Climate change related impacts on the transportation of the Caribbean SIDS

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Synopsis

CC and transportation in the Caribbean SIDS

Caribbean SIDS exposure to CC

Transport infrastructure impacts

Transport is demand-driven service (in Caribbean SIDS, tourism-driven)

Adaptation requirements

CC and transportation in the Caribbean SIDS

International (maritime and air) transportation, crucial for the sustainable development of SIDS

Recent research suggests that forecasts about CC and particularly the intensity/frequency of extreme events in the Caribbean may have to be upgraded (Allison et al., 2009; IPCC SREX, 2012)

But, transportation infrastructure in the Carribean SIDS has mostly been designed for typical weather patterns and is particularly vulnerable to the new extreme conditions

Caribbean SIDS exposure

High exposure

- Large population densities at the coast (CARICOM, 2003)
- Most infrastructure (including transport facilities), industry and services (particularly tourism) located at the coast
- A global hotspot for marine biodiversity (ECLAC, 2011)

Elevated CC-induced risks due to

- Long-term sea level rise (SLR)
- Increased air and sea surface temperatures and ocean acidification, resulting in habitat losses that increase environmental risks and lower incomes (tourism)
- Increases in extreme events

Transport infrastructure impacts

Port facilities will be affected by SLR and increased storm surges, resulting in periodic inundation and delays/interruption of shipping services

Jetties/breakwaters protecting ports will be less efficient, requiring raising and/or strengthening

Increasing sea levels will result in larger tidal prisms (volume of tidal water entering/leaving the harbours) and foundation scouring or silting

Heavy precipitation events can result in landslides and disruption of the road network

Higher temperatures/heat waves will affect runways (heat buckling) and aircraft lift, resulting in payload restrictions, cancellations and disruptions; runway length extensions will be required (which may not be always easy)

Recent case studies indicate very substantial CC-induced impacts for transportation in the Caribbean SIDS

Transport is demand-driven
(in Caribbean, tourism-driven)

International visitors fly to the Caribbean for the 'sun and sand'

→

However, most Caribbean beaches are under a deadly threat of CC-driven erosion- for many Caribbean islands, an average beach retreat/erosion of 0.5-1.0 m/yr- (Cambers, 2009).

It appears that the problem of CC-driven beach erosion can devastate the Caribbean SIDS economy (assets and services) →

If the tourism industry is devastated, then international transportation to Caribbean SIDS will also collapse

Adaptation requirements

Realistic predictions of impacts

Building local capacity is of paramount importance (UNEP-RiVAMP project) Open source modelling software particularly significant

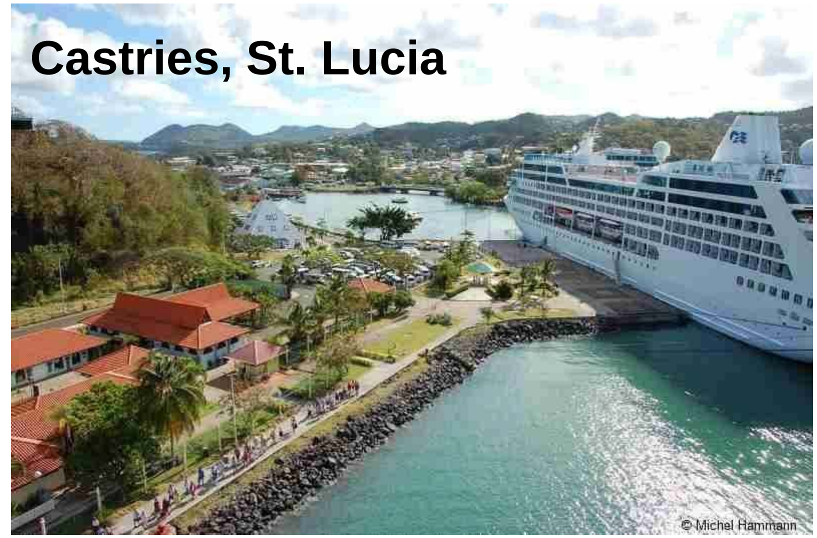
Science-based policy formulation, that takes into consideration the specifics of the region

Concerning transportation infrastructure, building resilience is very important as relocation of assets is, in most cases, not an option


International Conference on
Adaptation of Transport Networks to Climate Change
25 - 26 June 2012, Alexandroupolis, Greece
UNITED NATIONS
ECONOMIC COMMISSION FOR EUROPE
Hosted by Evros Chamber of Commerce and Industry and the Hellenic Chambers Transport Association
Under the auspices of the Ministry of Infrastructure, Transport and Networks and
the Ministry of Environment, Energy and Climate Change of Greece

Thank you!!

Seaports are lifelines for the Caribbean SIDS



Imports of food and petroleum products 3.5 and US $ 14 bn, respectively (Nurse, 2011)

Ports are also gateways for imports of most manufactured goods and for most bulky exports

Critical to tourism industry (cruise ships, yachts) and fisheries

Berthing & airport landing fees-significant foreign exchange contributions

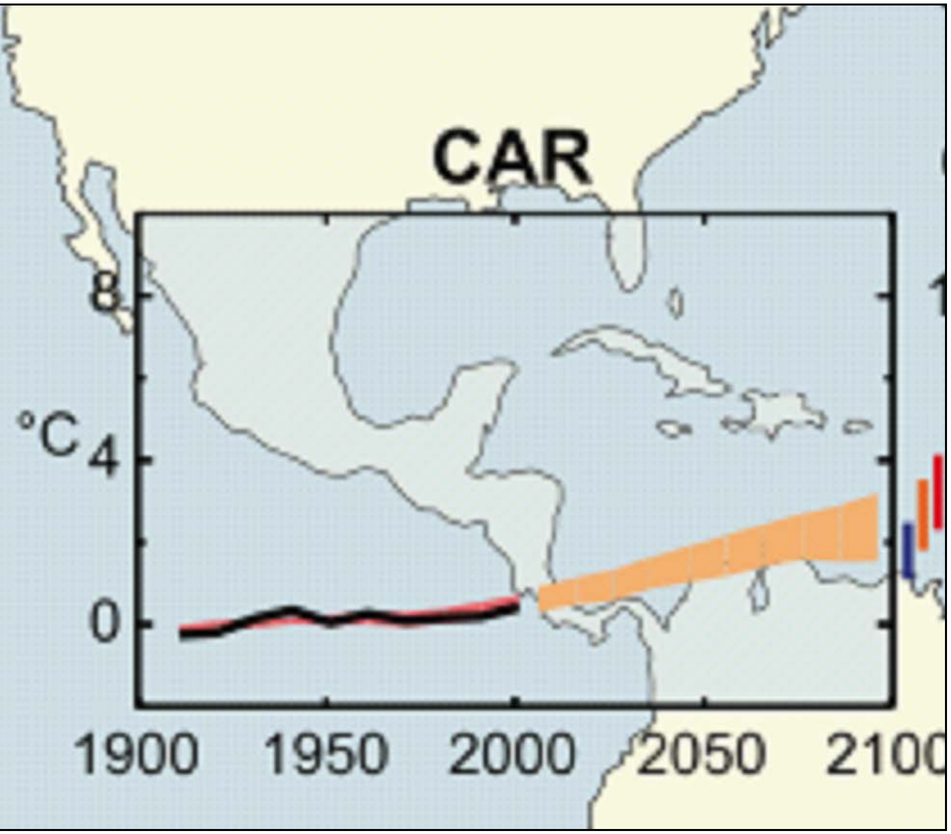
The most air transported tourist-dependent region in the world

Country	Travel & tourism % of GDP (World Ranking, 2010)	% visitors arriving by air
Anguilla	61.0 (5)	84
Antigua & Barbuda	78.5 (1)	95
Bahamas (the)	46.5 (8)	88
Barbados	48.1 (6)	92
Belize	28.2 (17)	85
Bermuda	11.2 (65)	86
British Virgin Islands	43.7 (10)	94
Cayman Islands	23.3 (24)	67
Dominica	23.3 (23)	88
Grenada	24.4 (22)	96
Guyana	11.5 (63)	99
Haiti	7.0 (125)	n.a.
Jamaica	25.4 (20)	92
Montserrat	n.a.	99
St. Kitts & Nevis	30.5 (16)	91
St. Lucia	35.1 (13)	90
St. Vincent & the Grenadines	23.6 (23)	98
Suriname	4.6 (164)	93
Trinidad & Tobago	10.9 (66)	95

12% of GDP

In some SIDS > 50% of GDP (ECLAC, 2011).

Trends and Projections: Temperature



Temperature anomaly relative to 1901-1950 (IPCC, 2007)

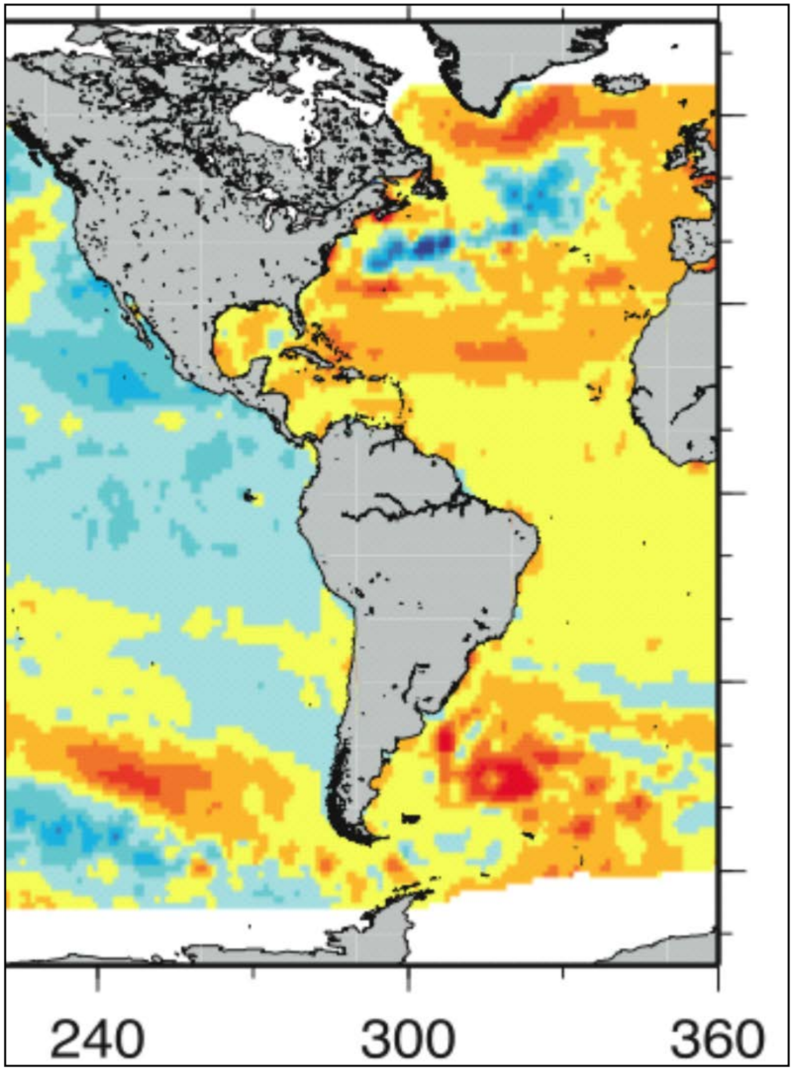
- Present trend (1906-2005): black line
- Projections or A1B scenario: orange envelope.

Projected ranges for 2091-2100 for the

- B1 scenario (blue),
- A1B scenario (orange)
- A2 scenario (red).

Projections of 0-9-4.1 ^{0}C increases in surface air temperature by 2070-2099

Trends: Sea level rise (SLR)

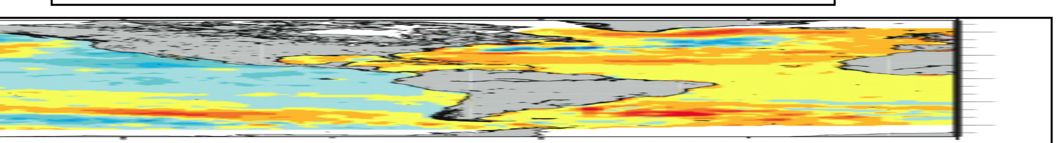


1993-2003 trends in mean SLR level (mm/y) based on satellite altimetry (after Cazenave & Nerem, 2004)

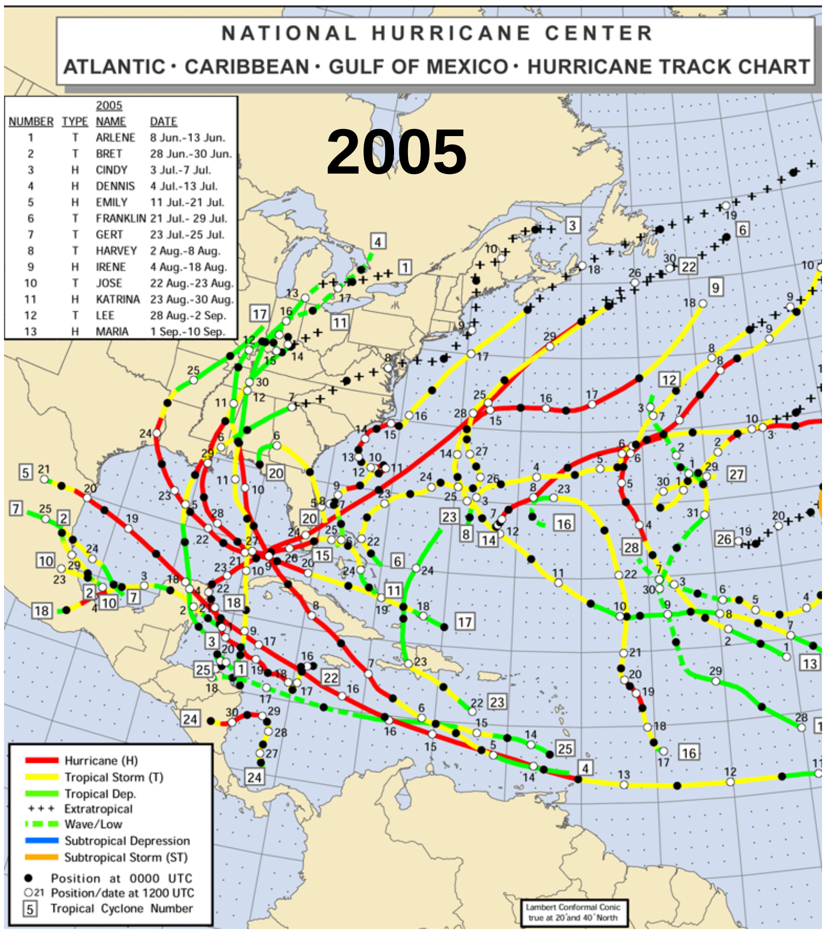
IPCC (2007) SLR projections for 2090s are 0.13-0.56 m relative to 1980-99

More recent studies suggest SLR rates up to 3 times higher by the 2090s (e.g. Rahmstorf 2007, Rohling et al, 2008)

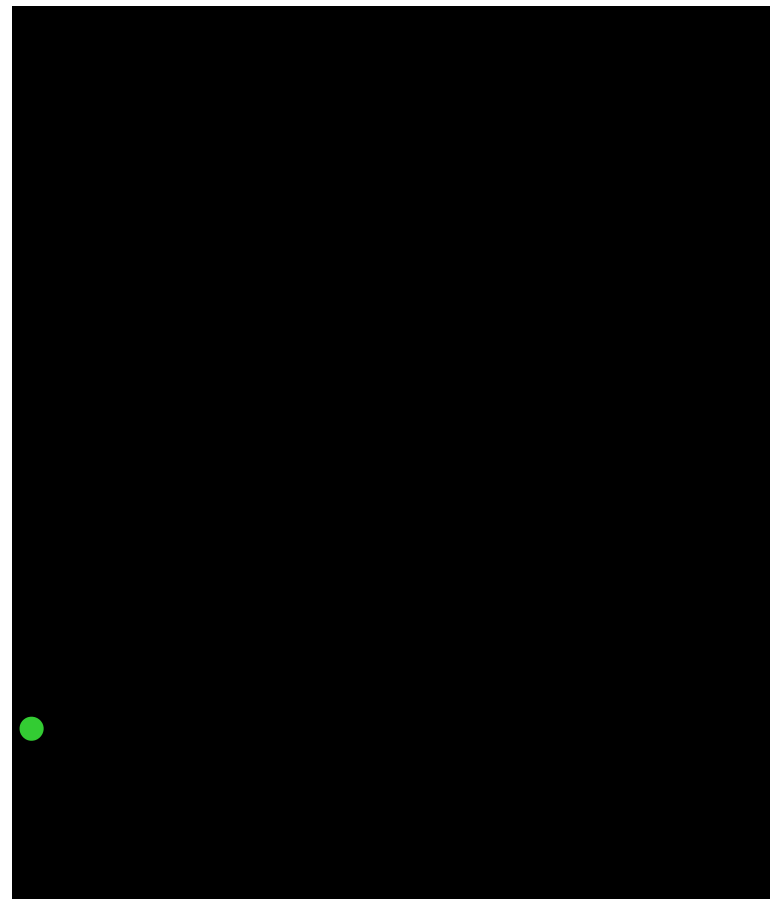
Land subsidence, which enhances SLR effects along coastal areas also occurs at varying rates (e.g. Guyana)



Trends: Tropical storms and hurricanes

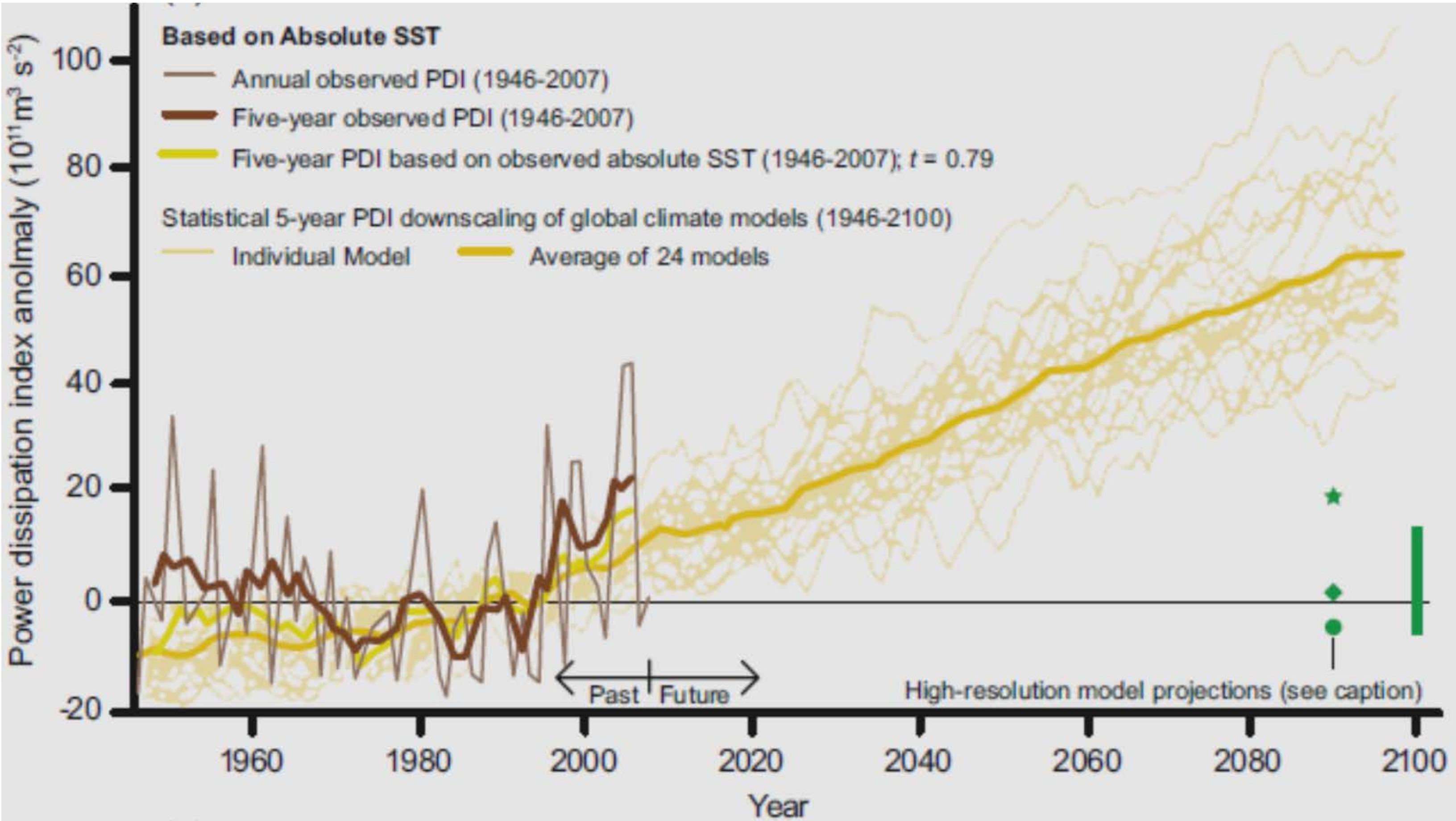


Tropical storms 1960-2010



Becker et al., 2012

Trends and Projections: Hurricanes

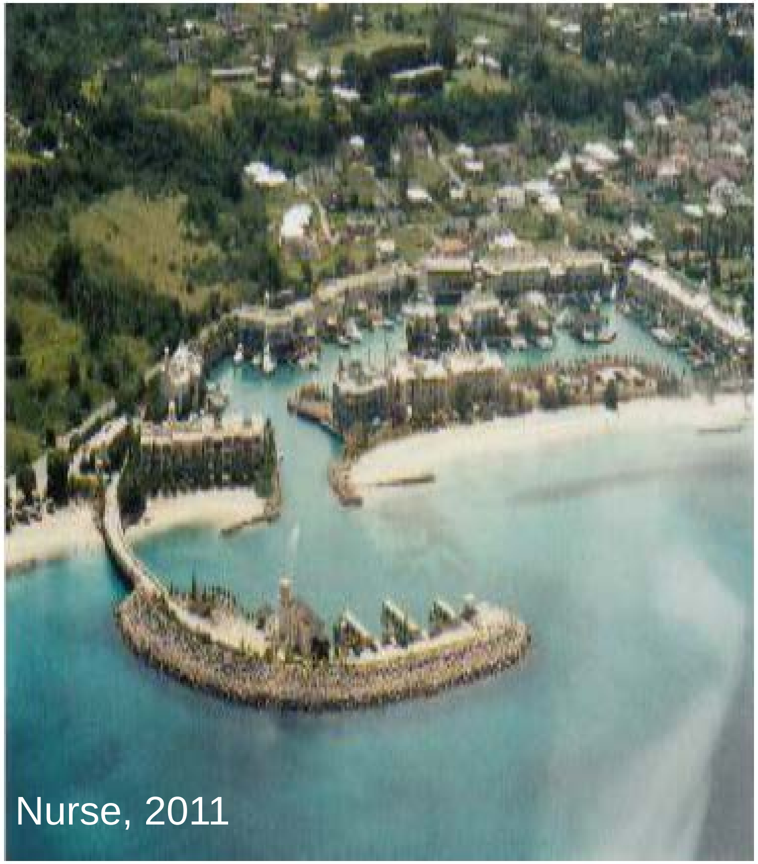


Observed/projected hurricane intensity (Power Dissipation Index-PDI). (Steffen, 2009).

Port Zante, St. Kitts

The cruiser pier was destroyed by Hurricane Georges (1998) and again by Hurricane Lenny (1999).
It has been now redesigned with massive revetments (Nurse, 2011)

Port St. Charles, Barbados



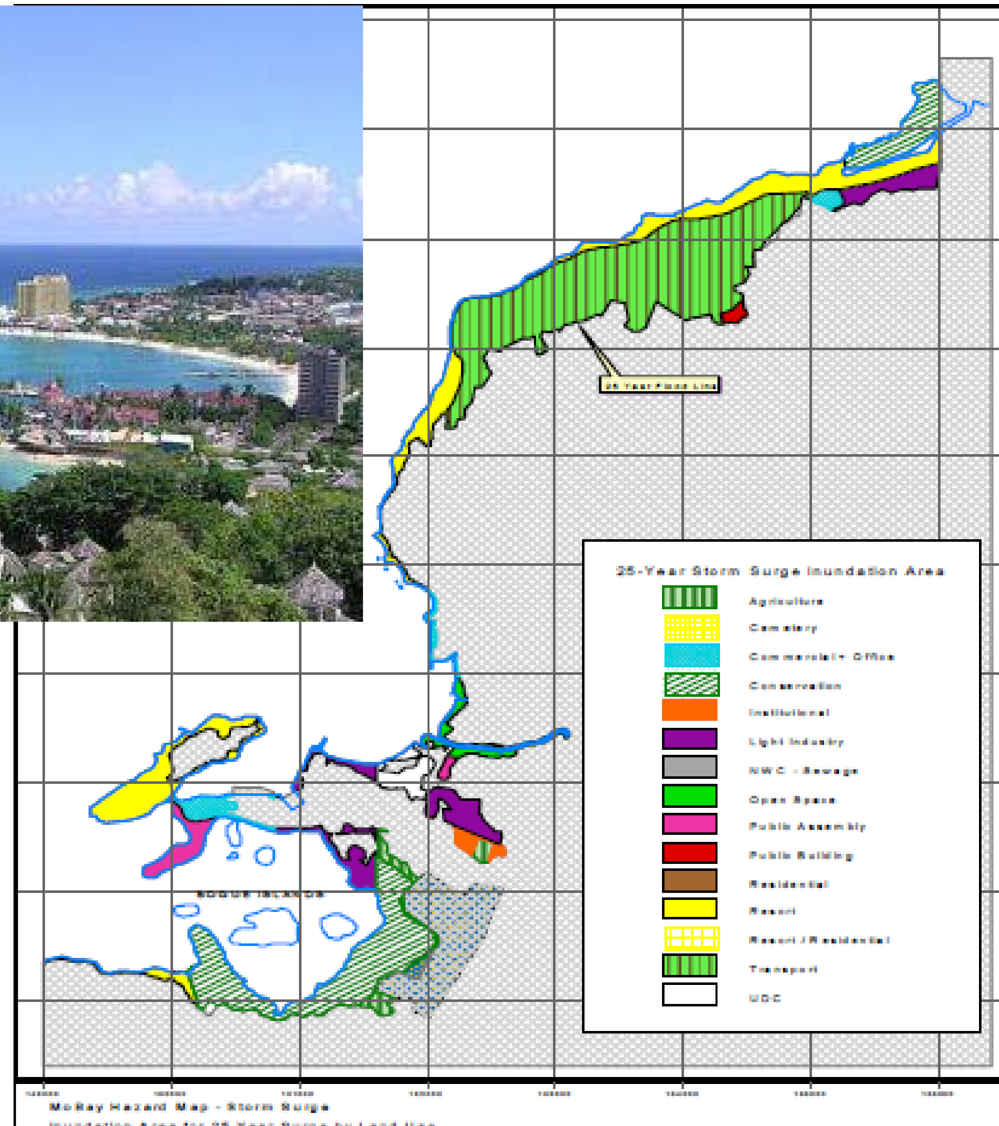
Nassau, Bahamas

Bahamas, highly vulnerable to SLR, as large part of the country has an elevation of < 2 m above the present MSL

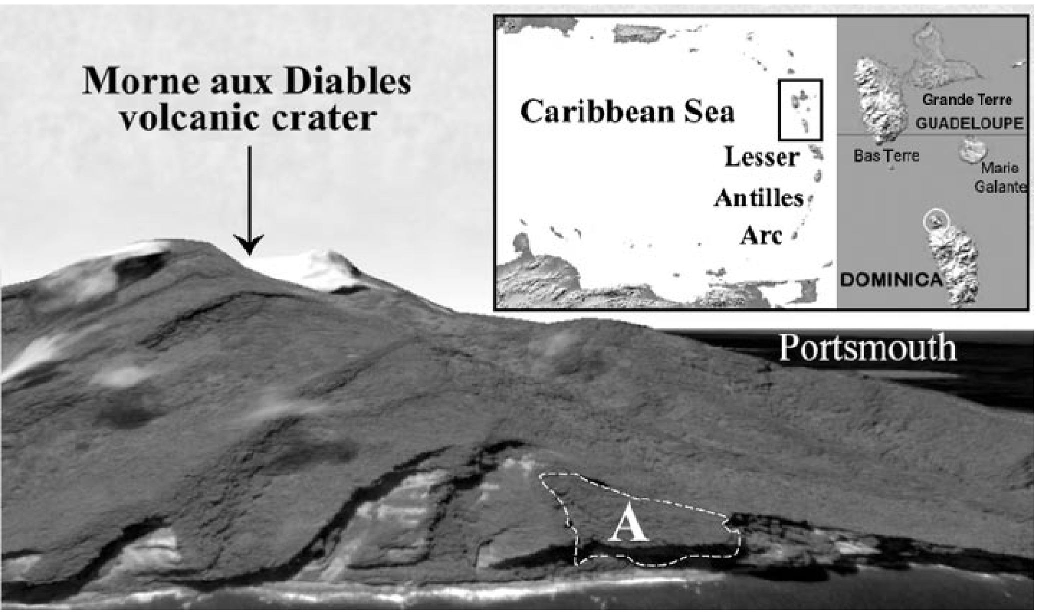
Also, high exposure to Atlantic storms/hurricanes (at least one every year)

Nurse, 2011

Montego Bay, Jamaica: Inundation for the 1 to 25 year storm surge



Caribbean SIDS transport networks are also exposed to landslides due to their (a) mostly volcanic nature and (b) extreme precipitation events



Oblique view (to south) of the north flank of Morne aux Diables volcano, Dominica. Area A is a landslide block of ~1 million tons ((Teuw et al., 2009 EOS, 90)

Caribbean landslides often block main arteries between port/airports and resorts

Case studies estimating the total impact of climate change (to 2050) on international transport expenditure in (a) Barbados and (b) Monseratt (A2 and B2 SRES scenarios) (ECLAC, 2011)

(2008 US$ millions)

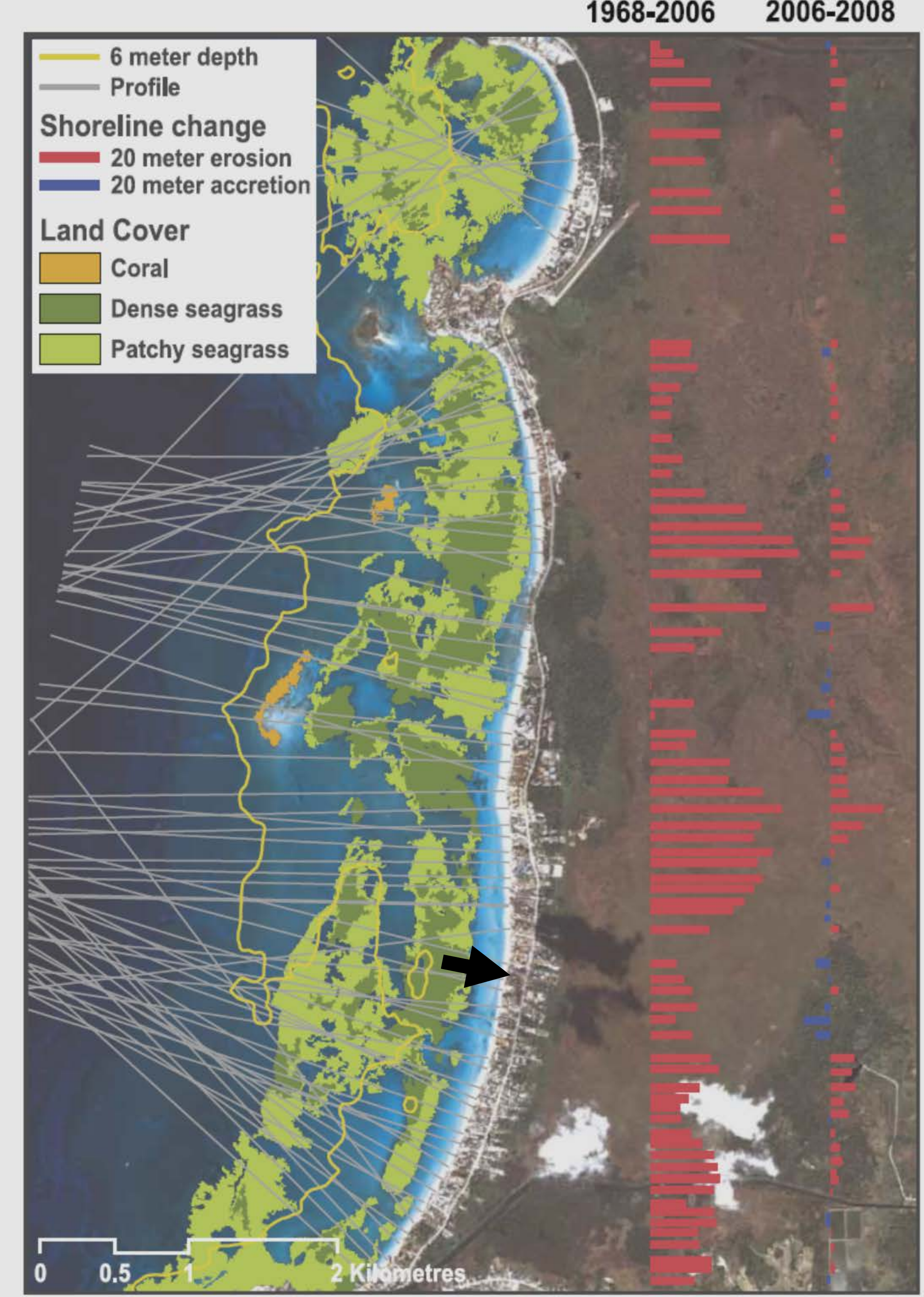
	Air Transportation		Maritime Transportation		International Transportation	
	A2	B2	A2	B2	A2	B2
Changes in Temperature & Precipitation	5,684	3,789	853	568	6,537	4,357
International Transport Mobility	3,342	3,820	501	573	3,843	4,393
Sea Level Rise	3,253	3,118	1,252	851	4,505	3,969
Total Impact	**12,279**	**10,727**	**2,606**	**1,992**	**14,885**	**12,719**

Losses Due To	Air Transportation		Maritime Transportation		International Transportation	
	A2	B2	A2	B2	A2	B2
Changes in Temperature & Precipitation	452	302	58	39	510	341
International Transport Mobility	266	316	34	39	300	355
Sea Level Rise	0	0	207	107	207	107
Eruption of Soufriere Hills Volcano	24	12	48	24	72	36
Total Impact	**742**	**630**	**347**	**209**	**1,089**	**839**

Impacts of changes in temperature, precipitation, new climate policies and SLR

Total losses of international transportation networks to 2050: (i) Barbados, **US$ 3,969-4,507** under the SRES B2 and A2 SRES scenarios and (ii) Montseratt, **US$ 107-207** under the SRES B2 and A2 scenarios

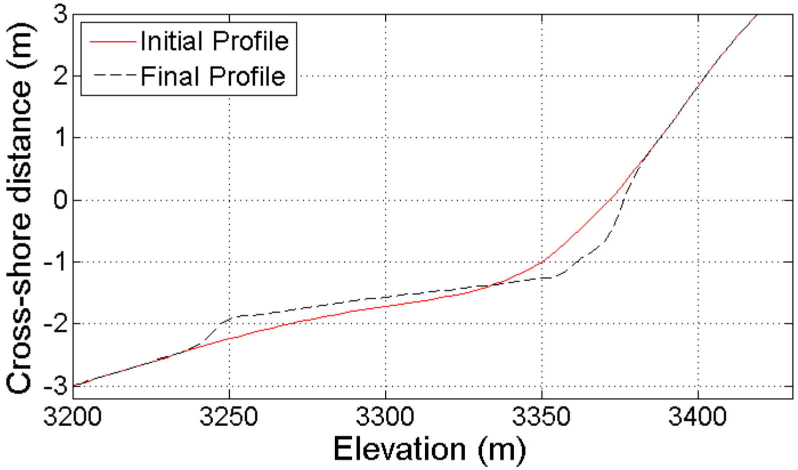
Beaches are by far the greatest asset of the Caribbean and drive the international transportation demand



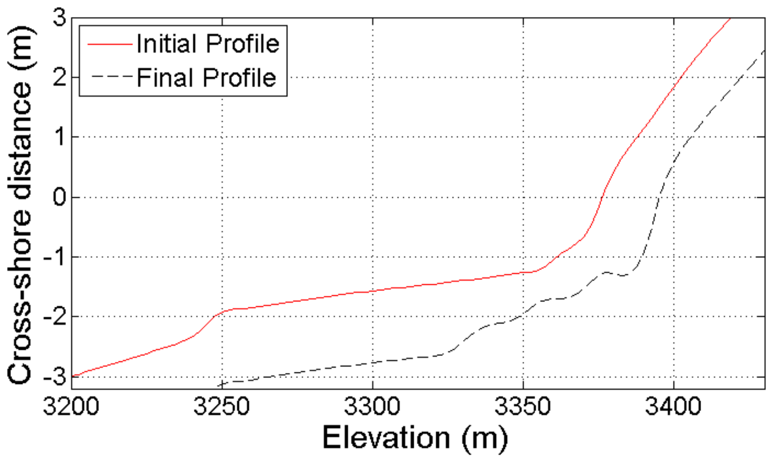
Negril beach (Jamaica) already suffers very large rates of CC-driven rates of erosion (UNEP-RiVAMP, 2010).

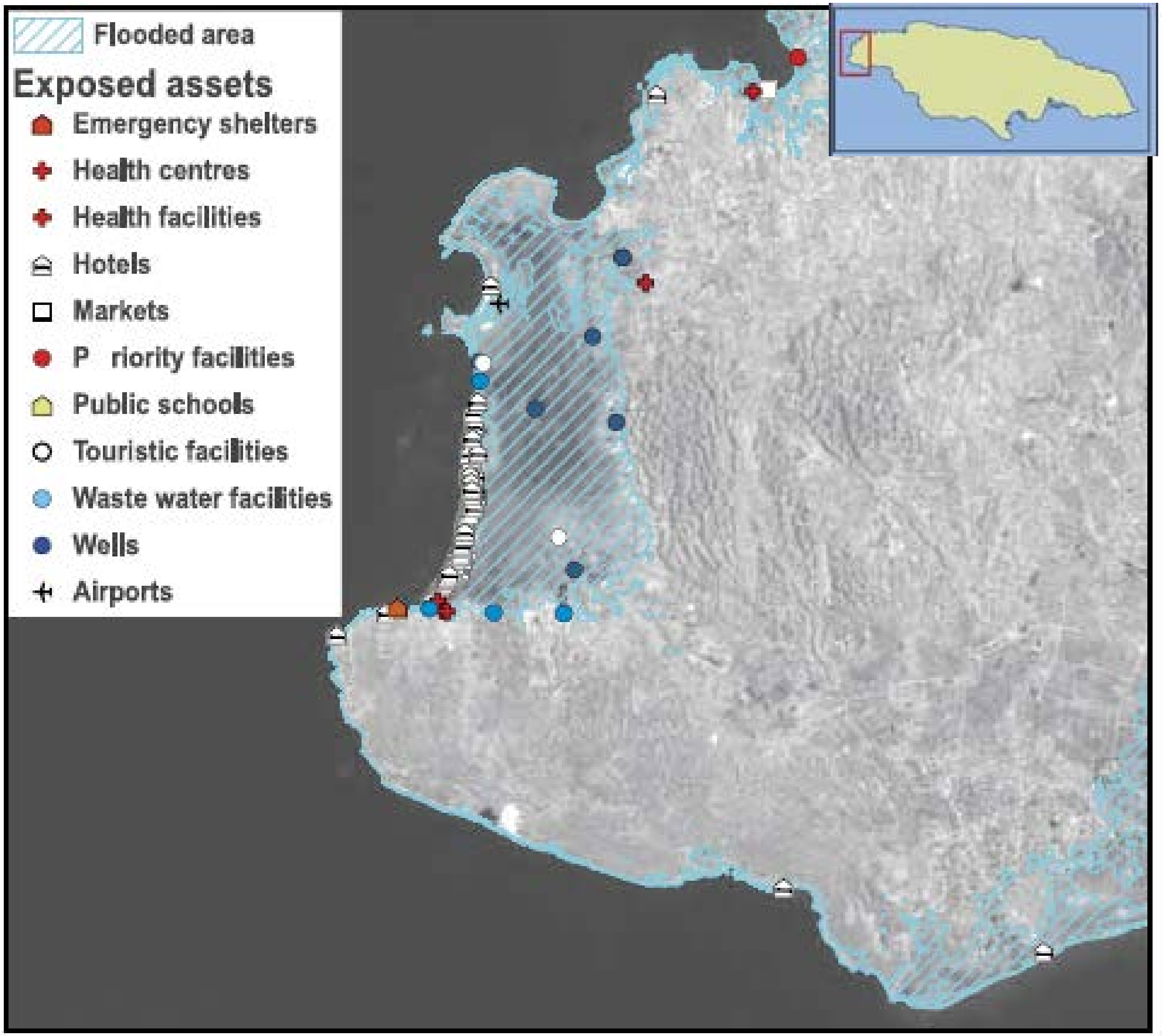
Beach retreat predictions under storm surges

Ho = 2.8 m, T = 8 s, sediment size (d50) = 0.28 mm.
Beach retreat of 4.8 m after 5-hour simulation



Same wave conditions
Short-term SL increase high tide + storm surge = 1.2 m
Beach retreat 19.8 m





50-year return flooding at Negril (Jamaica) on the basis of a simplified inundation model and Digital Elevation Models (DEM) (RiVAMP-UNEP, 2010).