CITY AND REGIONAL INFRASTRUCTURE AND RESOURCES

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Liesure

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“Small Island Developing States (SIDs) are particularly vulnerable to climate change, natural disasters, and external economic shocks - such as the impats of the pandemic. For SIDs to survive climate change and COVID-19, we need to adapt an integrated approach that promotes economic diversification, innovative financing instruments, and scaling up the “blue economy”

Leila Mead, March 29 2021 - Small Islands, Large Oceans: Voices on the Frontlines of Climate Change

EcoTourism in Small Island Developing States (SIDS)

EcoTourism in Small Island Developing States (SIDS)

"The vulnerability of tourism-dependent communities, coastal tourism fascilities, and beaches to climate change demands the use of measures that can urgently minimise vulnerability and in the long term, achieve sustainable deveolopment. "
- Michelle Mycoo - 28 Sustainable Tourism, climate Change and Sea Level rise Adaptation Policies in Barbados

Small Island Developing States (SIDS) are categorized as such due to the fact that they are vulnerable regions which host distinctive terrestrial and marine ecosystems such as coral reefs, etc. These Island states are identified through three key characteristics;
Small size - limited resources and economic diversity
Remoteness and Isolation - creating a reliance on imported goods and services but an environment of unique culture and biodiversity
Maritime Environment - strong tourism assets, but vulnerable to climate change
They suffer from underdeveloped economies with high transportation, communication, public administration and infrastructure costs as well, they contend with limited availability of human, institutional and financial resources to manage and use natural resources in a sustainable way (Ashe 2005).

Many SIDs rely on tourism, environmentally, socio-culturally and economically sometimes it being the only industry present. Tourism creates links with and stimulates demand in other economic sectors such as manufacturing, services, transportation, fisheries and agriculture. Tourists are attracted to SIDs due to their unique, exotic maritime and terrestrial ecosystems, however this creates an influx of tourists during certain seasons of the year that leads to inverted situations where there are more tourists than residents of these islands. This can overwhelm local natural resources and infrastructure causing it to degrade and become aesthetically unappealing. In 2019 about 44 million people visited SIDs for touristic purposes both locally and internationally, however due to COVID-19 this seasonal economical influx ceased for almost two years.

Governmental priority should be given to the integration of tourism policies with other sectors' policies in order to ensure that tourism is developed in harmony with overall economic, social, and environmental goals. The private sector (both domestic and foreign tourism enterprises) can also play a crucial role in destination development. The foreign tourism industry, which consists mainly of transportation, hotel, and tour-operator companies, should ensure that their business decisions take full account of the environmental, social, and, in particular, economic sustainability of the destination in which they operate (Ashe, 2005).

3 degrees. UN projections for 2100 show the Earth's temperature rising by 3 degrees. This is leading to sea level rise with projections of an increase of 1.6 feet by 2100. By the 2050s about 800 million people will live in cities where sea level could rise by more than 12 inches, a total of 570 cities could be affected.

We have chosen to focus on better understanding how ecotourism can create a way of providing economic and environmental stability by studying the following islands; Antigua and Barbuda, Aruba, Anguilla and Barbados. These are islands that can attribute 75% of their national GDPs to tourism, which employs over 80% of their labor force (Kanji 2006).

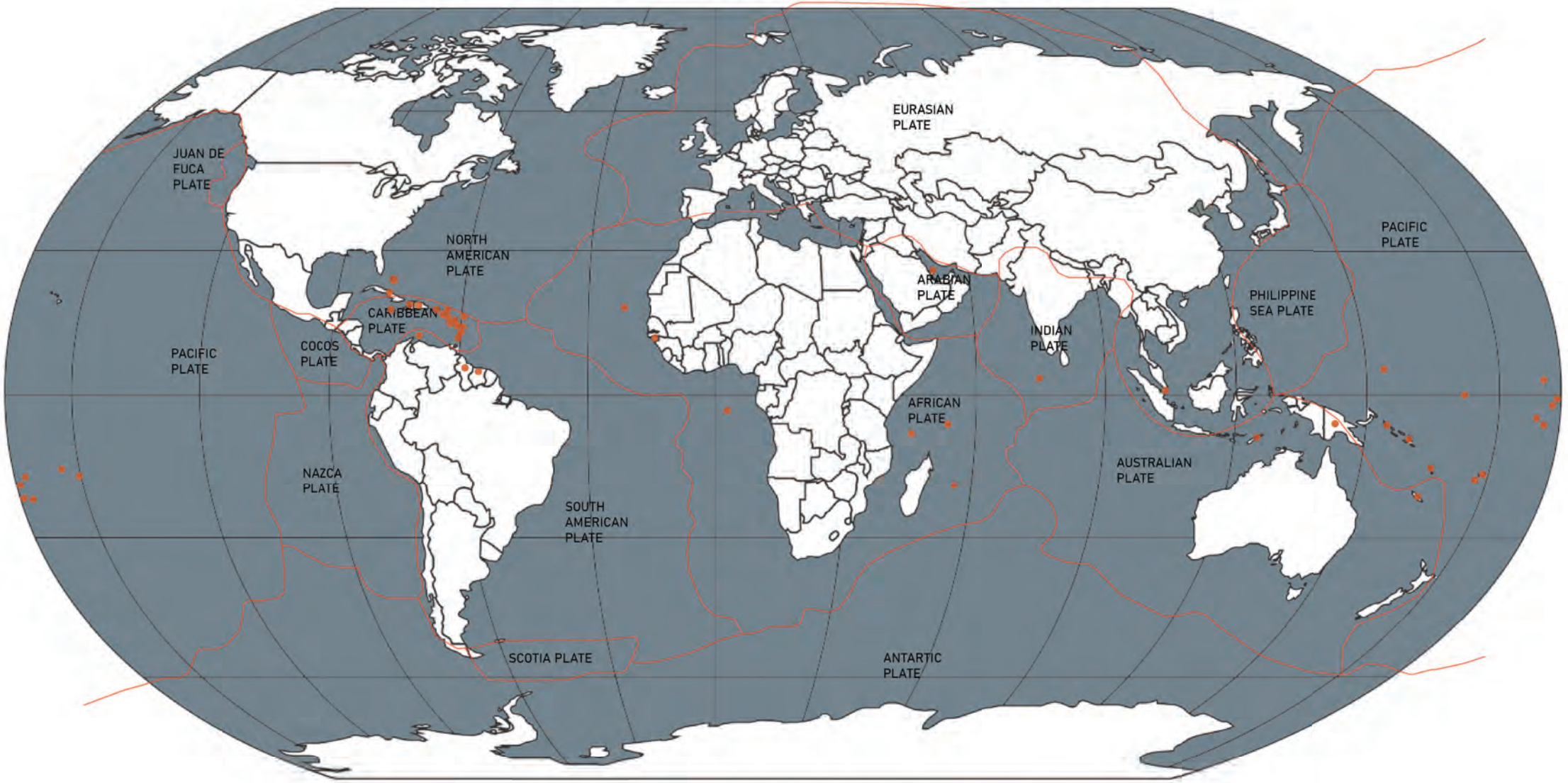
Antigua and Barbuda:
The small island nation of Antigua and Barbuda draws nearly 1 million tourists every year. However, sea level rise due to global warming emissions is projected to be between 2.6 to 6.6 feet which would affect the island's major resort. Global warming is predicted to reduce rainfall on the islands which is likely to worsen existing environmental stresses such as scarcity of fresh water and increase episodic hurricanes that can devastate the islands.

Barbados:
There are two major factors in the destruction of Barbados' ecosystems; beach erosion and coral reef degradation. Beaches in Barbados are very narrow, averaging between 12 to 15 meters which allows elevated sea levels to increase beach erosion. Main causes of coral reef destruction can be attributed to careless diving near the shore, disposal of solid waste, and changes to the coastal topography for tourism development, destructive fishing practices and anchoring boats over reefs. Approximately 80% of Barbados' fringing reefs were seriously degraded, and bank reefs decreased from 37% to 23% over a decade.

Aruba:
Aruba is one of the most tourism intensive small island economies in the caribbean.
The increasing pressures and risks of over-tourism are associated with rising social costs of deteriorating labor participation, stagnant productivity, higher public expenditures, and rising income inequality, as well as loss of nature reserves, coastal erosion, and environmental degradation.

Anguilla:
Anguilla's climate is tropical, with little seasonal variation. Rainfall is low causing poor soil quality leading to low scrub vegetation. This leaves Anguilla vulnerable to flooding from storm surges and sea level rise and major flooding during hurricane season from August to October. These events will aggravate losses from coastal erosion and flooding that impact tourism activities and the wider national economy, temporarily disrupting port operations and food security as well as access along essential roads and isolating or displacing settlements and businesses.

SMALL ISLAND DEVELOPING STATES OF THE WORLD



Anguilla[American Samoa Bahrain Antigua and Barbuda Cook Islands Cape Verde Aruba Federated States of Micronesia] Comoros Bahamas Fiji Guinea-Bissau[h][e] Barbados French Polynesia Maldives Belize Guam Mauritius British Virgin Islands Kiribati São Tomé and Príncipe Cuba Marshall Islands Seychelles Dominica Nauru Singapore Dominican Republic New Caledonia Grenada Niue Guyana Northern Mariana Islands Haiti Palau Jamaica Papua New Guinea Montserrat Samoa Netherlands Antilles Solomon Islands Puerto Rico Timor-Leste Saint Kitts and Nevis Tonga Saint Lucia Tuvalu Saint Vincent and the Grenadines Vanuatu Suriname Trinidad and Tobago United States Virgin Islands

Small Island developing states are categorized as such due to the fact that they are vulnerable regions which host distinctive terrestrial and marine ecosystems such as coral reefs, etc.

SMALL ISLAND DEVELOPING STATES OF THE CARIBBEAN

TRADE BALANCE

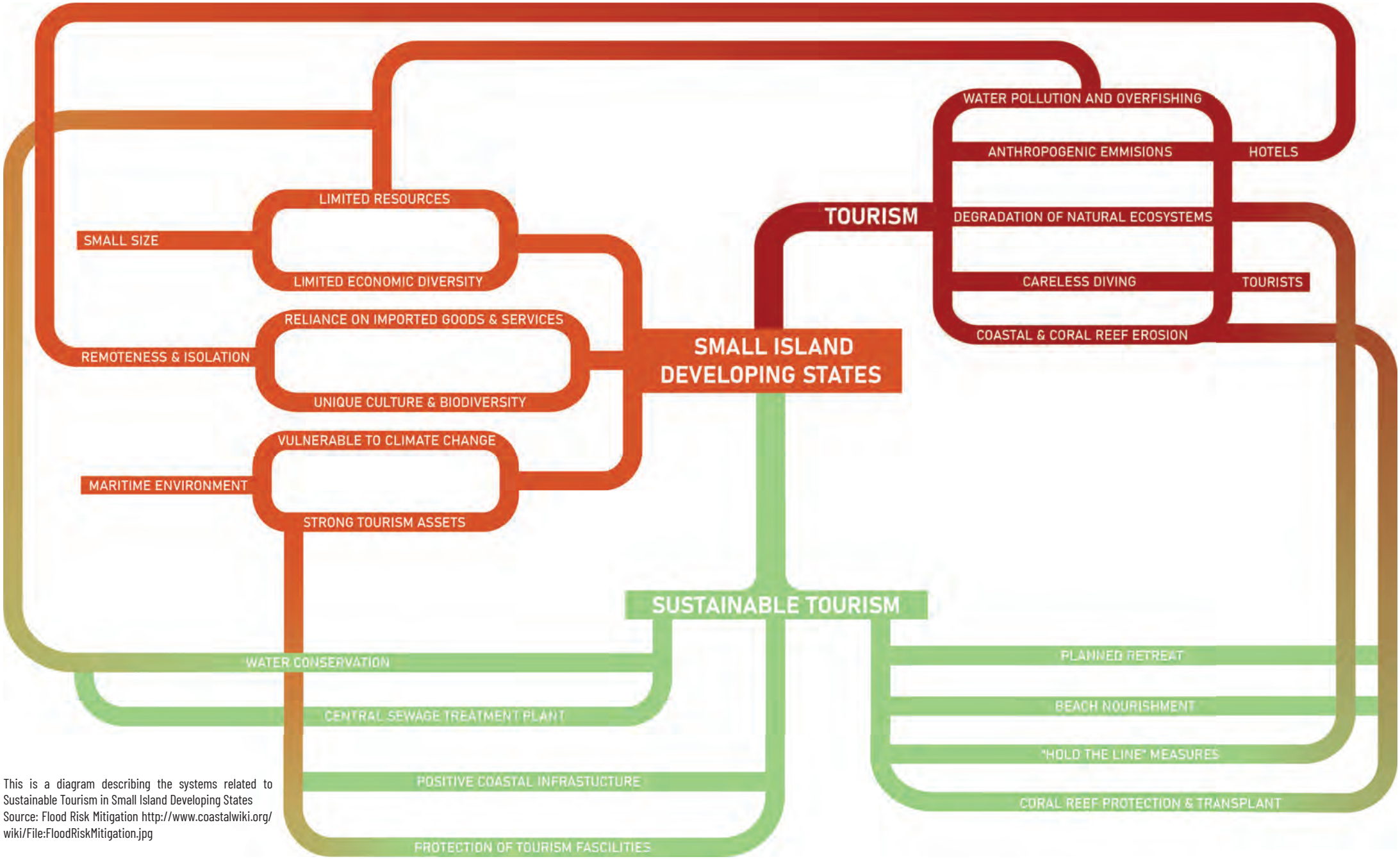
This graph shows that Small Island Developing Economies (SIDs) run on a deficit compared to developing countries. Due to the fact that they have limited resources and have to rely on imports of (mostly) goods and services.

SOURCES: UN DESA based on data from World Bank World Development Indicators database
Note: The values displayed are median

"It is imperitive that we rebuild the tourism sector in a safe, equitable and climate friendly manner and so ensure tourism regains its position as a provider of decent jobs, stable incomes and the protection of our cultural and natural heritage"

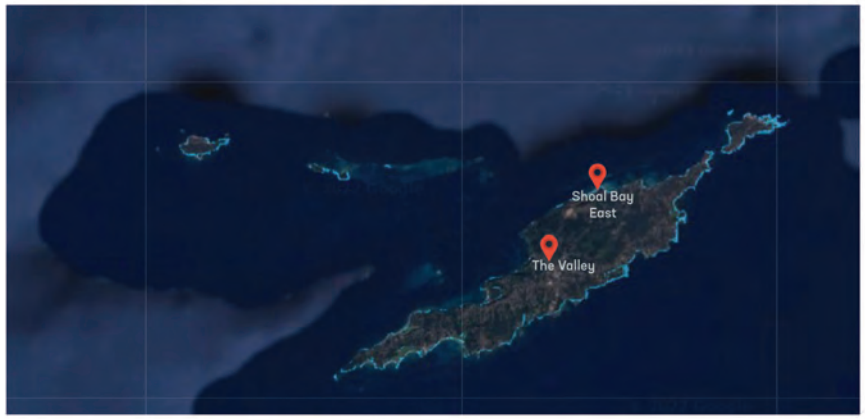
UN Secretary General Antonio Guterres - UN response to COVID-19
August 25 2020

SYSTEM DIAGRAM



This is a diagram describing the systems related to Sustainable Tourism in Small Island Developing States
Source: Flood Risk Mitigation http://www.coastalwiki.org/wiki/File:FloodRiskMitigation.jpg

2050 FLOOD PLAIN



ANGUILLA 2050

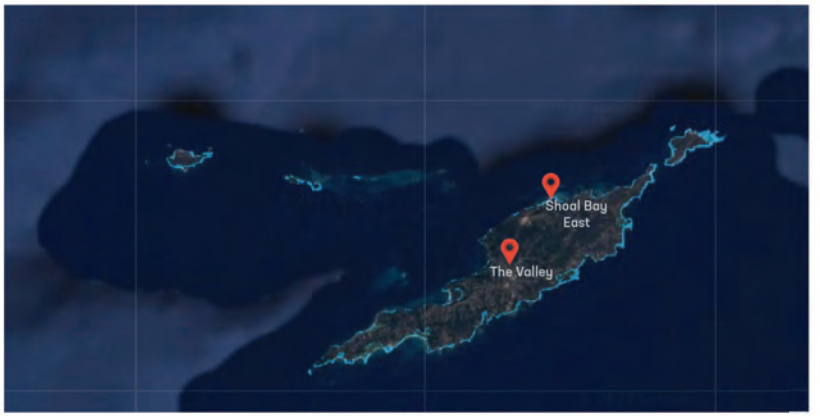
ANTIGUA 2050

BARBUDA 2050

ARUBA 2050

BARBADOS 2050

2100 FLOOD PLAIN



ANGUILLA 2100

ANTIGUA 2100

BARBUDA 2100

ARUBA 2100

BARBADOS 2100

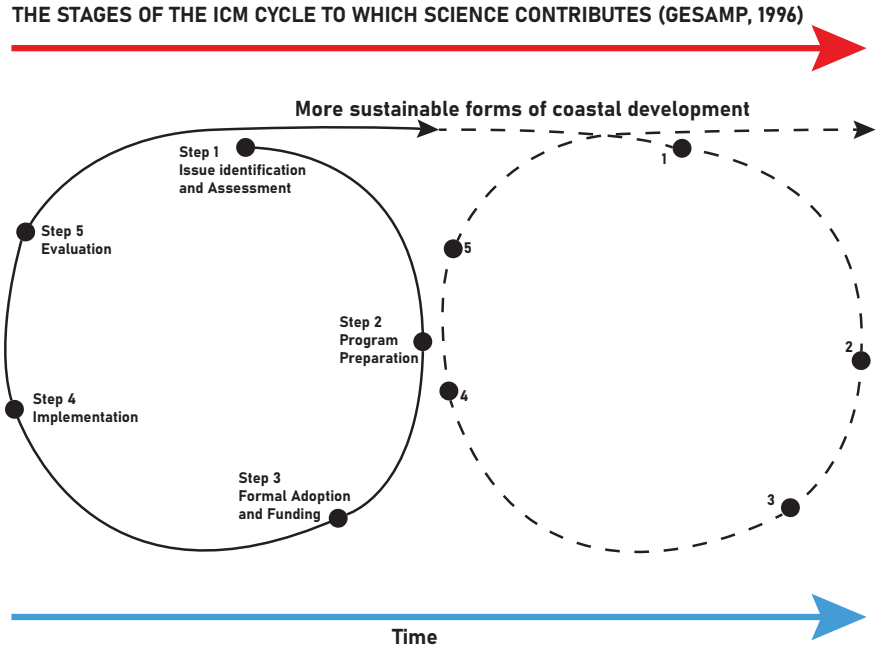
“Carribbean Islands are among the world’s most vulnerable to the impacts of climate change, with storm frequency and intensity, flodding, erosion and sea level rise all predicted to worsen. With over 70% of people in the caribbean living and working along the coast, these impacts threaten homes, hospitals, power plants, fresh water sources, roads and schools.”

- The Nature Conservancy’s Resilient Islands program in the Caribbean. The Nature Conservancy. (2020, December 1). Retrieved May 2, 2022, from https://www.nature.org/en-us/about-us/where-we-work/caribbean/stories-in-caribbean/caribbean-resilient-islands-program/

ICZM

Integrated coastal zone management (ICZM) is a dynamic, multidisciplinary and a continuous, proactive and adaptive process of resource management for sustainable development in coastal areas. It is a process of achieving goals and objectives of sustainable development in coastal areas, within the constraints of physical, social and economic conditions, and within the constraints of legal, financial and administrative systems and institutions. It is not a substitute for sectoral planning, but focuses on the links between sectoral activities to achieve more comprehensive goals. (UNEP, 1995) ICZM could also be defined as a dynamic process of the sustainable management and use of coastal zones simultaneously taking into account the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interactions, the maritime orientation of certain activities and uses and their impact on both the maritime and land elements. (UNEP/MAP/PAP, 2008).

In coastal areas, where accommodation to rapid change is often required, flexible decision-making calls for a continuous process of planning, implementation and goal-adjustment. GESAMP (1996) defined five stages of the ICZM cycle to which science contributes. They also claimed that these five consecutive stages form an ongoing, iterative process that may go through a number of cycles before the programme is sufficiently refined to produce effective results. The cyclical process is shown on the next page .



ICZM and Tourism

Coastal tourism is a key component of coastal and marine economies. Coastal tourism is, in many countries, the fastest growing area of contemporary tourism, which has placed increased pressure on the coast, i.e. an area in which uses may already be highly concentrated in the form of agriculture, human settlements, fishing, industry, etc. An understanding of tourism policy lies at the heart of broader goals of ICZM. Coastal tourism can be enhanced by ICZM. It can help solving the conflicts between coastal tourism and other marine and terrestrial sectors; resolve overlapping responsibilities of involved agencies; and increase the cooperation between coastal tourism and other coastal sectors. It is clear that coastal tourism depends on the quality and diversity of the coastal environment. Increases in tourist numbers have been shown to threaten areas of high ecological and resource value in the coastal environment. Finally, as stated in Chapter 3, the integrated management approach should not only be applied for general coastal zone management but also for special sectors such as coastal tourism. The importance of tourism in the ICZM process is much greater in tourism dependent regions, such as the Mediterranean and the Caribbean, than in most other regions of the world. There are two main reasons for this:

a) In almost all countries within such regions, tourism is one of the principal economic activities strongly identifying the overall economy of those countries. The need to develop tourism directly affects the development of agriculture, trade, and traffic, and indirectly impacts on all other activities. Tourism development plans wield a key influence upon the development and planning of

traffic routes, of infrastructure, of communications, etc.
b) In the case of enclosed seas, such as the Mediterranean, which is a closed system and an ecologically-sensitive one, the development of all other activities has a strong impact on the development of tourism. Therefore, it is necessary to harmonize overall development planning with the tourism development planning process, even in areas where tourism is not particularly significant. This is especially important in the context of environmental hazards and dangers, since contemporary trends in tourism require effectively protected and attractive environments.

Coastal Countries with ICZM Efforts: 1993 and 2000 Comparison (Cicin-Sain et al., 2000)

CONTENT	COASTAL COUNTRIES	1993		2000	
North America	3	3	100%	3	100%
Central America	7	4	57%	7	100%
Europe	33	11	31%	30	91%
Asia	17	13	62%	14	82%
South America	11	5	45%	8	73%
Caribbean	13	5	45%	8	62%
Near East	15	6	40%	7	47%
Oceania	17	7	33%	8	47%
Africa	37	5	13%	13	35%
Total		**59**		**98**	

Source: Sustainable Coastal Tourism - an integrated planning and management approach - UNEP + Priority Sctions Programme

Barbados' Policies and Projects to support sustainable tourism, Green Economy and Climate Change Adaptation

Policy measures	Sustainable tourism	Adaptation to climate change
TCDP policy		
Sediment control plan mandatory for all building and engineering operations Coastal setbacks applied over 30 years	Coral reef protection Protection of tourism facilities	Natural breakwater against SLR and coastal erosion Protects property and population from SLR and storm surges that may cause coastal flooding and erosion Can eliminate use of engineering structures to reduce beach erosion and flooding
ICZMU policies and practices		
"Hard" options implemented (sea walls, revetments, groyne fields, gabions and breakwaters) to protect developed southwest and west coasts	Absorb wave energy and stimulate beach nourishment. Important in protecting beach-based tourism product	CZMU is focusing on incorporation of climate change adaptation in engineering designs
"Soft" options used e.g. beach nourishment	Projects located in areas of high investments in tourism facilities and beach supports economic activities	An adaptation response to climate change e.g. erosion and SLR
Coral reef transplant	Supports beach & diving tourism	Reduces coastal erosion from SLR and storm surges
Infrastructure policy & projects		
Water conservation	Desalination plant (1999) Water recycling and water storage mandatory for hotels	Adaptation to drought and water scarcity Tax rebate for new hotels
Central sewerage system	On tourism intensive southwest and west coasts.	Reef health maintained and coastal protection promoted

Source: Michelle Mycoo, Sustainable Tourism, Climate Change and Sea Level rise adaptation Policies

ICZM Benefits

SOCIAL BENEFITS	ECONOMIC BENEFITS	ENVIRONMENTAL BENEFITS
Provides diverse opportunities for recreation, leisure and cultural activities and thus improves the quality of life	Supports sustainable economic activities and thereby ensures income in the long run	Ensures integrity of the coastal environment and biodiversity as a natural system
Helps resolve conflicts	Allows better zoning and use allocation	Ensures the sustainable use of natural resources
Strengthens institutional frameworks and enforces cooperation among stakeholders on the basis of shared objectives	Improves management (legal framework, risks, help to the decision-making process) and thus permits gains in efficiency and time	Preserves and improves natural areas (habitats, species and biodiversity)
Provides security from natural hazards and risks	Develops new economic instruments to finance environmental protection	Improves pollution control
Raises public awareness and favours information exchange on sustainable development and environmental issues	Promotes environmentally-friendly technologies and cleaner production for the markets of tomorrow	Improves beachfronts and soil alteration management
Encourages broader public participation	Adds value to products through eco-labelling schemes	Integrates river basin management

Source: Sustainable Coastal Tourism - an integrated planning and management approach - UNEP + Priority Sctions Programme

[MAP description and sources]

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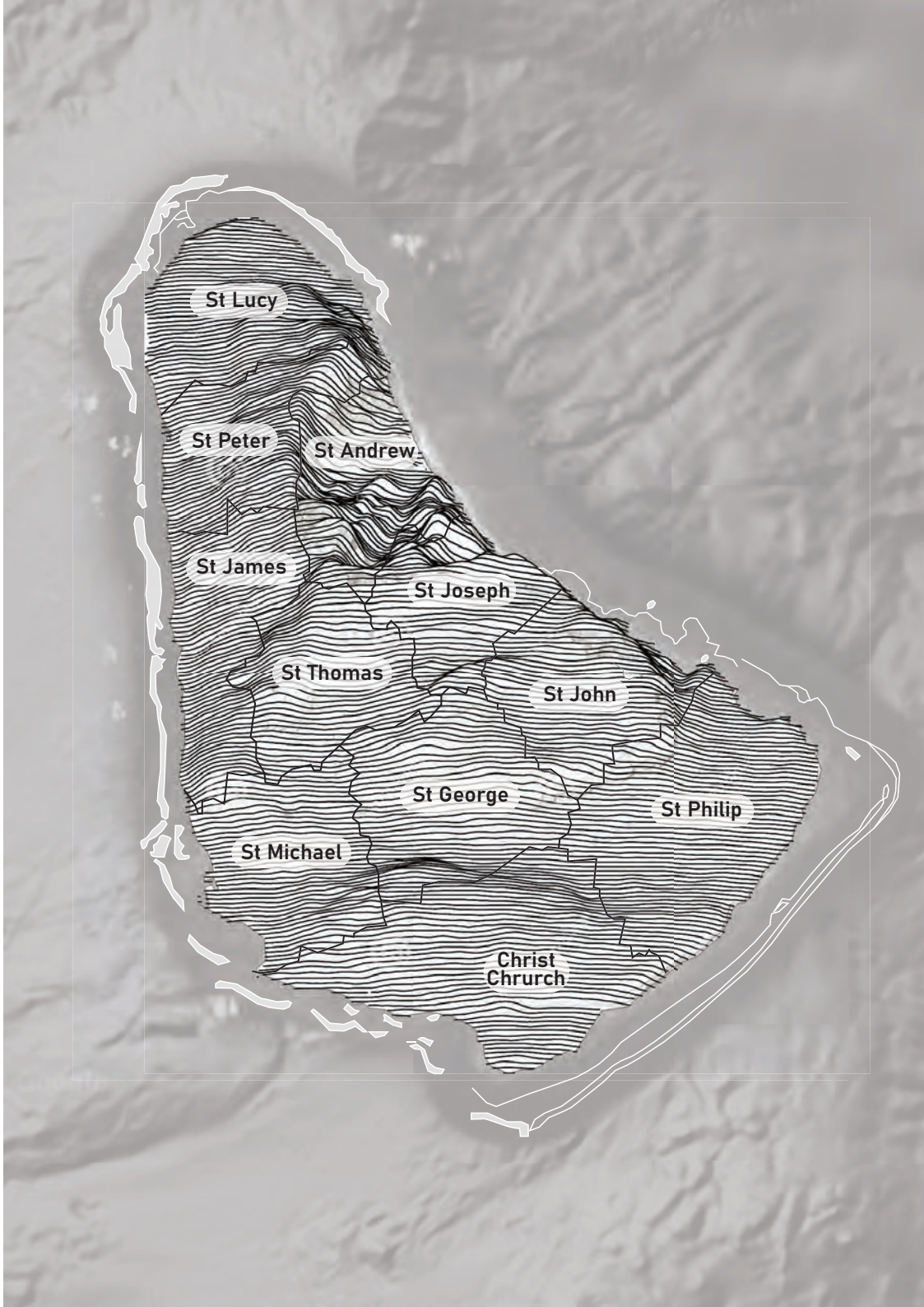
BARBADOS

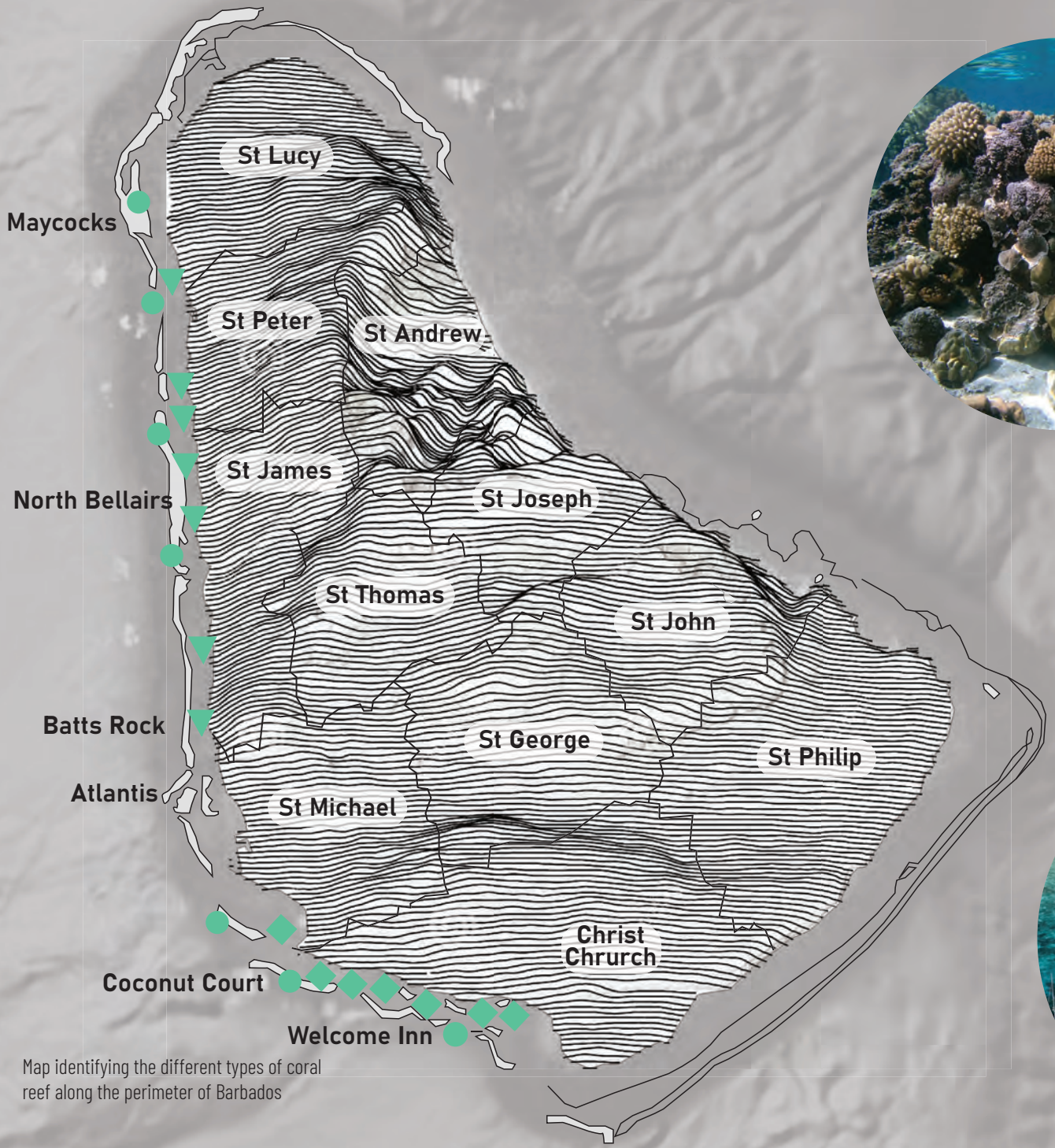
Sustainable tourism, physical planning policy and practice, and climate change adaptation:

Sustainable tourism in Barbados is unattainable if coral reefs, one of its most important coastal assets, are vulnerable. In the context of SLR and coastal erosion, reefs play a key role in ecosystem-based adaptation to climate change because they serve as natural breakwaters.
Barbados' existing physical planning policy minimizes soil erosion and sedimentation given that coral reefs require clear water conditions to survive.

Over the past 30 years, coastal setbacks have been used to regulate development in Barbados. A coastal setback distance is a prescribed distance to a coastal feature within which all or certain types of development are prohibited. The TCPD applies a coastal setback policy because it eliminates the need for seawalls and other engineering structures that reduce beach erosion and flooding but which may also affect coastal property. In islands such as Barbados, setbacks also provide buffer zones between the ocean and coastal infrastructure, where the beach zone may expand or contract naturally, as observed by French (2006). Additionally, setbacks enhance the probability that artificial light will not shine directly on the beach to disturb turtle nesting.
Despite the flexible application of policy guidelines, setback distances remain short, given the storm surges and coastal erosion that Barbados has experienced in the past. This argument dates as far back as the 1990s, when Wason and Nurse (1994) suggested variations in coastal setbacks for Barbados. They recommended that for slopes less than 1:20, a 30 meter distance should apply; slopes of 1:4 to 1:20 should be setback 15 meters; and for coastal cliffs of 1:1 or greater, an 8 meter distance should be adopted.

New evidence on climate change projections highlights the importance of revisiting the setback policy for Barbados. Fish et al. (2008) found that beach area was lost from all of Barbados' beaches under all SLR scenarios with a 10 meter and 30 meter setback. They argued that whereas the benefits of long-term beach maintenance accrued from adequate setback regulations are clear, consideration must also be given to issues that can hinder the implementation or effectiveness of setbacks.. One difficulty is that the tourism industry has been concentrated in the coastal area since long before the imposition of setback standards. Over 90% of all hotels are within or proximal to the beach (GOB, 2001; Belle and Bramwell, 2005). Approximately 90% of the island's hotels are located within 1 kilometer of the high water mark and less than 20 meters above sea level (Belle and Bramwell, 2005; Dulal et al., 2009). The island's hotels are therefore located almost exclusively within 1 in 500 and 1 in 100 inundation zones, placing them at risk of major structural damage (GOB, 2001). Moreover, although Barbados has not experienced a major hurricane in recent times, it remains vulnerable. Approximately 50% of hotel rooms in Barbados are at risk from a category 3 hurricane because of their proximity to the mean sea level, and Becken and Hay (2007) estimate replacement costs of hotels could be up to US$ 550 million.



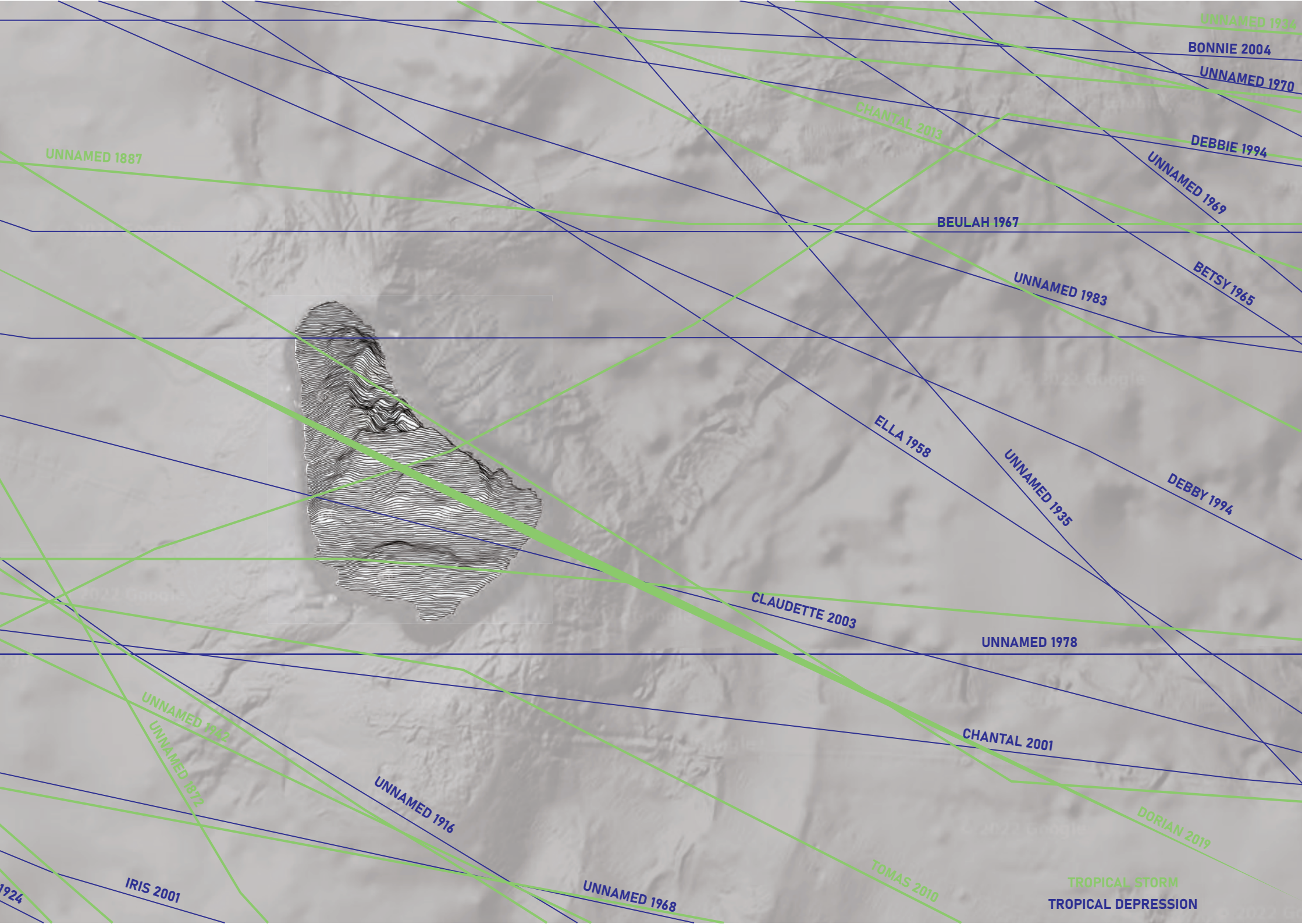


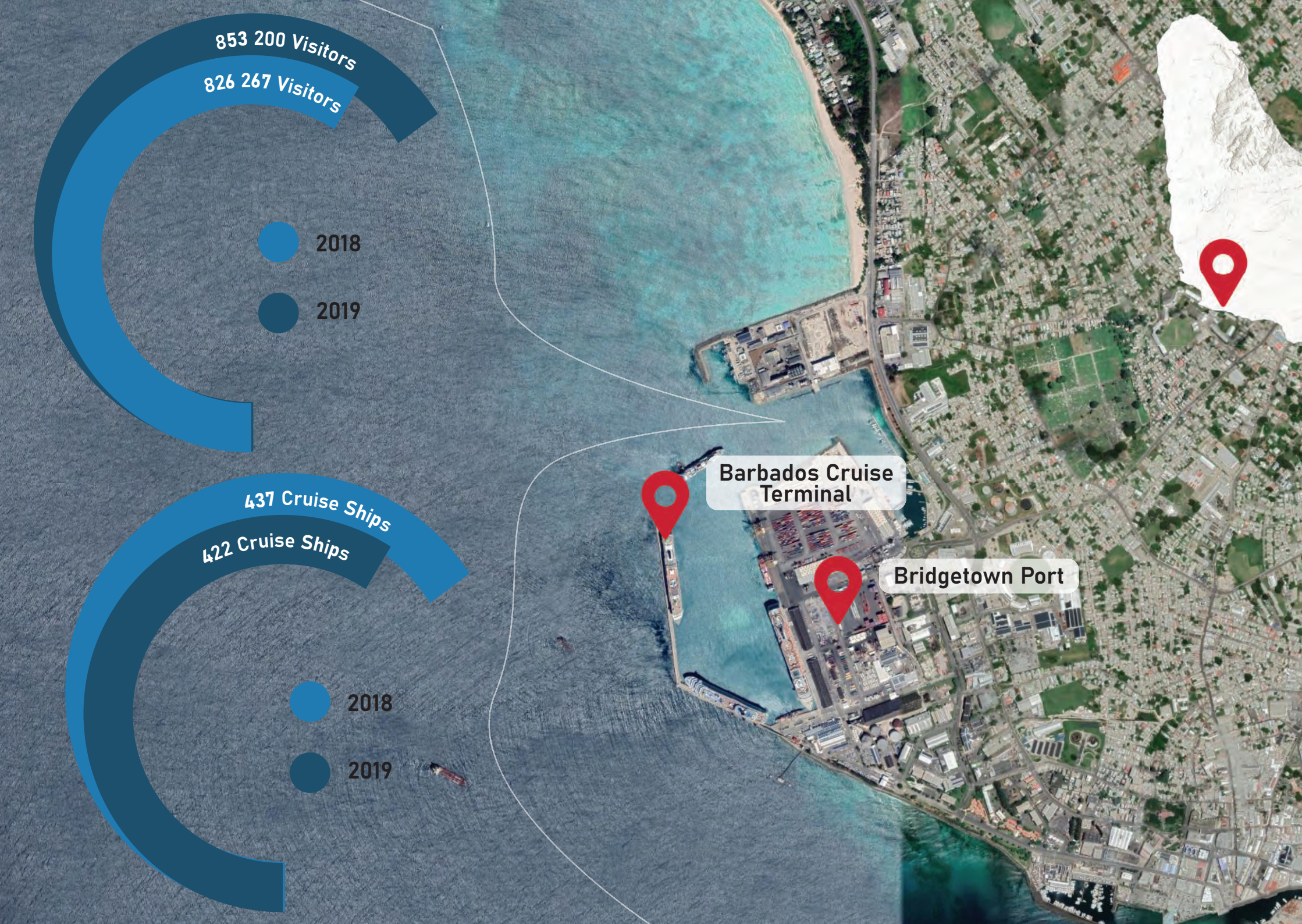
Map identifying the different types of coral reef along the perimeter of Barbados

PATCH CORAL REEF

FRINGING CORAL REEF

BANK CORAL REEF


UNNAMED 1887
BONNIE 2004
UNNAMED 1970
CHANTAL 2013
DEBBIE 1994
UNNAMED 1969
BEULAH 1967
BETSY 1965
UNNAMED 1983
ELLA 1958
UNNAMED 1935
DEBBY 1994
CLAUDETTE 2003
UNNAMED 1978
UNNAMED 1942
UNNAMED 1972
CHANTAL 2001
UNNAMED 1916
DORIAN 2019
TOMAS 2010
IRIS 2001
UNNAMED 1968
TROPICAL STORM
TROPICAL DEPRESSION


853 200 Visitors
826 267 Visitors
2018
2019
437 Cruise Ships
422 Cruise Ships
2018
2019
Barbados Cruise Terminal
Bridgetown Port

Integrated coastal zone management (ICZM) can assist in planning for adaptation to climate change because it provides an anticipatory and predictive approach to facilitate a response to medium and long-term concerns such as SLR, as well as responds to short-term needs (Belle and Bramwell, 2005; Tobey et al., 2010). Tobey et al. (2010) have argued that the process and best practices of ICZM are not radically changed by applying a climate lens. From their perspective, the best practices of planning and implementation of coastal management measures apply equally to climate change as they do to other coastal issues.

Among the three generic climate change adaptation strategies that exist, Barbados has focused on protection and accommodation as opposed to retreat. The accommodation or "do nothing" approach has been applied to undeveloped locations on the east coast of the island. Measures for beach protection and enhancement have been implemented on the more highly developed southwest and west coasts (Brewster, 2007; Fish et al., 2008). These include "hard options" such as sea walls, revetments, groyne fields, gabions and breakwaters, which absorb wave energy and stimulate beach nourishment.

Protection measures

The CZMU has taken into account that "hold the line" measures intended to reinforce coastal lands should be designed to the highest standards otherwise they would temporarily mitigate erosion and be costly to maintain if poorly designed. But these "hard" structures are also aesthetically unpleasing, as they visually impair the natural ambience of beaches (Mycoo and Chadwick, 2012). However, the CZMU has "softened" the vista of a highly engineered shoreline by integrating landscaping to help the beaches look more natural in appearance. As part of the promotion of sustainable tourism, the design of visually pleasing boardwalks and landscaping has helped dilute the harsh concrete vistas that would otherwise encircle the coast.

Site visits in 2010 and 2013 revealed that three projects were completed: the Welches Beach Improvement Project, the Rockley to Coconut Court Waterfront Improvement Project and one segment of the Holetown Beach Improvement Project. In mid-2013, site investigations into the impact of the "hard" coastal structures revealed positive results. On the southwest and west coasts where these structures have been built there has been success in minimizing erosion and achieving beach accretion.

Planned retreat

Planned retreat is a controversial, untenable option for dealing with climate change and SLR because the coast of Barbados is highly developed. Cambers et al. (2003) have found that planned strategic retreat using setback distances for hotels takes a long time because these buildings have an economic life span of 25 to 30 years before they need to be extensively renovated, converted or demolished. They argue that it is at the end of this life span when there is the opportunity for rebuilding further back from the water. Fish et al. (2008) argue that although it is an expensive option, moving buildings back could minimize the likelihood of paying out considerable amounts in the future.

Beach nourishment

Another popular approach is the use of "soft" measures such as beach nourishment. Restoration occurs by bringing sand to the beach from inland sites or adjoining beach segments, or by hydraulically pumping sand onshore from an offshore site. With climate change, beaches will seek to re-establish their equilibrium by shifting landward in response to rising seas.

Ecosystem-based adaptation

Eco-system based measures are used in Barbados to address reef damage and coastal erosion arising from SLR and storm surges. Given coral reef damage over the years, the CZMU has embarked on a coral reef transplantation project because corals are an essential constituent of Barbados' beaches and a major asset for sustainable tourism. Recent assessments have shown that the transplanted corals are in good health.

The CZMU uses several adaptation measures in response to erosion and flooding in coastal areas, but the right balance between "hard" and "soft" options needs to be achieved over the long term, and cost-benefit analysis will be of tremendous help as a decision-making tool. Striking the right balance of adaptation measures is especially important in economic, ecological, social and political terms.

Policy recommendations for SIDS

SIDS policymakers can learn from sustainable tourism policies implemented in Barbados that are doubling as pre-emptive measures for adaptation to climate change and SLR.

Physical planning policies, risk assessment and hazard mapping

In SIDS where coastal erosion is severe, physical planning policies should be implemented to control sediment loss and minimize beach erosion. Failure to do so will result in coral reef damage, beach loss, and erosion of beachfront tourism accommodations. Coastal setbacks are recommended to minimize these impacts, but some flexibility in applying setbacks would be needed.A place-based approach to coastal tourism management is essential and therefore these setbacks should be based on the merits of the specific proposed coastal development.

Sea Wall

Image: the Maldives

Sea walls are structures that usually incorporate into a promenade, and are built to limit erosion caused by wave attack. They can be made from materials such as; timber, steel, masonry blocks, precast concrete units and in situ concrete. They are commonly 3-5 m (10-16 ft) high and curved to reflect back the energy of the waves and prevent wave overtopping.

Advantages;
Effectively minimizes loss of life in extreme events and damage to property caused by erosion.
Can exist longer in high energy environments in comparison to 'soft' engineering methods.
Forms a hard and strong coastal defense.
Can prevent coastal flooding in some areas.

Disadvantages;
Cost to built and maintain is high.
Can cause beaches to dissipate rendering them useless for beach goers.
Scars the very landscape that they are trying to save and provides an 'eyesore.'
Can disrupt natural processes that can lead to increased erosion down drift from the structure.
Curved sea walls reflect the energy of the waves back to the sea. This means that the waves remain powerful. Over time the wall may begin to erode.

Breakwaters

Image: Faw Port, Iraq

'moles' are constructed in outer harbour areas to dampen heavy waves and allow vessels to enter and exit with less swell. They can be sloped or vertical and are typically constructed from concrete blocks, rock fill or a combination of both depending on site-specific conditions such as water depth, range of tides, and foundation conditions.

Advantages;
Fixed breakwaters usually consist of mounded rubble or concrete barriers. These types of breakwaters offer protection from high and fast-moving waves and can still offer protection even if mildly damaged in heavy storms. Stone or rubble dislocated by heavy waves can be easily repaired without having to replace the entire structure. Some aquatic creatures use breakwaters as a habitat, and fixed breakwaters placed with open segments allow free movement of aquatic wildlife.

Disadvantages;
Fixed breakwaters are semi-permanent structures that require construction by a knowledgeable person with an understanding of the area's wave transmission. Construction costs can be relatively high when compared to floating breakwaters. Breakwaters that are continuous can pose an ecological hazard when placed in wetlands by barring organisms from entering or leaving. Fixed breakwaters are often an eyesore -- an aesthetically displeasing sight on the shoreline.

Rip-Rap

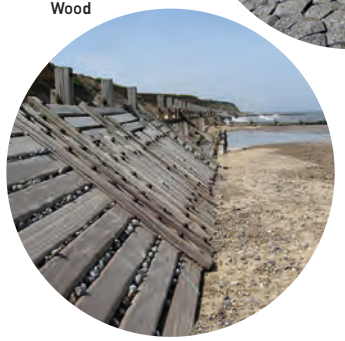
Image: Lake Norman, North Carolina

Riprap is a permanent layer of large, angular stone, cobbles, or boulders typically used to armor, stabilize, and protect the soil surface against erosion and scour in areas of concentrated flow or wave energy.

Advantages;
Absorb the energy of waves.
Allows the build up of a beach.

Disadvantages;
Can be expensive to obtain and transport the boulders.
Can be a visual eyesore
Possibly dangerous for kids

Stone



Wood

Revetments

Image: Marazion, Cornwall, UK

Revetments are onshore sloped structures used as an alternative to sea walls to reduce the landward migration of beaches. They limit the energy of the waves as they break and so reduce their erosive power. They can be constructed using stepped concrete, stone or asphalt and should be designed to have a sufficiently high crest to avoid wave overtopping. In their most basic form, they can be constructed using timber with a rock infill.

Advantages;
Strong and provide good protection by absorbing the waves energy.

Disadvantages;
Have a relatively short life span (30-50 years)
Quite expensive.

Gabions

Image: Newcastle, Australia

Gabions are steel mesh cages that are filled with rocks, concrete and sometimes aggregate, and used to stabilise vulnerable areas, by absorbing wave energy. They can project out at right angles from the coastline like groynes, or can be constructed as retained walls, battered or stepped back rather than being stacked vertically. The strength of the wire used to tie the cages together is the critical factor. Galvanised steel wire is commonly used, but stainless steel and PVC-coated wire can also be used.

Advantages;
Helps to protect the coast line by stopping the waves pounding at the cliffs.
Quite natural, as rubble or pebbles can be used.
Gabions are also quite cheap.

Disadvantages;
May be considered unsightly by some people
May take up quite a lot of space up on the beach as lots of gabions are needed to provide plenty of protection
If the rocks inside the cage become worn down the whole cage will need taking out and replacing. if the gabions are stacked up in a wall and a lower one needs replacing this will mean taking out all the ones above it aswell before replacing it and rebuilding the wall. this would take lots of time and money

Groynes

Image: Maroochy Beach, Queensland, Australia

Groynes are walls of concrete, stone or timber that extend out from beaches, acting as barriers. They protect or retain beach material and slow losses through long-shore drift. Steel sheet piling may also be used, but it must be suitably capped and backed with concrete. It is important that the piling penetrates to a depth that will prevent wave action from underscoring the structure.

Advantages;
Prevents the movement of beach material along the coast by longshore drift.
Doesn't affectr access of the beach.
Allows the build up of a beach. Beaches are a natural defence against erosion and an attraction for tourists.

Disadvantages;
Can be seen as unattractive.
Costly to build and maintain.

Living Breakwaters

Image: Living Breakwaters Coastal Resilience for Staten Island

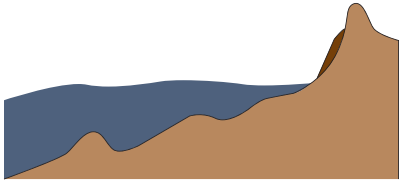
The project is designed to reduce the risk of storm damage to Staten Island by creating habitat breakwaters to attenuate waves and reduce shoreline erosion. The living infrastructure will also provide habitat to the bay's rich ecosystem of marine life, rebuild local oyster populations and create educational, recreational and commercial opportunities for residents. Additionally, a land-based "Water Hub" facility will be constructed to provide educational, monitoring, stewardship and social engagement programs designed to bring residents to the water to re-engage with their ecology

Ocean Pools

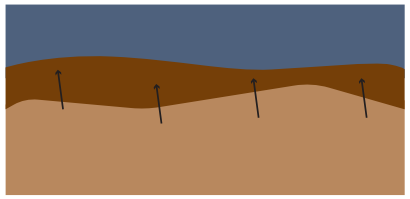
Image: Ocean Pools in Australia

A version of a sea wall. Ocean pools or ocean baths are defined as public seawater pools sited on a rocky surf coast, so that waves can wash into the pool. The width, length and depth of ocean pools varies and often depends on their location on the coastline. Can be used as a tourist attraction.

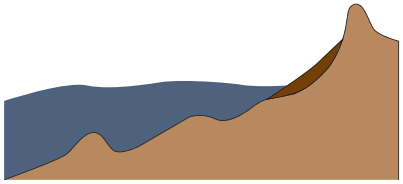
Types of Coastal Nourishment



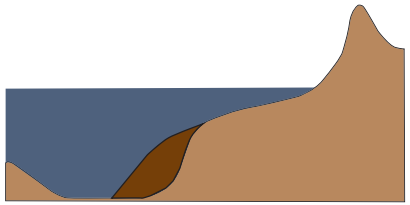
Backshore Nourishment



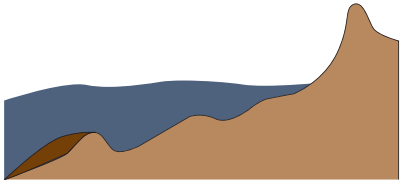
Creation of New Beach



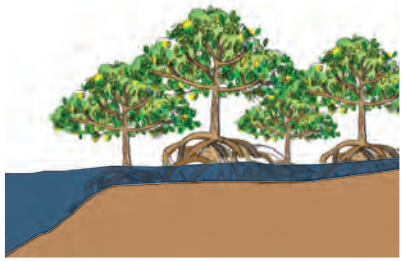
Beach Nourishment



Channel Wall Nourishment



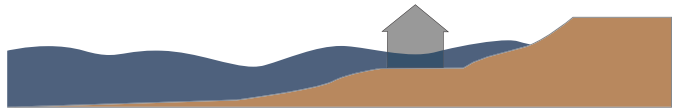
Shoreface Nourishment



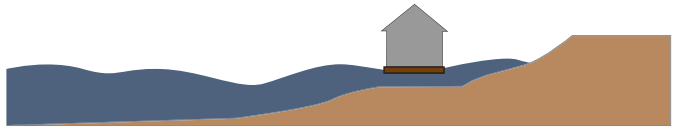
Vegetation

Source: Shore Nourishment - http://www.coastalwiki.org/wiki/Shore_nourishment

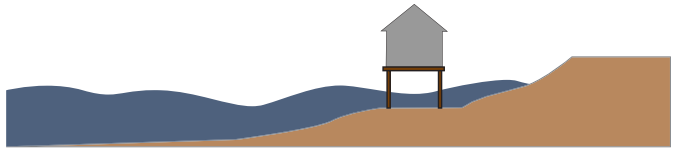
Types of Sea Level Rise Adaptation



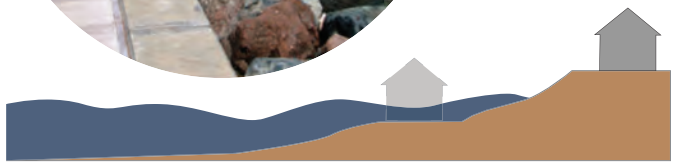
No Response



Accomodate



Accomodate



Planned Retreat

Source: Managed Retreat in The United States - https://www.sciencedirect.com/science/article/pii/S2590332219300806

ICZM, sustainable tourism, and climate change adaptation strategies

SIDS should adopt ICZM because it has proven to be a successful strategy for addressing past failures in the promotion of coastally-oriented mass tourism and has become important in the context of climate change adaptation, as the Barbados case study highlights. Moreover, as the Barbados study has revealed and as noted by Nicholls (2011), SIDS require an integrated coastal management philosophy that incorporates climate change adaptation strategies with wider societal and sustainable development objectives.
SIDS have three strategies to select from: protection; accommodation; and retreat. However, a stand-alone strategy is ill-advised because it may compromise successful adaptation to climate change. In practice, many real-world responses are hybrid, combining elements of more than one approach.

One of the lessons for SIDS is that not all three strategies can be easily implemented and will need to be considered over the short, medium and long term. SIDS policymakers should be aware that protection and accommodation strategies are short to medium term measures and less contentious to implement. In contrast, relocating built development is a long-term costly measure, especially if the overwhelming majority of hotels are already located in the coastal zone. Moreover, policymakers should be sensitized to the possibility that stakeholders will resist the abandonment of high value real estate to the sea unless cost benefit analysis is conducted.
SIDS that are economically dependent on erosion-prone beaches should consider the use of coastal structures in the short term if they are affordable. Barbados has successfully used protective coastal infrastructure to arrest severe beach erosion on the southwest and west coasts where most of its hotels and popular beaches are concentrated.

In addition, ecosystem-based measures such as maintaining existing vegetation, re-vegetation where loss has occurred, and coral reef replanting should be incorporated into climate change adaptation strategies and the costs of doing so should be weighed against long-term benefits.
SIDS are concerned about the financial costs of climate change adaptation, especially given their small carbon footprints. The question of who will pay and who will benefit from adaptation measures is controversial and should be the subject of policy debate among Governments, investors, and communities. Barbados has secured loans from international financial institutions to address severe coastal erosion where its hotels are spatially concentrated.

Infrastructure policies and projects
Infrastructure policies and projects that promote sustainable tourism are useful adaptation measures to climate change. An important policy reform for SIDS is increased investment in central sewage treatment projects with the appropriate level of treatment to minimize coastal ecosystem degradation. As Barbados has found, without effective sewage treatment, coral reefs will be degraded. Coral reefs are essential to beach sand production, snorkeling, diving and fisheries, as well as to minimizing the coastal erosion associated with climate change and SLR, as they function as natural breakwaters. In SIDS where no central sewerage system exists and hotels located on the coast use private sewerage treatment plants, these plants should be carefully monitored by certified inspectors trained by academic institutions to ensure compliance with waste disposal regulations. Additionally, tax incentives should be offered to hoteliers for improving their wastewater disposal system.

Water conservation
Climate change models predict that water scarcity will result from drought or saline intrusion of freshwater resources associated with climate change. The construction of desalination plants can cause severe environmental damage of the sensitive coastal ecosystems found in SIDS. Water conservation policies therefore should be given high priority. Among the policies that should be implemented is the use of volumetric-based charges for hotels, charges which should not be heavily subsidized so as to discourage high water consumption levels. Providing tax incentives for hotels that install water-saving devices should also discourage water wastage. A mandatory policy should be implemented requiring that all new tourism-related buildings with a gross area of 93 meters or more should build cisterns or rainwater storage tanks for secondary use such as the irrigation of golf courses and hotel landscapes.

Capacity-building and institutional reform
Although there is no national coastal tourism policy to support sustainable development, Barbados has shown that this policy gap can be managed when there is clear responsibility and delegation of powers between government agencies such as the TCPD and CZMU. SIDS need to ensure that there is strong collaboration among their physical planning and environmental management agencies as well as CZMUs where these have been established. The success of policy implementation depends on strong institutional capacity for monitoring and enforcement, reliable databases for decision-making and sensitisation of policymakers on how critical governance is to sustainable natural resources management in the face of climate change challenges.

CONCLUSIONS, LESSONS LEARNED, AND FUTURE SCENRIOS

Policies should be linked to market mechanisms that offer incentives for adoption, including subsidies and rebates. This matter calls for stakeholder input informed by an awareness of the philosophy of equity, economic efficiency, and environmental sustainability. Furthermore, these policies should be an integral part of SIDS' national sustainable development policy. Much work still needs to be done among SIDS, including: conducting rigorous research, prioritizing and costing measures that will achieve climate change adaptation and sustainable tourism, weighing the benefits to society, building adaptive capacity among all stakeholders, exercising vigilance in systematically monitoring, and evaluating the effectiveness of these measures in adapting to climate change.

We may be Small Island Developing States but we are also BIG OCEAN STATES!

The Blue Economy Encourages SIDS to look beyond immediate land spaces and towards exclusive economic zones (EEZ), which represent about 30% of all oceans and seas.

By harnessing all of our potential, including the blue, we can promote sustainability, resilience and achieve greater development and growth in the region!

UNDP Barbados and the Eastern Carribbean

[MAP description and sources]

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