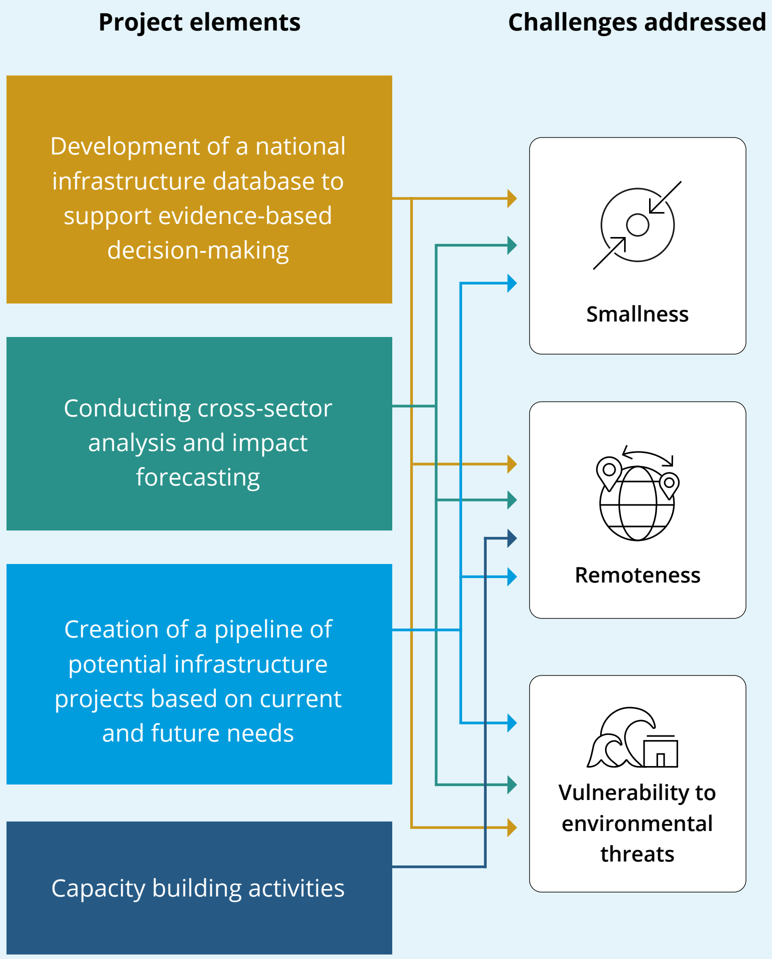
Duration: 2018–2020

UNOPS supported the government of Saint Lucia in implementing its National Vision Plan by increasing the availability of national Infrastructure data and enhancing technical capacity within the government. UNOPS and collaborating partners performed extensive data collection on the status and performance of Saint Lucia's national infrastructure. This data was stored in a government database, and capacity building activities were conducted to enhance the government's ability to manage the database. Capacity building helps reduce the country's dependence on foreign experts who are difficult to attract and retain due to Saint Lucia's distance from international knowledge centers.

The database further enables evidence-based decisions on effective land use, helping prevent land competition on the small island. It also guides decisions on resilient infrastructure development, ultimately protecting communities and avoiding the high costs of reconstruction. Reducing communities' exposure to climate shocks supports the achievement of SDG 1 by enabling long-term access to essential services and supporting economic resilience.

UNOPS also performed infrastructure cross-sectoral analysis and impact forecasting. Based on this information, UNOPS provided targeted recommendations and identified a pipeline of potential projects to address the country's infrastructure needs, with a particular focus on climate adaptation. Integrating climate change measures into Saint Lucia's national planning is a direct contribution to the country's attainment of SDG 13. It also encourages the sustainable management and conservation of Saint Lucia's marine and land resources, positively impacting SDGs 14 and 15.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed Saint Lucia's challenges and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Protecting communities in Saint Vincent and the Grenadines from hazards

Country: Saint Vincent and the Grenadines

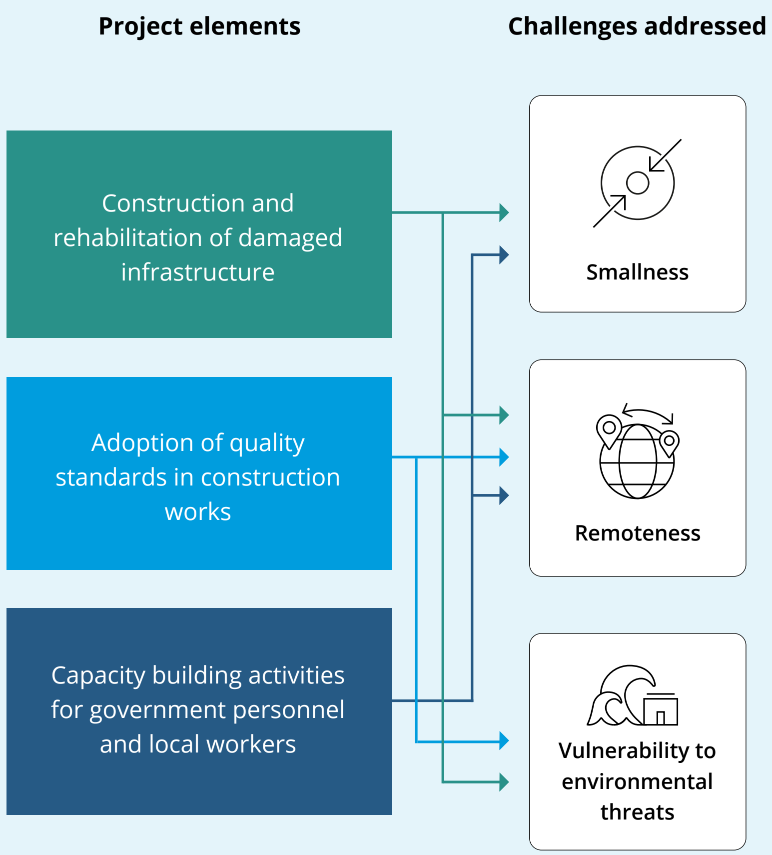
Partners: Governments of Mexico and Saint Vincent and the Grenadines

Duration: 2016–2019

In response to the destruction caused by a 2013 tropical storm, UNOPS supported climate change adaptation efforts in Saint Vincent and the Grenadines. This included the construction and rehabilitation of damaged infrastructure, including bridges, roads and a river defence system. The adoption of quality standards in infrastructure works enhanced assets' resilience to environmental shocks, protecting communities and avoiding future high costs of post-disaster reconstruction. Developing quality and resilient infrastructure to support the well-being of residents contributes to the achievement of SDG 9. Moreover, resilient infrastructure also enables long-term access to services, markets and employment opportunities, contributing to inclusive economic growth and the achievement of SDG 8.

UNOPS worked closely with national authorities to include technical specifications and normative standards in the project design. Government personnel benefited from capacity building activities on the design process to ensure that technical specifications and standards are included in future infrastructure projects and reduce national reliance on foreign experts, who are difficult to attract and retain. Finally, local workers engaged in infrastructure works received training on resilient construction principles, which increased the pool of skilled labour in the small domestic market of Saint Vincent. Capacity building activities also supported the country's achievement of SDG 4 by increasing the number of adults who have relevant skills for employment and decent jobs.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed the challenges faced by Saint Vincent and the Grenadines and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Strengthening the Caribbean's health landscape

Country: Trinidad and Tobago

Partners: Caribbean Public Health Agency (CARPHA), Pan American Health Organization and the government of Trinidad and Tobago

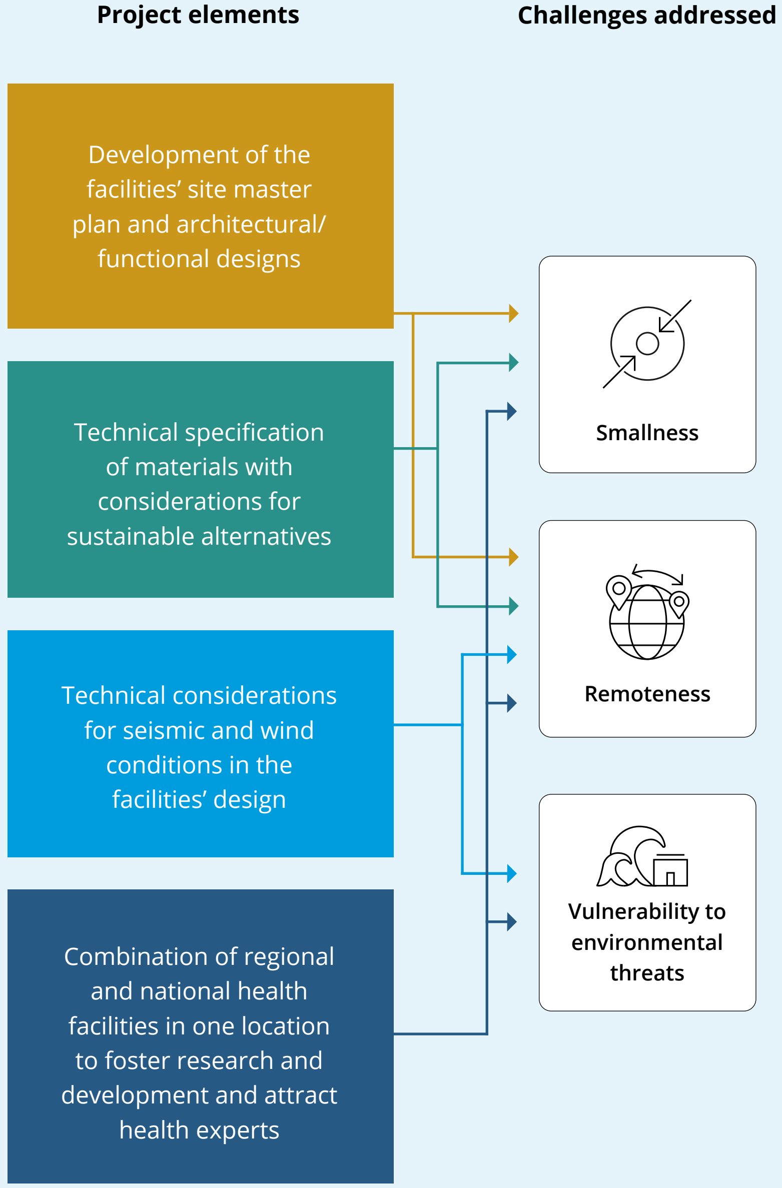
Duration: 2018 - 2020

To strengthen regional and national healthcare services in Trinidad and Tobago, UNOPS supported the development of a regional public health facility that will also host CARPHA laboratories. Following design studies, UNOPS developed the site master plan as well as architectural and functional designs for the facilities. Technical considerations for seismic and wind conditions were included in the building designs to ensure its resilience to environmental shocks and circumvent the potential costs of infrastructure reconstruction.

Resilient infrastructure promotes long-term access to healthcare services and related technology, supporting the attainment of SDG 1. Sustainability considerations were also incorporated in material specifications for the facilities, for example by including the use of locally sourced materials. Using locally sourced materials fosters economic activity in the small domestic market of Trinidad and Tobago and circumvents the high importation and transportation costs of bringing foreign materials to the country.

Finally, establishing national and CARPHA facilities in one location strengthens the region's healthcare sector by helping attract experts and fostering research and development. This enhances the regional capacity to implement joint health interventions, which is particularly beneficial to smaller islands that rely on limited technical capacity. It also contributes to the country's achievement of SDGs 3 and 17 by promoting international cooperation in science through healthcare research and development.

The diagram shows the links between the project elements, the challenges faced by SIDS and the SDG co-benefits. It indicates how project elements addressed the challenges faced by Trinidad and Tobago and supported the country's progress towards achieving the 2030 Agenda.



SDG co-benefits

Conclusion

Despite their significant improvements in climate change adaptation, disaster preparedness, environmental protection and socio-economic development, SIDS remain vulnerable to climate change impacts and are constrained by often underperforming infrastructure systems. With the increase of infrastructure stressors, such as more frequent extreme weather events, the implementation of sustainable, resilient and inclusive infrastructure systems is a priority in the development agendas for SIDS. As SIDS and global initiatives set targets to reduce carbon emissions and embark on awareness campaigns to encourage change in harmful human behaviour, **it is crucial that the implementation of sustainable, resilient and inclusive infrastructure is equally championed.** Improved transportation networks, electrification from renewable energy, digital communications infrastructure, freshwater supply, wastewater treatment, solid waste management and safer buildings can help SIDS overcome their geographical constraints and environmental vulnerabilities. This will not only build their capacity to achieve their sustainable development targets but also protect their populations and development gains against natural and anthropogenic hazards.

In view of the projected economic downturn caused by the immediate effects of COVID-19 on tourism, international remittances and supply chains, on which SIDS rely, the effective allocation of infrastructure investments becomes more critical than ever. The implementation of 'silo-based' infrastructure projects needs to be re-examined and challenged to ensure investment of limited funds into infrastructure systems that yield long-term gains.

In addition, poor infrastructure can reinforce inequitable conditions for women, girls and vulnerable and marginalized groups. The challenges SIDS face affect women, girls, men and boys in different ways, therefore, it is critical that infrastructure solutions be gender-responsive and consider the individual needs of all. This will avoid the development of gender-blind infrastructure that limits women's and girls' access to basic services and leaves them more vulnerable to the impacts of climate change. Gender-responsive infrastructure can only be achieved through women's participation in infrastructure development at all stages. As previous UNOPS research indicates:

"[...] increasing the employment opportunities for women in the infrastructure sector can support the development of gender-responsive infrastructure that meets the needs of all end users. In addition, due to their traditional role as educators in both the household and the community, women can act as changemakers by teaching new generations how to live more sustainably, for example, by recycling waste and adapting to climate change."[269]

In an effort to contribute to an inclusive and holistic approach to infrastructure development, this publication investigated three main challenges that hinder sustainable development in SIDS – smallness, remoteness and vulnerability to environmental threats. In spite of these challenges, the distinct geographic location and natural resources of SIDS provide significant development opportunities. Through a sectoral analysis, this paper sought to identify sector-specific challenges and opportunities to improve the provision of infrastructure services in SIDS, based on examples of successful case studies. Drawing from the findings of this research, UNOPS proposes key cross-cutting approaches to take into consideration to ensure that infrastructure investments result in lasting benefits.

In view of its experience in sustainable, resilient and inclusive infrastructure development, UNOPS is well positioned to provide technical assistance and support in the planning, delivery and management of infrastructure in SIDS. The successful implementation of infrastructure projects, as well as the provision of strategic and technical advisory services to governments of SIDS, reflects UNOPS ability to adapt its approach to infrastructure development to support governments and communities on their unique path toward sustainable, resilient and inclusive development. SIDS demonstrate encouraging leadership in the frontline of climate change mitigation and adaptation, and UNOPS remains committed to helping build the foundations they need to achieve peace and sustainable development.

UNOPS supports sustainable, resilient and inclusive development in SIDS

With a mandate in infrastructure and over 25 years of experience in project implementation in developing countries, UNOPS is committed to supporting SIDS in achieving the 2030 Agenda. Considering that networked and non-networked infrastructure systems impact the achievement of up to 92 per cent of all SDG targets, UNOPS track record in the development of transport, energy, digital communications, water, wastewater, solid waste management, civic, education and health infrastructure makes it a valuable partner for SIDS governments seeking to achieve the SDGs. Figure 5 shows the percentage of infrastructure expenditure in 2019 for different sectors.

Beyond its influence on the achievement of SDG targets, infrastructure plays a vital role in the attainment of other strategic agendas for SIDS, such as the Sendai Framework for Disaster Risk Reduction and the Paris Agreement. Furthermore, as extensively explored in the previous sections, SIDS face unique infrastructure challenges that make their populations increasingly vulnerable to environmental hazards. This situation calls for immediate action based on a holistic and evidence-based approach to the planning, delivery and management of national infrastructure.

It is both this need and opportunity that drive UNOPS to support its partners in the design and construction of infrastructure as well as to provide technical and strategic assistance in the planning, delivery and management of infrastructure solutions in SIDS. In addition, UNOPS seeks to contribute to research and knowledge on the role of infrastructure in the fulfilment of global agendas in SIDS.

Figure 5: UNOPS Infrastructure expenditure by thematic sector in 2019*

*Thematic sectors based on the OECD Development Assistance Committee framework for classifying the specific area of the recipient's economic or social structure the activity is intended to foster.

Infrastructure delivery

UNOPS supports governments in the construction of sustainable, resilient and inclusive infrastructure assets while ensuring carbon emissions are minimized. When planning and implementing these projects, UNOPS makes use of the highest international standards and global best practices in project management. This includes UNOPS project management methodology and manuals as well as a series of corporate guidelines on construction supervision, site logistics and gender mainstreaming in projects, among others. These resources guide project teams in the implementation of projects within cost, scope and schedule while meeting quality requirements that deliver sustainable results to communities. Furthermore, as a development-oriented organization, UNOPS incorporates the needs of marginalized and vulnerable groups throughout all stages of project management. This approach ensures that communities are engaged in infrastructure projects, which supports livelihoods and enhances local adaptive capacity, thus reducing vulnerability to climate shocks and stresses.

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Technical assistance

Beyond the delivery of infrastructure projects, UNOPS supports governments in strengthening their infrastructure planning, implementation and management by encouraging an approach based on evidence and transparent business cases. UNOPS has developed an evidence-based infrastructure initiative that supports best practice approaches, providing systems and tools to assist countries in aligning their infrastructure processes with global development agendas, including methodologies to help protect their populations from environmental hazards:

- **Capacity assessment:** UNOPS supports countries in improving their infrastructure development by identifying gaps in their capacity to plan, deliver and manage (i.e., operate, maintain and decommission) their infrastructure systems. Using its capacity assessment methodology and tool (the Capacity Assessment Tool for Infrastructure – CAT-I), UNOPS is able to issue recommendations on governance challenges, which, for instance, may lead to better adaptation planning to protect SIDS populations from environmental hazards. In the particular context of SIDS, capacity assessments can help governments identify and address gaps in quality control and regulatory capacity, which is critical to enable service provision in remote areas.

- **Upstream planning:** In partnership with the University of Oxford, UNOPS can help decision-makers evaluate the performance of existing and future infrastructure systems. This allows governments to understand their infrastructure needs and develop strategies to meet those needs in alignment with international commitments like the Paris Agreement and SDGs. Central to this is the planning of projects and policies to meet capacity requirements. The support provided by UNOPS

also includes the identification of infrastructure's system-wide vulnerabilities to environmental hazards and where adaptation options can be prioritized to optimally build resilience. In doing so, governments can ensure the continuity of public service provision in the long-term, while also planning ways of granting access to public services to communities living in remote islands.

In Curaçao, UNOPS supported the long-term strategic planning of the energy, water, wastewater and solid waste sectors, combined with risk and resilience planning for the country's transportation and non-networked infrastructure. This was enabled by the use of a long-term infrastructure planning model (the National Infrastructure Systems Model – NISMOD) that accounted for the current state of infrastructure service provision in Curaçao and forecasted future infrastructure demands (based on national projections and identified trends for each sector). The model examined moderate and extreme scenarios based on the likelihood of identified shocks and stresses against Curaçao's infrastructure. This information enables the government of Curaçao to make evidence-based decisions for future infrastructure development and prioritize the appropriate risk reduction initiatives to protect its population and economy.

- **Asset assessment:** With extensive experience gained through thousands of infrastructure projects, UNOPS can help governments assess specific infrastructure assets to better understand their current holdings, associated performance and use. Based on identified risks, UNOPS provides recommendations on improvement measures to ensure that assets will be able to withstand environmental shocks, improve their operational performance and enable long-term access to public services. This work can feed into the development of wider asset management systems.

In Haiti, UNOPS supported the Ministry of Public Works to conduct assessments of building damage and repairs, following the 2010 earthquake. Over 400,000 buildings were assessed by teams of local UNOPS engineers. The collected information was stored in a national database, which was used to inform the government's decision-making on short-term emergency response activities as well as long-term decisions regarding strategic urban planning initiatives for resettlement and infrastructure development. The asset assessment database was later used to develop a technology programme that, based on detailed repair assessments, calculates the quantities of materials necessary for repair works.

Investing in sustainable, resilient and inclusive infrastructure is vital to improve the living standards of SIDS populations and provide safeguards against extreme weather events. UNOPS teams of qualified advisors, architects, engineers, project managers and specialists bring knowledge of industry best practices to help partners with their infrastructure needs. Using an evidence-based approach to inform decision-making, UNOPS remains committed to supporting sustainable, resilient and inclusive development in SIDS to meet the needs of the present generation and those to come.

End notes

1. UN Department of Global Communications, 'Samoa Pathway High-Level Midterm Review 2019', United Nations High-level Week, New York, 21–27 September 2019.

2. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers*, UN-OHRLLS, New York, 2015, p. 6.

3. Watson, Charlene, et al., 'Climate Finance Briefing: Small Island Developing States', Heinrich Böll Stiftung Foundation, Berlin, November 2016, p. 1.

4. Diez, S.M., et al., *Marine Pollution in the Caribbean: Not a Minute to Waste*, World Bank Group, Washington, D.C., 2019, p. 19.

5. United Nations Conference on Trade and Development, 'WIR – Foreign Direct Investment to the most vulnerable countries remains fragile, says United Nations Report', Press release, UNCTAD Communications and Information Unit, Geneva, Switzerland, 6 June 2018, <https://unctad.org/en/pages/PressRelease.aspx?OriginalVersionID=463>, accessed 25 February 2020.

6. The World Bank, 'Net official development assistance received (current US$) - Pacific island small states, Caribbean small states, Cabo Verde, Comoros, Guinea-Bissau, Maldives, Sao Tome and Principe, Seychelles, Mauritius, Papua New Guinea, Timor-Leste, Dominican Republic, Cuba, Haiti', <https://data.worldbank.org/indicator/DT.ODA.ODAT.CD?locations=S2-S3-CV-KM-GW-MV-ST-SC-MU-PG-TL-DO-CU-HT>, accessed 25 February 2020.

7. International Monetary Fund, *Small States' Resilience To Natural Disasters And Climate Change—Role for the IMF*, IMF, Washington, D.C., pp. 8, 11–12.

8. Ibid., pp. 8, 11–12.

9. Keating, Joshua, 'The sinking state: This is what happens when climate change forces an entire country to seek higher ground', *The Washington Post*, 26 July 2018.

10. Merchant, Brian, 'First Official Climate Change Refugees Evacuate Their Island Homes for Good', Earth First! Journal, 6 April 2014, <https://earthfirstjournal.org/newswire/2014/04/06/first-official-climate-change-refugees-evacuate-their-island-homes-for-good>, accessed 26 August 2020.

11. Vidal, John, 'We need development': Maldives switches focus from climate threat to mass tourism', *The Guardian*, 3 March 2017.

12. Dauenhauer, Nenad Jarić, 'On front line of climate change as Maldives fights rising seas', *NewScientist*, 20 March 2017, <www.newscientist.com/article/2125198-on-front-line-of-climate-change-as-maldives-fights-rising-seas>, accessed 26 August 2020.

13. Bortolato, Antonella, 'Gender Equality in Small Island Developing States', *UNESCO Working Papers on Gender Equality*, Division for Gender Equality, United Nations Educational, Scientific and Cultural Organization, France, p. 6.

14. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, 'World's most vulnerable countries lack the capacity to respond to a global pandemic', UN-OHRLLS, <http://unohrlls.org/covid-19>, accessed 30 June 2020.

15. Coke-Hamilton, Pamela, 'Impact of COVID-19 on tourism in small island developing states', United Nations Conference for Trade and Development, 24 April 2020, <https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2341>, accessed 17 September 2020.

16. World Tourism Organization, 'Tourism in Small Island Developing States (SIDS): Building a more sustainable future for the people of Islands', UNWTO, Madrid, 2014.

17. Zarrilli, Simonetta, and Nursel Aydiner-Avsar, 'COVID-19 puts women working in SIDS tourism industry at risk', 13 May 2020, <https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2370>, accessed 14 September 2020.

18. Thacker S, Adshead D, Morgan G, Crosskey S, Bajpai A, Ceppi P, Hall JW & O'Regan N., *Infrastructure: Underpinning Sustainable Development*, UNOPS, Copenhagen, Denmark, p. 41.

19. Resolution adopted by the United Nations General Assembly, *'SIDS Accelerated Modalities of Action (SAMOA) Pathway'*, A/RES/69/15,14 November 2014, pp. 5, 6, 16, 17.

20. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, 'About SIDS: Country Profiles', UN-OHRLLS, <http://unohrlls.org/about-sids/country-profiles>, accessed 11 March 2020.

21. United Nations Conference on Trade and Development, 'UNCTAD's Unofficial List of SIDS', UNCTAD, <https://unctad.org/en/pages/aldc/Smallper cent20Islandper cent20Developingper cent20States/UNCTADper centC2per centB4s-unofficial-list-of-SIDS.aspx>, accessed 10 October 2019.

22. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, 'About the Small Island Developing States', UN-OHRLLS, <http://unohrlls.org/about-sids>, accessed 1 July 2020.

23. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, 'Small Island Developing States (SIDS) Statistics', UN-OHRLLS, New York, 2013, p. 4.

24. United Nations Conference on Trade and Development, 'Data: National accounts – Gross domestic product: Total and per capita, growth rates, annual', UNCTAD, <https://unctadstat.unctad.org/wds>, accessed 1 July 2020.

25. United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, *Small Island Developing States in Numbers*, UN-OHRLLS, New York, 2015, p. 12.

26. Diez et al., *Marine Pollution in the Caribbean*, p. 14.

27. Division for Sustainable Development Goals, 'BPOA (1994) - Barbados Programme of Action', United Nations Department of Economic and Social Affairs, <https://sustainabledevelopment.un.org/conferences/bpoa1994>, accessed 25 February 2020.

28. Division for Sustainable Development Goals, 'MSI (2005): Mauritius Strategy of Implementation', United Nations Department of Economic and Social Affairs, <https://sustainabledevelopment.un.org/conferences/msi2005>, accessed 25 February 2020.

29. United Nations Small Island Developing States Action Platform, 'New Partnerships & Progress Reports', <https://sidspartnerships.un.org/partnerships>, accessed 21 January 2020.

30. Department of Economic and Social Affairs Division for Sustainable Development, *Trends In Sustainable Development: Small Island Developing States*, United Nations, New York, 2010, p. 13.

31. United Nations Treaty Collection, 'Paris Agreement', UNTC, <https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en>, accessed 9 April 2020.

32. The Republic of the Marshall Islands, 'Intended Nationally Determined Contribution', Communication to the UNFCCC, Marshall Islands, 22 November 2018, pp. 7, 21, 39.

33. Wehner, Stefan, et al., 'Achieving 100% Renewable Energies for Small Island Developing States', Policy Brief 11/2017, the greenwerk. GbR, Hamburg, November 2017, p. 10.

34. Ibid., p. 8.

35. United Nations Conference on Trade and Development, *Closing the Distance: Partnerships for Sustainable and Resilient Transport Systems in SIDS*, United Nations, New York and Geneva, 2014, p. 52.

36. Li, Meng, and David Le Blanc, *Financing for Sustainable Development in Small Island Developing States (SIDS)*, United Nations Department of Economic and Social Affairs, New York, September 2013, p. 10.

37. Organisation for Economic Co-operation and Development, *Development Co-operation Report 2018: Joining Forces to Leave No One Behind*, OECD Publishing, Paris, 11 December 2018, pp. 267–269.

38. Ibid., p. 278.

39. Li and Le Blanc, *Financing for Sustainable Development*, p. 11.

40. Organisation for Economic Co-operation and Development and The World Bank, *Climate and Disaster Resilience Financing in Small Island Developing States*, OECD Publishing, Paris, 10 November 2016, p. 47.

41. Ibid.

42. Watson, Charlene, and Liane Schalatek, *'Climate Finance Briefing: Small Island Developing States'*, Heinrich Böll Stiftung Foundation, Berlin, Germany, February 2019, p. 3.

43. Ibid.

44. Hurley, Gail, *Financing for Development and Small Island Developing States: A Snapshot and Ways Forward*, United Nations Development Programme and United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States, New York, June 2015, p. 29.

45. International Monetary Fund, 'Pacific Islands Threatened by COVID-19', IMF, 27 May 2020, <www.imf.org/en/News/Articles/2020/05/27/na-05272020-pacific-islands-threatened-by-covid-19>, accessed 12 June 2020.

46. Akhtar, Shamshad, Hongjoo Hahm and Hamza Ali Malik, *Asia-Pacific Countries with Special Needs Development Report 2017: Investing in Infrastructure for an Inclusive and Sustainable Future*, United Nations Economic and Social Commission for Asia and the Pacific, Bangkok, 2017, p. 25.

47. *Closing the Distance*, p. 14.

48. Food and Agriculture Organization of the United Nations, *'Small Island Developing States Agricultural Production and Trade, Preferences and Policy'*, FAO Commodities and Trade Technical Paper 7, FAO, Rome, 2005, p. 16.

49. Gibson, John, 'Are the Pacific Island Economies Growth Failures? Geo-Political Assessments and Perspectives', Working Paper 3, Pasifika Interactions Project, Hamilton, New Zealand, January 2007, p. 2.

50. Wu, Hongbo, 'Island Voices, Global Choices', Our Planet, United Nations Environment Programme, Nairobi, September 2014, p. 19.

51. The World Bank, 'Data: Population, total - Pacific island small states, Caribbean small states, Cabo Verde, Comoros, Guinea-Bissau, Maldives, Sao Tome and Principe, Seychelles, Mauritius, Papua New Guinea, Timor-Leste, Dominican Republic, Cuba, Haiti', <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=S2-S3-CV-KM-GW-MV-ST-SC-MU-PG-TL-DO-CU-HT>, accessed 11 March 2020.

52. United Nations Environment Programme, *Emerging Issues for Small Island Developing States: Results of the UNEP/UN DESA Foresight Process*, UNEP, Nairobi, June 2014, p. 27.

53. *Closing the Distance*, p. 14.

54. World Population Review, 'Countries By Density 2020 by Population 2020', <https://worldpopulationreview.com/countries/countries-by-density/#dataTable>, accessed 11 March 2020.

55. House, William J., 'Population and Sustainable Development in Small Island Developing States: Challenges, Progress made and Outstanding Issues', Technical Paper No. 2013/4, Population Division of the United Nations Department of Economic and Social Affairs, New York, 2013, pp. 3, 12.

56. Gibson, 'Are the Pacific Island Economies Growth Failures?', p. 3.

57. Steiner, Achim, 'Reflections', Our Planet, United Nations Environment Programme, Nairobi, September 2014, p. 5.

58. *Closing the Distance*, p. 9.

59. Ibid., p. 14.

60. De la Croix, David, Frédéric Docquier and Maurice Schiff, 'Brain Drain and Economic Performance in Small Island Developing States', Discussion paper 2013-31, Institut de Recherches Économiques et Sociales de l'Université catholique de Louvain, Ottignies-Louvain-la-Neuve, Belgium, 2013, p. 126.

61. 'Small Island Developing States Agricultural Production and Trade, Preferences and Policy', p. 17.

62. International Labour Organization, 'A Study on the Future of Work in the Pacific', ILO Office for Pacific Island Countries, Fiji, May 2017, p. 5.

63. Bortolato, 'Gender Equality in Small Island Developing States', p. 6.

64. Gibson, 'Are the Pacific Island Economies Growth Failures?', p. 4.

65. United Nations Conference on Trade and Development, Review

of Maritime Transport 2014, UNCTAD, New York and Geneva, 2014, p. 110.

66. United Nations World Tourism Organization, 'Small Island Developing States (SIDS)', <www.unwto.org/sustainable-development/small-islands-developing-states>, accessed 23 March 2020.

67. Organisation for Economic Co-operation and Development and United Nations World Tourism Organization, *Aid for Trade at a Glance 2019: Economic Diversification and Empowerment*, OECD Publishing, Paris, 11 July 2019, pp. 28–29.

68. Ibid., p. 29.

69. United Nations Conference on Trade and Development, 'FDI in Small Island Developing States: Its Limitations and Potential', Special Edition No. 17, Global Investment Trends Monitor, UNCTAD, Geneva, 1 September 2014, p. 2.

70. United Nations Department of Economic and Social Affairs, *Trends In Sustainable Development: Small Island Developing States (SIDS)*, United Nations, New York, 2010, p. 20.

71. Everest-Phillips, Max, *Small, So Simple? Complexity in Small Island Developing States*, United Nations Development Programme Global Centre for Public Service Excellence, New York, October 2015, p. 8.

72. International Monetary Fund Western Hemisphere Department, 'Caribbean Small States: Challenges of High Debt and Low Growth', IMF Policy Paper, IMF, 20 February 2013, p. 11.

73. Sufrauj, Shamnaaz, 'Islandness and Remoteness as Resources: Evidence from the Tourism Performance of Small Remote Island Economies (SRIES)', European Journal of Tourism, Hospitality and Recreation, vol. 2, issue 1, Polytechnic Institute of Leiria, Portugal, 2011, p. 23.

74. Chandra, Rajesh, 'Harnessing technology for tertiary education in small island developing states (SIDS)', IIEP policy brief: tertiary education in small states, no. 3, 2011, p. 1.

75. Gheuens, Jana, Nidhi Nagabhatla and Edangodage Duminda Pradeep Perera, 'Disaster-Risk, Water Security Challenges and Strategies in Small Island Developing States (SIDS)', Water 2019, vol. 11, no. 4, MDPI, Basel, Switzerland, 27 March 2019, p. 6.

76. United Nations Conference on Trade and Development, 'Small island developing States: Challenges in transport and trade logistics', Note by the UNCTAD secretariat, 15 September 2014, paragraph 27.

77. United Nations, 'UN committed to helping Haiti build better future, says Guterres, marking 10-year anniversary of devastating earthquake', UN News, 12 January 2020, <https://news.un.org/en/story/2020/01/1055161>, accessed 7 September 2020.

78. Cavallo, Eduardo, Michael Treadway and Rita Funaro, 'The Economics of Natural Disasters', *Ideas for Development in the Americas 2010*, Vol. 22, Inter-American Development Bank Research Department, Washington, D.C., May–August 2010, pp. 4, 6.

79. Cavallo, Eduardo and Ilan Noy, 'The Economics of Natural Disasters: A Survey', IDB Working Paper Series No.124, Inter-American Development Bank, Washington, D.C., May 2010, pp. 4–6.

80. Reid, Kathryn, '2010 Haiti earthquake: Facts, FAQs, and how to help', World Vision, 25 November 2019, <www.worldvision.org/disaster-relief-news-stories/2010-haiti-earthquake-facts>, accessed 19 May 2020.

81. United Nations Economic and Social Council, 'Gender equality and the empowerment of women in natural disasters: Report of the Secretary-General', 10–21 March 2014, paragraph 25.

82. Ibid., paragraph 29.

83. Gheuens, Nagabhatla and Perera, 'Disaster-Risk, Water Security Challenges and Strategies', pp. 10–11.

84. Nurse, Leonard A., et al., 'Small Islands', ch. 29 in *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part B: Regional Aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by V.R. Barros et al., Cambridge University Press, Cambridge and New York, 2014, pp. 1613–1654.

85. Food and Agriculture Organization of the United Nations, *The impact of disasters on agriculture: Addressing the information gap*, FAO, Rome, 2017, p. 17.

86. United Nations Environment Programme, 'UNEP at Work: Green Tourism and Climate Change', Our Planet, UNEP, Nairobi, September 2014, p. 20.

87. Climate Zone, 'SIDS and their coral reefs', <https://climatezone.org/small-island-developing-states/sids-and-coral-reefs>, accessed 7 July 2020.

88. Gheuens, Nagabhatla and Perera, 'Disaster-Risk, Water Security Challenges and Strategies', p. 6.

89. Mycoo, Michelle A., 'Beyond 1.5 °C: vulnerabilities and adaptation strategies for Caribbean Small Island Developing States', *Regional Environmental Change*, vol. 18, 13 November 2017, p. 2343.

90. Thacker, S., Adshead, D., Morgan, G., Crosskey, S., Bajpai, A., Ceppi, P., Hall, JW. & O'Regan, N., *Infrastructure: Underpinning Sustainable Development*, United Nations Office for Project Services, Copenhagen, 2018, p. 41.

91. 'Challenges in transport and trade logistics', p. 8.

92. *Review of Maritime Transport 2014*, p. 110.

93. Ibid., p. 4.

94. Marigot Bay, 'Marina Information: All Above Board – Saint Lucia's Premier Marina', <www.marigotbayresort.com/marina/marina-information>, accessed 17 March 2020.

95. 'Challenges in transport and trade logistics', p. 2.

96. The World Bank, 'Climate Resilience and Transport in Small Island Developing States', World Bank Group, 15 November 2017, <www.worldbank.org/en/topic/transport/publication/climate-resilience-and-transport-in-small-island-developing-states>, accessed 17 March 2020.

97. Review of Maritime Transport 2014, pp. 4, 106, 110.

98. 'Challenges in transport and trade logistics', p. 8.

99. Ibid., p. 4.

100. Morgan G, Bajpai A, Ceppi P, Al-Hinai A, Christensen T, Kumar S, Crosskey S & O'Regan N., *Infrastructure for gender equality and the empowerment of women*. UNOPS, Copenhagen, Denmark, 2018, p. 13.

101. The World Bank, 'In Small Island States, Resilient Transport is Providing a Lifeline Against Disasters', World Bank Group, 11 June 2019, <www.worldbank.org/en/news/feature/2019/06/11/in-small-island-states-resilient-transport-is-providing-a-lifeline-against-disasters>, accessed 17 March 2020.

102. Government of Fiji, Fiji Post-Disaster Needs Assessment: Tropical Cyclone Winston, February 20, 2016, Government of Fiji, May 2016, pp. 2, 79.

103. Miranda, Eduardo, et al., *Puerto Rico Mw 6.4 Earthquake: Preliminary Virtual Reconnaissance Report (PVRR)*, Structural Extreme Events Reconnaissance, 7 January 2020, pp. 41–44.

104. The World Bank, *Climate and Disaster Resilient Transport in Small Island Developing States: A Call for Action*, The World Bank, Washington, D.C., October 2017, p. 12.

105. Gillespie, Patrick, Rafael Romo and Maria Santana, 'Puerto Rico aid is trapped in thousands of shipping containers', Cable News Network, 28 September 2017, <https://edition.cnn.com/2017/09/27/us/puerto-rico-aid-problem/index.html>, accessed 17 March 2020.

106. Schlumberger, Charles E., 'Air transportation – the critical infrastructure when disaster strikes', World Bank Blogs, 6 May 2015, <https://blogs.worldbank.org/transport/air-transportation-critical-infrastructure-when-disaster-strikes>, accessed 17 March 2020.

107. United States Agency for International Development, 'Climate Resilience in the Transport Sector: Challenges and opportunities for Small Island Developing States (SIDS)', USAID, February 2018.

108. Schlumberger, 'Air transportation', <https://blogs.worldbank.org/transport/air-transportation-critical-infrastructure-when-disaster-strikes>, accessed 17 March 2020.

109. 'Climate Resilience in the Transport Sector'

110. Thacker, S., Adshead, D., Morgan, G., Crosskey, S., Bajpai, A., Ceppi, P., Hall, JW. & O'Regan, N., *Infrastructure: Underpinning Sustainable Development*, United Nations Office for Project Services, Copenhagen, 2018, p. 41.

111. Dornan, Matthew, 'Renewable Energy Development in Small Island Developing States of the Pacific', *Resources*, vol. 4, 8 July 2015, p. 495.

112. Shumais, Mohamed, and Ibrahim Mohamed, 'Dimensions of Energy Insecurity on Small Islands: The Case of the Maldives', ADBI Working Paper 1049, ADBI Working Paper Series, Asian Development Bank Institute, Tokyo, December 2019, p. 3.

113. European Geothermal Energy Council, 'Unlocking the potential of geothermal energy in islands', EGEC, 22 September 2017, <www.egec.org/unlocking-potential-geothermal-energy-islands>, accessed 10 April 2020.

114. Rogers, Tom, 'Small tropical islands could become the world's first 100% renewable nations', The Conversation, 15 June 2016, <www.theconversation.com/small-tropical-islands-could-become-the-worlds-first-100-renewable-nations-59357>, accessed 10 April 2020.

115. *Emerging Issues for Small Island Developing States*, p. 29.

116. Manijean, Lynn, and Pascal Saffache, 'Geothermal energy slowly makes it entrance in the caribbean region', *Dynamiques Environnementales*, vol. 38, 2016, p. 116.

117. Shumais and Mohamed, 'Dimensions of Energy Insecurity on Small Islands', p. 11.

118. Blechinger, P., et al., 'Global analysis of the techno-economic potential of renewable energy hybrid systems on small islands', *Energy Policy*, vol. 98, November 2016, pp. 674–687.

119. Prasad, Ravita D., R. C. Bansal and Atul Raturi, 'A review of Fiji's energy situation: Challenges and strategies as a small island developing state', *Renewable and Sustainable Energy Review*s, vol. 75, August 2017, p. 7–8.

120. Shumais and Mohamed, 'Dimensions of Energy Insecurity on Small Islands', p. 11.

121. The World Bank, *Accelerating Sustainable Private Investments in Renewable Energy (ASPIRE) Project*, The World Bank, The Republic of Maldives, 23 May 2014, p. 1.

122. Shumais and Mohamed, 'Dimensions of Energy Insecurity on Small Islands', p. 14.

123. Ephraim, Judith, 'Full steam ahead: geothermal energy can fuel the future of the Eastern Caribbean', LSE Latin America and Caribbean, 30 January 2018, <https://blogs.lse.ac.uk/latamcaribbean/2018/01/30/full-steam-ahead-geothermal-energy-can-fuel-the-future-of-the-eastern-caribbean>, accessed 10 April 2020.

124. Gischler, Christiaan, 'Developing Geothermal Power in Small Islands Developing States', Inter-American Development Bank, 17 December 2018, <https://blogs.iadb.org/caribbean-dev-trends/en/developing-geothermal-power-small-islands-developing-states>, accessed 10 April 2020.

125. UN Women, *Turning Promises into Action: Gender Equality in the 2030 Agenda for Sustainable Development*, 2018, pp. 106-107.

126. Feinstein, Charles, 'SIDS – Towards a Sustainable Energy Future', World Bank-United Nations High Level Dialogue on Advancing Sustainable Development in Small Island Developing States, World Bank Group, 13 June 2014, p. 4.

127. Surroop, Dinesh, et al., 'Energy Access in Small Island Developing States: Status, barriers and policy measures', *Environmental Development*, vol. 27, September 2018, p. 7.

128. United Nations, *Accelerating SDG 7 Achievement: SDG 7 Policy Briefs in Support of the High-Level Political Forum 2019*, United Nations, 2019, p. 138.

129. UN Women, *Turning Promises into Action*, pp. 106-107.

130. The International Bank for Reconstruction and Development and The World Bank, 'Pacific Islands Development in 3D', The International Bank for Reconstruction and Development and The World Bank, Washington, D.C., 2009, pp. 2, 5.

131. Surroop et al., 'Energy Access in Small Island Developing States', p. 3.

132. The World Bank, 'The World Bank In Pacific Islands', <www.worldbank.org/en/country/pacificislands/overview>, accessed 17 March 2020.

133. Swimsol GmbH, 'Taking Solar Offshore: Bringing Unlimited Renewable Energy to Small Island States', SIDS Global Business

Network, 10 July 2017, <https://sidsgbn.org/2017/07/10/taking-solar-offshore-bringing-unlimited-renewable-energy-to-small-island-states>, accessed 17 March 2020.

134. Atteridge, Aaron, and Georgia Savvidou, 'Development aid for energy in Small Island Developing States', *Energy, Sustainability and Society*, vol. 9, 25 March 2019, pp. 1, 13.

135. Zahari, A. R., et al., 'Wind Energy Development in Small Islands', *Journal of Green Engineering*, vol. 8, no. 3, July 2018, pp. 283–300.

136. Tawake, Akuila, 'SPC promotes geothermal energy as a catalyst for sustainable economic development in the Pacific', The Pacific Community, Suva, 21 September 2017, <www.spc.int/updates/blog/2017/09/spc-promotes-geothermal-energy-catalyst-sustainable-economic-development>, accessed 10 April 2020.

137. Minister for Communications and Works, 'Update on Electricity Restoration Efforts', Statement on The Restoration of Electricity in the Territory, 13 November 2017.

138. Malo, Sebastien, 'In British Virgin Islands, hurricane whips up green energy transition', Thomson Reuters Foundation, Road Town, 31 July 2018, <www.reuters.com/article/us-energy-britishvirginislands-renewable/in-british-virgin-islands-hurricane-whips-up-green-energy-transition-idUSKBN1KL1PY>, accessed 17 March 2020.

139. Burgess, Christopher, and Justin Locke, 'Rebuilding the Caribbean for a Resilient and Renewable Future', Rocky Mountain Institute, 15 September 2017, <https://rmi.org/rebuilding-caribbean-resilient-renewable-future>, accessed 17 March 2020.

140. Scanlon, Bill, and William Scanlon, 'Assuring Solar Modules Will Last for Decades', National Renewable Energy Laboratory, 13 April 2015, <www.nrel.gov/news/features/2015/16488.html>, accessed 17 March 2020.

141. New Energy, 'Solar PV and microgrids post-Irma: Some survive, others sustain damage', New Energy, 28 September 2017, <http://newenergyevents.com/solar-pv-post-irma-and-maria-some-survive-others-sustain-damage>, accessed 17 March 2020.

142. The meeco Group, 'Antigua's well-built PV systems sustain impact of hurricane Irma', meeco, 21 September 2017, <www.meeco.net/blog/antiguas-well-built-pv-systems-sustain-impact-of-hurricane-irma>, accessed 17 March 2020.

143. Ephraim, 'Full steam ahead', <https://blogs.lse.ac.uk/latamcaribbean/2018/01/30/full-steam-ahead-geothermal-energy-can-fuel-the-future-of-the-eastern-caribbean>, accessed 10 April 2020.

144. Mustapa, Muhammad Adli, et al., 'Wave energy device and breakwater integration: A review', *Renewable and Sustainable Energy Reviews*, vol. 77, September 2017, p. 44.

145. Blechinger et al., 'Global analysis of the techno-economic potential of renewable energy hybrid systems on small islands', p. 683.

146. Heathman, Amelia, 'This island is powered entirely by solar panels and batteries thanks to SolarCity', Wired, 22 November 2016, <www.wired.co.uk/article/island-tau-solar-energy-solarcity>, accessed 17 March 2020.

147. Jensen, Mike, and Michael Minges, *Ensuring Sustainable Connectivity in Small Island Developing States*, Discussion draft, Internet Society, 2017, pp. 8–10.

148. Thacker, S., et al., *Infrastructure: Underpinning Sustainable Development*, United Nations Office for Project Services, Copenhagen, 2018, p. 41.

149. International Telecommunication Union, *Small island developing states (SIDS) and ICTs: Mid-term review of the Samoa Pathway*, ITU, Geneva, 2019, pp. 4, 15.

150. Ibid., p. 3.

151. Ibid., p. 6.

152. Ibid., pp. 29–30.

153. Jensen and Minges, *Ensuring Sustainable Connectivity*, p. 5.

154. Ibid., p. 5.

155. Ibid., p. 4.

156. Ibid., p. 29.

157. Small island developing states (SIDS) and ICTs, p. 5.

158. Mlambo-Ngcuka, Phumzile, 'ICT as a powerful means to advance women's rights, empowerment and gender equality', UN Women, 20 September 2013, <www.unwomen.org/en/news/stories/2013/9/ed-speech-to-broadband-gender-group>, accessed 12 March 2020.

159. Jensen and Minges, Ensuring Sustainable Connectivity, p. 30.

160. United Nations Office for Outer Space Affairs, 'Benefits of Space: Communication', <www.unoosa.org/oosa/en/benefits-of-space/communication.html>, accessed 20 May 2020.

161. Jensen and Minges, Ensuring Sustainable Connectivity, p. 31.

162. *Small island developing states (SIDS) and ICTs*, pp. iii, 9.

163. Halais, Flavie, 'Small island states turn to innovation to build climate resilience', Devex, Montreal, 4 June 2019, <www.devex.com/news/small-island-states-turn-to-innovation-to-build-climate-resilience-94865>, accessed 20 May 2020.

164. International Telecommunication Union, 'Requirements for Network Resilience and Recovery', Focus Group Technical Report, ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, ITU, May 2014, p. 26.

165. Burcharth, H. F., and S. A. Hughes, 'Types and Functions of Coastal Structures', *Coastal Engineering Manual*, vol. 6, Coastal Engineering Research Center, Aalborg Universitet, 2003, p. VI-2-1.

166. 'Requirements for Network Resilience and Recovery', p. 9.

167. World Bank Group and Global Facility for Disaster Reduction and Recovery, 'Small Island States Resilience Initiative (SISRI): Workshop on Building a Community of Practice for Resilience of Small Island States to Climate and Disaster Risk – Final Workshop Report', World Bank Group and GFDRR, Understanding Risk Forum 2016, Venice, 16–17 May 2016, p. 11.

168. Government of Haiti, World Bank, Inter-American Development Bank, United Nations Educational, Scientific and Cultural Organization and the Intergovernmental Oceanographic Commission, *Republique d'Haïti: Analysis of Multiple Natural Hazards in Haiti (NATHAT)*, Government of Haiti, Port-au-Prince, 26 March 2010, pp. 54–55.

169. United Nations, 'Goal 6: Ensure access to water and sanitation for all', <www.un.org/sustainabledevelopment/water-and-sanitation>, accessed 3 June 2020.

170. Thacker, S., et al., *Infrastructure: Underpinning Sustainable Development*, United Nations Office for Project Services, Copenhagen, 2018, p. 41.

171. Cherry-Fevrier, Norma, 'Integrated Water Resources Management (IWRM) and Sustainable Development in the OECS', *The Cowrie: SIDS Times*, 1st ed. 2018, Small Island Developing States (SIDS) Unit, Division for Sustainable Development Goals, United Nations Department of Economic and Social Affairs, June 2018, p. 24.

172. Hillel, Oliver, and Kate Brown, 'Opportunities for SIDS to Mainstream Ecosystem Services into the Water Sector', *The Cowrie: SIDS Times*, 1st ed. 2018, Small Island Developing States (SIDS) Unit, Division for Sustainable Development Goals, United Nations Department of Economic and Social Affairs, June 2018, p. 32.

173. *Emerging Issues for Small Island Developing States*, p. vi.

174. Hillel and Brown, 'Opportunities for SIDS to Mainstream Ecosystem Services into the Water Sector', p. 32.

175. World Bank Group, *Rapid Review of Water Knowledge for Pacific Small Islands Developing States*, World Bank, June 2018, p. 7.

176. Ibid., p. 35.

177. Bortolato, 'Gender Equality in Small Island Developing States', p. 6.

178. United Nations Sustainable Development Goals Partnerships Platform, 'Atlantic and Indian Ocean SIDS Integrated Water Resources Management Project', <https://sustainabledevelopment.un.org/partnership/?p=7480>, accessed 15 May 2020.

179. Government of the Republic of Trinidad and Tobago Ministry of Public Utilities, 'National Integrated Water Resources Management Policy' (draft document), Trinidad and Tobago, 2017, p. 2.

180. Gheuens, Nagabhatla and Perera, 'Disaster-Risk, Water Security Challenges and Strategies', p. 9.

181. *Rapid Review of Water Knowledge*, p. 36.

182. Ritschel, Alexander, and Olabode Esan, 'Renewable Energy Desalination for Small Islands', PowerPoint presentation at IRENA – Martinique Conference on Island Energy Transitions: Pathways for Accelerated Uptake of Renewables, Martinique, 22–24 June 2015, p. 7.

183. Peters, Adele, 'The water in this hospital is all pulled out of thin air', Fast Company, 27 February 2019, <www.fastcompany.com/90312067/the-water-in-this-hospital-is-all-pulled-out-of-thin-air>, accessed 15 May 2020.

184. Zero Mass Water, 'How Does SOURCE Work?', <www.zeromasswater.com/fields/source>, accessed 4 June 2020.

185. Peters, 'The water in this hospital is all pulled out of thin air', <www.fastcompany.com/90312067/the-water-in-this-hospital-is-all-pulled-out-of-thin-air>, accessed 15 May 2020.

186. Gheuens, Nagabhatla and Perera, 'Disaster-Risk, Water Security Challenges and Strategies', pp. 10–11.

187. Ibid., p. 11.

188. *Emerging Issues for Small Island Developing States*, p. 23.

189. United Nations Children's Fund, 'Harvesting Rainwater to Improve Access to Safe Drinking Water and Adapt to Climate Change', UNICEF, 2014.

190. Burcharth and Hughes, 'Types and Functions of Coastal Structures', p. VI-2-2.

191. The World Bank, 'Kiribati: Kiribati Adaptation Program - Phase III', World Bank Group, Washington, D.C., 15 September 2011, <www.worldbank.org/en/results/2011/09/15/kiribati-adaptation-program-phase-3>, accessed 21 April 2020.

192. Bortolato, 'Gender Equality in Small Island Developing States', p. 30.

193. Thacker, S., et al., *Infrastructure: Underpinning Sustainable Development*, p. 41.

194. United Nations, 'Goal 6: Ensure access to water and sanitation for all', <www.un.org/sustainabledevelopment/water-and-sanitation>, accessed 3 June 2020.

195. *Emerging Issues for Small Island Developing States*, p. 23.

196. Organisation for Economic Co-operation and Development, et al., *Latin American Economic Outlook 2019: Development in Transition*, OECD Publishing, Paris, 27 September 2019, p. 195.

197. World Health Organization Regional Office for the Western Pacific, et al., *Sanitation, Drinking-water and Health in Pacific Island Countries: 2015 Update and Future Outlook*, WHO Regional Office for the Western Pacific, Manila, 2016, p. 11.

198. Morgan G, Bajpai A, Ceppi P, Al-Hinai A, Christensen T, Kumar S, Crosskey S & O'Regan N. Infrastructure for gender equality and the empowerment of women. UNOPS, Copenhagen, Denmark, p. 13.

199. Ibid., pp. 1, 25.

200. Frank, Alexandra, 'A Paradise in Need', Kreditanstalt für Wiederaufbau, 3 April 2018, <www.kfw.de/stories/environment/nature-conservation/galapagos-wastewater>, accessed 3 June 2020.

201. *Sanitation, Drinking-water and Health in Pacific Island Countries*, p. 58.

202. Spuhler, Dorothee, and Beat Stauffer, 'Simplified and Condominial Sewers', Sustainable Sanitation and Water Management Toolbox, <https://sswm.info/sanitation-systems/sanitation-technologies/simplified-and-condominial-sewers>, accessed 3 June 2020.

203. Gheuens, Nagabhatla and Perera, Disaster-Risk, Water Security Challenges and Strategies, p. 9.

204. *Rapid Review of Water Knowledge*, p. 36.

205. Fluence Corporation, 'The Caribbean's Wastewater Problem', Fluence Corporation, 27 August 2018, <www.fluencecorp.com/the-caribbeans-wastewater-problem>, accessed 3 June 2020.

206. United Nations Environment Programme, 'What is our Pollution or LBS Protocol?', <www.unenvironment.org/cep/what-our-pollution-or-lbs-protocol>, accessed 3 June 2020.

207. United States Virgin Islands Hurricane Recovery and Resilience Task Force, *USVI Hurricane Recovery and Resilience Task Force Report 2018*, USVI Hurricane Recovery and Resilience Task Force, 2018, p. 128.

208. Ibid., p. 132.

209. Healthy Waters, Department of Environment and Heritage Protection, *Natural Assets for Flood and Cyclone Resilience: Synthesis of Scientific Evidence on the Role of Natural Assets to Reduce the Human Impacts of Floods and Cyclones*, Department of Environment and Heritage Protection, The State of Queensland, 2012, p. iv.

210. Ibid., p. 26.

211. Van Lavieren, Els, 'Building with Nature concept successfully introduced in Suriname', Wetlands International, 14 June 2016, <www.wetlands.org/blog/building-with-nature-concept-successfully-introduced-in-suriname>, accessed 21 April 2020.

212. Thacker, S., et al., *Infrastructure: Underpinning Sustainable Development*, p. 41.

213. *Emerging Issues for Small Island Developing States*, p. 40.

214. Mohee, R., et al., 'Current Status of Solid Waste Management in Small Island Developing States: A review', *Waste Management*, vol. 43, 2015, p. 540.

215. Diez et al., *Marine Pollution in the Caribbean*, pp. 15–16.

216. United Nations Environment Programme, 'Caribbean Nations Rally around Pollution-free Future', Press release, UNEP, Trinidad and Tobago, 27 August 2019, <www.unenvironment.org/news-and-stories/press-release/caribbean-nations-rally-around-pollution-free-future>, accessed 21 January 2020.

217. Agamuthu, P., and S. Herat, 'Sustainable Waste Management in Small Island Developing States (SIDS)', Waste Management & Research, vol. 32, no. 8, 2014, p. 681.

218. Diez et al., Marine Pollution in the Caribbean, pp. 15–16.

219. United Nations Conference on Trade and Development, 'Oceans Economy and Fisheries', <https://unctad.org/en/Pages/DITC/Trade-and-Environment/Oceans-Economy.aspx>, accessed 21 January 2020.

220. Agamuthu and Herat, 'Sustainable Waste Management in Small Island Developing States (SIDS)', p. 681.

221. Asian Development Bank, 'Solid Waste Management in the Pacific: Appropriate Technologies', June 2014, p. 8

222. Ibid., p. 8.

223. Ibid., p. 7.

224. Mohee et al.,'Current Status of Solid Waste Management in Small Island Developing States', pp. 544–545.

225. Catherine, I. S., B. Y. R. Surnam and A. Khoodaruth, 'Biogas Production in Mauritius Using Livestock Waste', Conference paper, International Conference on Computer Science, Data Mining & Mechanical Engineering (ICCDMME'2015), Bangkok, 20–21 April 2015, p. 83.

226. 'Solid Waste Management in the Pacific', p. 3.

227. Mohee et al., 'Current Status of Solid Waste Management in Small Island Developing States', p. 543.

228. Laboy-Nieves, E. N., 'Energy Recovery from Scrap Tires: A Sustainable Option for Small Islands like Puerto Rico', *Sustainability*, vol. 6, no. 5, 21 May 2014, pp. 3105–3121.

229. United Nations Environment Programme, 'Small Island Developing States Waste Management Outlook' (summary document), Nairobi, 2019, p. 1.

230. Shumais and Mohamed, 'Dimensions of Energy Insecurity on Small Islands', p. 12.

231. 'Solid Waste Management in the Pacific', p. 4.

232. Riquelme, Rodrigo, Paola Méndez and Ianthe Smith, 'Solid Waste Management in the Caribbean: Proceedings from the Caribbean Solid Waste Conference', Inter-American Development Bank, April 2016, p. 31.

233. 'Solid Waste Management in the Pacific', p. 3.

234. Street, Andrew, 'The Answer for Remote Islands', Waste Management World, 1 February 2013, <https://waste-management-world.com/a/the-answer-for-remote-islands>, accessed 20 March 2020.

235. United Nations Environment Programme, 'Small Island Developing States Waste Management Outlook', Nairobi, 2019, p. 77, 100.

236. Mead, Leila, 'Pacific Islands Partner to Transfer Waste for Sustainable Treatment and Recycling', International Institute for Sustainable Development, 27 March 2018, <http://sdg.iisd.org/news/pacific-islands-partner-to-transfer-waste-for-sustainable-treatment-and-recycling>, accessed 20 March 2020.

237. Luken, Karen, 'SIDS Approaches to Waste Management and The Circular Economy', Economic Environmental Solutions, Caribbean Waste Management Conference, Kingston, Jamaica, 4-6 July 2017, p. 4.

238. USVI Hurricane Recovery and Resilience Task Force Report 2018, p. 128.

239. Luken, 'SIDS Approaches to Waste Management and The Circular Economy', p. 4.

240. Saint Lucia Solid Waste Management Authority, 'Services', <www.sluswma.org>, accessed 20 March 2020.

241. Burcharth and Hughes, 'Types and Functions of Coastal Structures'. VI-2-6.

242. Thacker, S., et al., *Infrastructure: Underpinning Sustainable Development*, p. 41.

243. Suzana, Mariyam, et al., 'Achieving Universal Health Coverage in Small Island States: could importing health services provide a Solution?', *BMJ Global Health*, vol. 3, 2018, p. 1.

244. Royal Turks and Caicos Island Police, 'Police Stations and Locations', <www.tcipolice.tc/police-stations-and-locations>, accessed 3 April 2020.

245. Department of Gender Affairs, *Twenty-Fifth Anniversary of the Fourth World Conference on Women and Adoption of the Beijing Declaration and Platform for Action*, Ministry of Education, Youth Culture Library and Social Services, Government of Turks and Caicos Islands, p. 19.

246. *Trends in Sustainable Development: Small Island Developing States*, p. 31.

247. Atchoaréna, David, Patricia Dias Da Graça and José Manuel Marquez, 'Strategies for Post-Primary Education in Small Island Developing States (SIDS): Lessons from Cape Verde', *Comparative Education*, vol. 44, no. 2, 2008, p. 172.

248. *Trends in Sustainable Development: Small Island Developing States*, p. 31.

249. Burger, Andrew, 'The Bahamas Launches Family Islands Solarization Program', Solar Magazine, 8 August 2019, <https://solarmagazine.com/the-bahamas-launches-family-islands-solarization-program>, accessed 20 June 2020.

250. 'Gov't embarks on 'new frontier in renewable energy', *The Bahama Journal*, 19 March 2019, <http://jonesbahamas.com/govt-embarks-on-new-frontier-in-renewable-energy>, accessed 20 June 2020.

251. United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics, *Good neighbours: Caribbean students at the tertiary level of education*, UNESCO Institute for Statistics, Paris, 2001, p. 14.

252. Babinard, Julie, et al., *Sustainably managing natural resources and the need for construction materials in Pacific island countries: The example of South Tarawa*, Kiribati, The World Bank, January 2014, p. 6.

253. United Nations Framework Convention on Climate Change, *Climate Change, Small Island Developing States*, UNFCCC, Bonn, Germany, 2005, p. 14.

254. Ocean Action Hub, 'Sand Mining And Tourist Infrastructure Are Destroying Beaches', <www.oceanactionhub.org/sand-mining-and-tourist-infrastructure-are-destroying-beaches>, accessed 23 April 2020.

255. Lewis, Deirdre, et al., *Baseline Assessment of Development Minerals in Jamaica*, United Nations Development Programme, Kingston, Jamaica, November 2017, pp. 5, 202.

256. Babinard et al., *Sustainably managing natural resources*, p. 7.

257. 'Small Island States Resilience Initiative (SISRI)', p. 11.

258. Wu, Hongbo, Under-Secretary-General for Economic and Social Affairs, 'Adaptation to Climate Change, Boosting Financing and Investment, and Advancing Science and Technology', Third Special Thematic Session on Water and Disasters, New York, 20 July 2017.

259. *Climate Change, Small Island Developing States*, pp. 14, 21.

260. Correa, Tracy, et al., *StEER: Hurricane Dorian Preliminary Virtual Reconnaissance Report (PVRR)*, Structural Extreme Events Reconnaissance, 1 September 2019, pp. 33–58.

261. Pan American Health Organization, 'Climate Change and Health in Small Island Developing States: A WHO Special Initiative in collaboration with UNFCCC and the Fijian Presidency of the COP-23 – SIDS in the Caribbean Region', Background document for the Meeting to Develop the Caribbean Region Action Plan, WHO Geographically Dispersed 3rd Global Conference on Climate Change and Health, PAHO and World Health Organization, Grenada, 16-17 October 2018, p. 16.

262. 'Small Island States Resilience Initiative (SISRI)', p. 8.

263. 'Climate Change and Health in Small Island Developing States', p. 8.

264. Pan American Health Organization, *Smart Hospitals Toolkit*, PAHO and World Health Organization, Washington, D.C., 2017, pp. 66–73.

265. *Climate Change, Small Island Developing States*, p. 27.

266. Organisation for Economic Co-operation and Development, *Climate-resilient Infrastructure: Policy Perspectives*, OECD Environment Policy Paper No. 14, OECD, 2018, pp. 20–21.

267. Pacific Islands Forum Secretariat, The Government of the Republic of Nauru, Australian Aid, United Nations Development Programme, *Pacific Climate Change Finance Assessment Nauru Case Study*, PIFS, The Government of the Republic of Nauru, Australian Aid, UNDP, May 2013, p. 38.

268. International Trade Centre, 'The Caribbean', <www.intracen.org/itc/regions/caribbean>, accessed 4 May 2020.

269. Morgan G, Bajpai A, Ceppi P, Al-Hinai A, Christensen T, Kumar S, Crosskey S & O'Regan N., *Infrastructure for gender equality and the empowerment of women*. UNOPS, Copenhagen, Denmark, 2018, p. 9.