Ad Hoc Expert Meeting on

# Addressing the Transport and Trade Logistics Challenges of the Small Island Developing States (SIDS): Samoa Conference and Beyond

11 July 2014

## Climate Change and Climate Variability: Critical Risk Factors for Air and Seaport Operations in Small Islands

Presentation by

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# Climate Change and Climate Variability: Critical Risk Factors for Air and Seaport Operations in Small Islands

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**Addressing the Transport and Trade Logistics Challenges of the Small Island Developing States (SIDS): Samoa Conference and Beyond**

**UNCTAD Ad Hoc Expert Meeting**
**Palais des Nations, Geneva, 11 July 2014**

## Importance of Air and Seaports in SIDS

- Social and economic development of most SIDS - Caribbean, Pacific, AIMS regions - is closely tied to the functionality and efficiency of their air and seaports →imports an exports
  - Between 50% and 95% of all food and beverages consumed in SIDS come from external sources
  - >90% of all energy products used in SIDS, primarily hydrocarbon fuels, handled through seaports
  - >75% of consumables in other sectors imported
- SIDS earn significant foreign and local revenues from port-related activities, including:
  - Berthing, bunkering & airport landing fees
  - Air and cruise passenger imposts
  - Containerized and other storage charges; waste reception fees, etc.

## Key Climate Risk Factors for Seaports and Airports in SIDS

- Rising air and ocean temperatures → (i) thermal expansion of ocean surface (ii) greater *convection potential* over ocean
- Rising sea level and surge → (a) raise $H_2O$ levels (b) *high amplitude waves* and increased potential for damage
- Higher wind speeds→ increased storminess (IPCC AR5)
  - No clear trend in projections of total number of storms BUT t*ropical cyclone intensity projected to increase*
  - *Frequency of the most intense storms* likely to increase substantially in some basins
  - Likely increase in both *global mean tropical cyclone maximum wind speed* and *rain rates*

## Top 10 Countries in Asia-Pacific Region - Exposure to Storms and Impact on GDP, 1998 -2009 (ESCAP & UNISDR, 2010)

| Rank | Absolute Exposure (Millions) | Relative Exposure (% of pop. Exposed) | Absolute GDP loss | Loss as % of GDP |
|---|---|---|---|---|
| 1 | Japan 30.9 | N. Mariana Island 58.2 | Japan 1,226.7 | N. Mariana Islands 59.4 |
| 2 | Philippines 12.2 | Niue 25.4 | Rep. of Korea 35.6 | Vanuatu 27.1 |
| 3 | China 11.1 | Japan 24.2 | China 28.5 | Niue 24.9 |
| 4 | India 10.7 | Philippines 23.6 | Philippines 24.3 | Fiji 24.1 |
| 5 | Bangladesh 7.5 | Fiji 23.1 | Hong Kong 13.3 | Japan 23.9 |
| 6 | Rep. of Korea 2.4 | Samoa 21.4 | India 8.0 | Philippines 23.9 |
| 7 | Myanmar 1.2 | New Caledonia 20.7 | Bangladesh 3.9 | New Caledonia 22.4 |
| 8 | Viet Nam 0.8 | Vanuatu 18.3 | N. Mariana Islands 1.5 | Samoa 19.2 |
| 9 | Hong Kong 0.4 | Tonga 18.1 | Australia 0.8 | Tonga 17.4 |
| 10 | Pakistan 0.3 | Cook Islands 10.5 | New Caledonia 0.7 | Bangladesh 5.9 |

**Sample of Assets and operations At Risk : Air- and Seaports**

- Climate-induced changes can cause serious damage to port infrastructure and cause major business interruption:
- Tarmacs/runways & aircraft, fuel storage tanks
- Terminal facilities & associated throughput of passengers, goods and related services
- Utilities → $H_2O$, power supply, telecommunications
- Berths, bulkheads, seawalls, breakwaters
- Emergency response → e.g. fire and ambulance services
- Projected impacts could overwhelm existing capacities, e.g. storm and wastewater management systems
- SIDS, like other nations, will be faced with increased exposure and related cumulative risks at air – and seaports

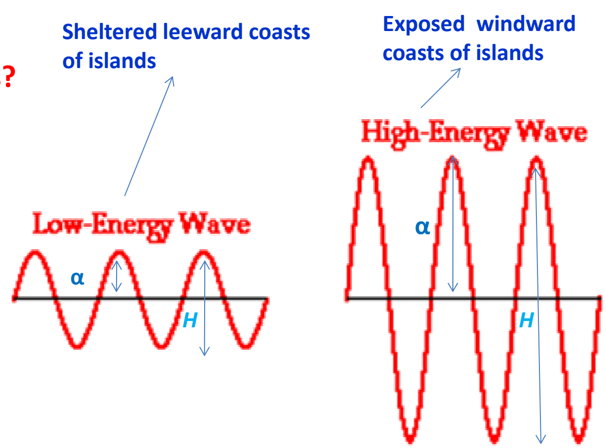
◊ Implications for *insurance, legal liability* & *operating costs*?

**How Would Climate Change Affect Wave Energy?**

- *Wave Energy* (*E*) is proportional to the *amplitude* (α) of wave
- *α* is also partly controlled by wind speed (*V*)

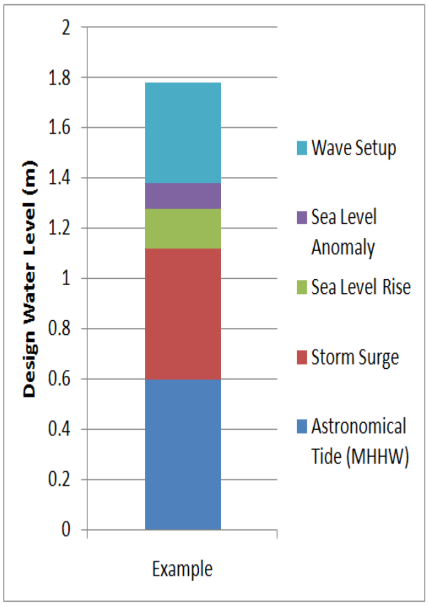
**Climate change signals?**

↑ $^0$T (air & sea) →
(a)Thermal expansion
(b)Melting of land ice
↓
$H_2O$ Depth (*d*)
(c)Increasing wind speed
(d)Pressure gradient change
↓
**Higher wave energy**




- *E* increases *exponentially* with increasing *V*
- *E* also increases as *d* ($H_2O$ depth)

## Key Components of Water level Change: Implications for Coastal Infrastructure




i. Astronomical Tide

ii Wave set up → increase in mean water level landward of breaker zone due to *flux of $H_2O$* at coast

iii Sea Level Anomaly → measure of the difference between short- and long-term MSL → *negative* and *positive* anomalies

iv Sea level Rise

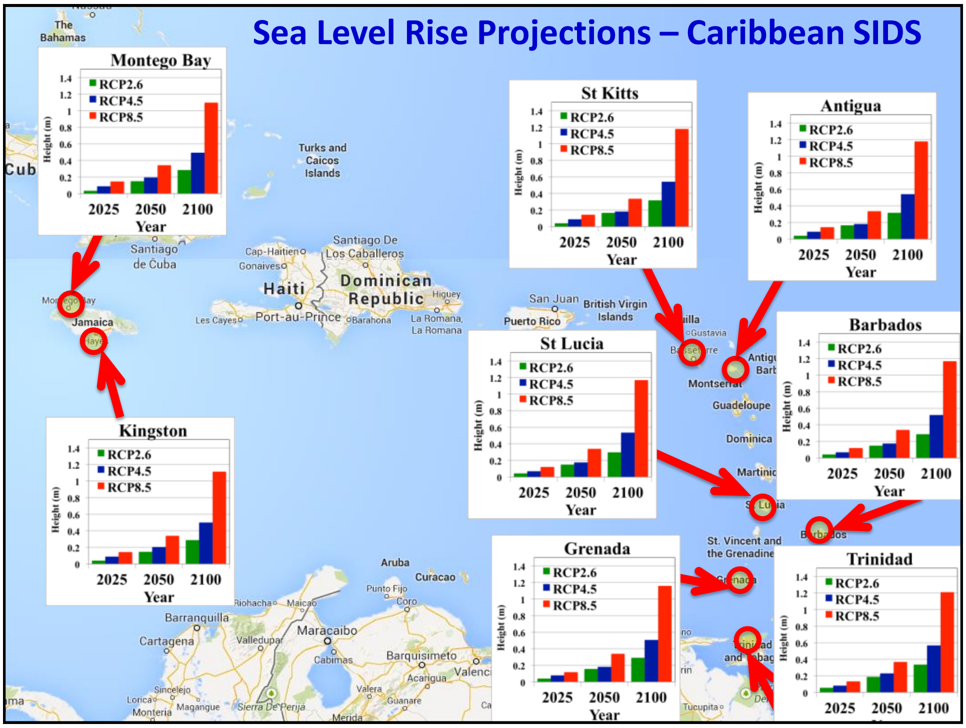
iv. Storm Surge

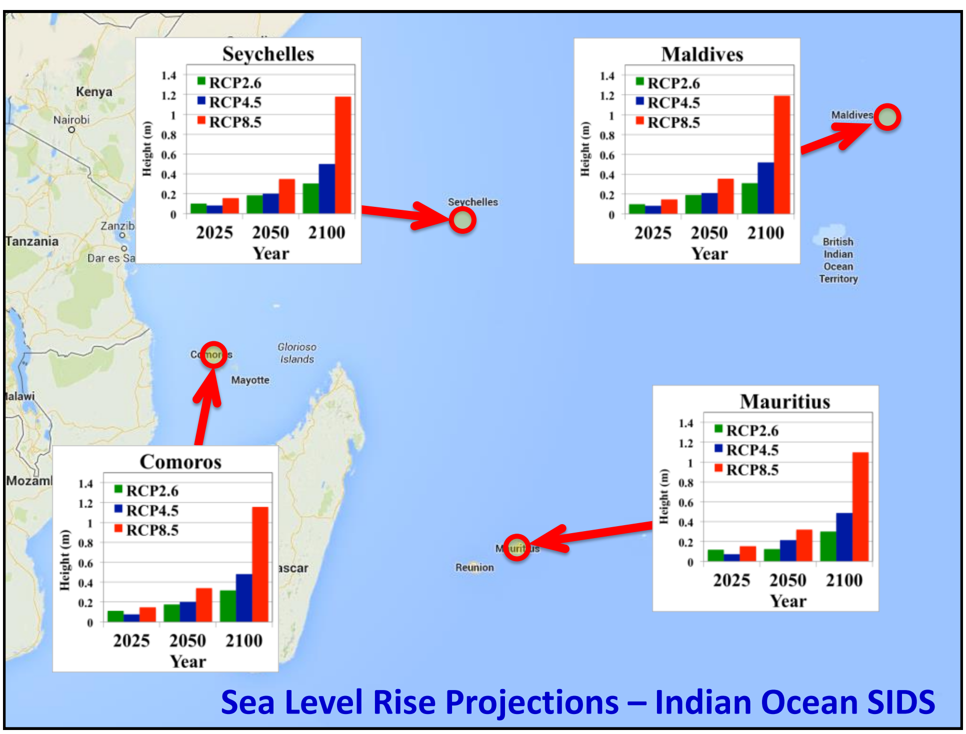
Note:

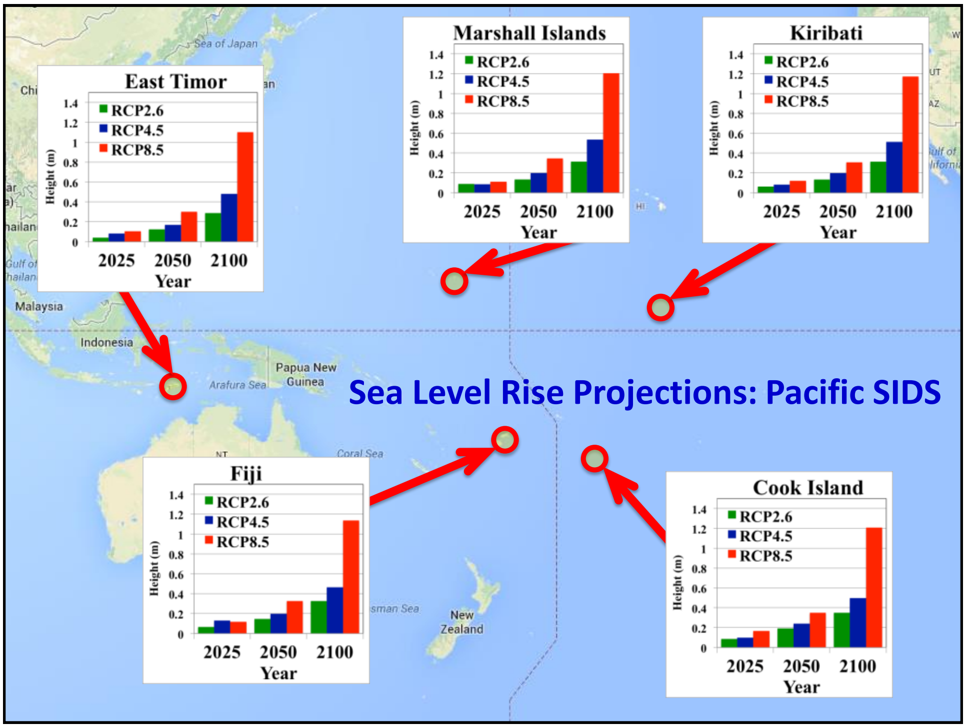
ii., iii. iv. and v. are *climate-sensitive phenomena*

## In coastal areas, quantitatively small changes have disproportionately large effects, e.g. storm surge

- Storm surge is associated with a rapid fall in barometric pressure, accompanied by strong *onshore* winds, as hurricane passes → '*Inverse barometer*' triggers a rapid elevation of $H_2O$ level.
- Surge generates large surface waves, leading to the 'piling up' of $H_2O$ at the coast.
- Relationship between reduction in pressure and $H_2O$ level is not linear:
  - Small drop in pressure can induce a significant rise in $H_2O$ level. For example, a 25.4 mm (1.0 in.) fall in the barometric pressure could produce a sea surface rise of approx. 33 cm (13.0 in.).


Sea Level Rise Projections – Caribbean SIDS
Montego Bay
Kingston
St Kitts
Antigua
Barbados
St Lucia
Grenada
Trinidad
RCP2.6
RCP4.5
RCP8.5
Height (m)
2025
2050
2100
Year

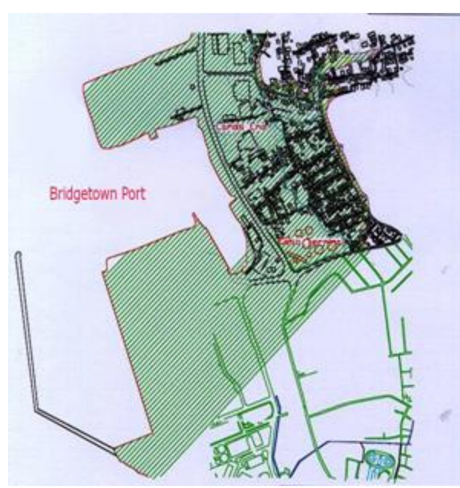

Seychelles
Maldives
Comoros
Mauritius
RCP2.6
RCP4.5
RCP8.5
Height (m)
2025
2050
2100
Year
Sea Level Rise Projections – Indian Ocean SIDS



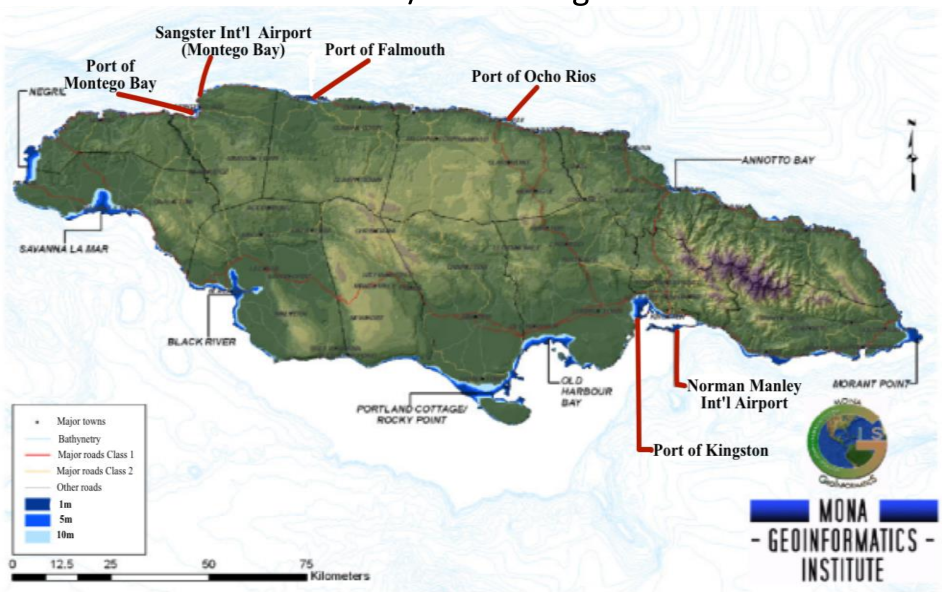

# Port of Bridgetown, Barbados

- Handles >90% of all goods used in retail, manufacturing and tourism.
- Contributed > USD 2.0 Billion in direct revenues in 2011

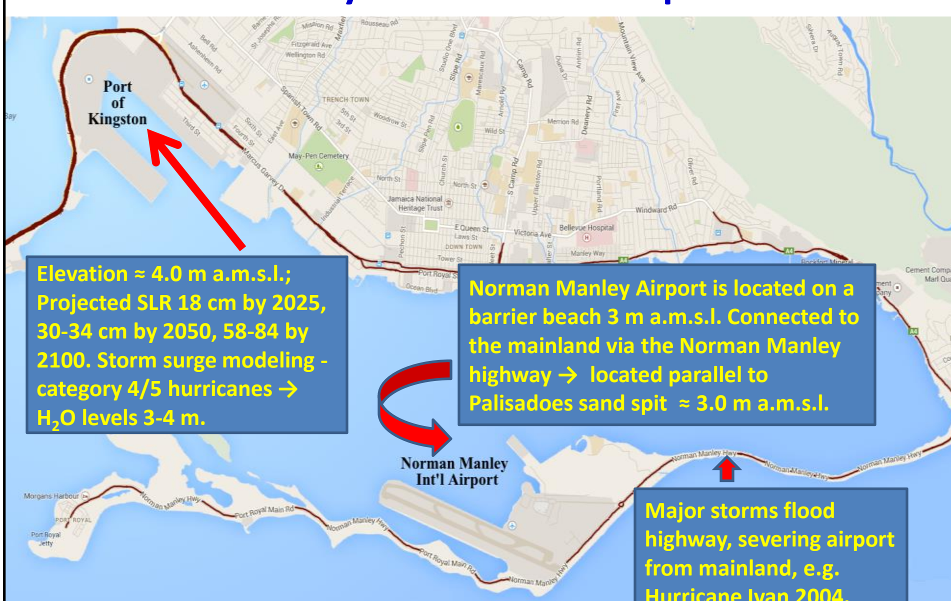
Area (shaded green) that would be inundated by a category 3 hurricane , whose passage coincides with astronomical high tide, under a *likely* sea level rise scenario of 0.5 m (50 cm) relative to 1992 MSL.

## Scenario for Coastal Vulnerability to Sea Level Rise/Storm Surge




## Key Risk Factors for Port of Kingston and Norman Manley International Airport



## Many SIDS airports vulnerable to SLR and storm surge




## Papeete Airport, French Polynesia

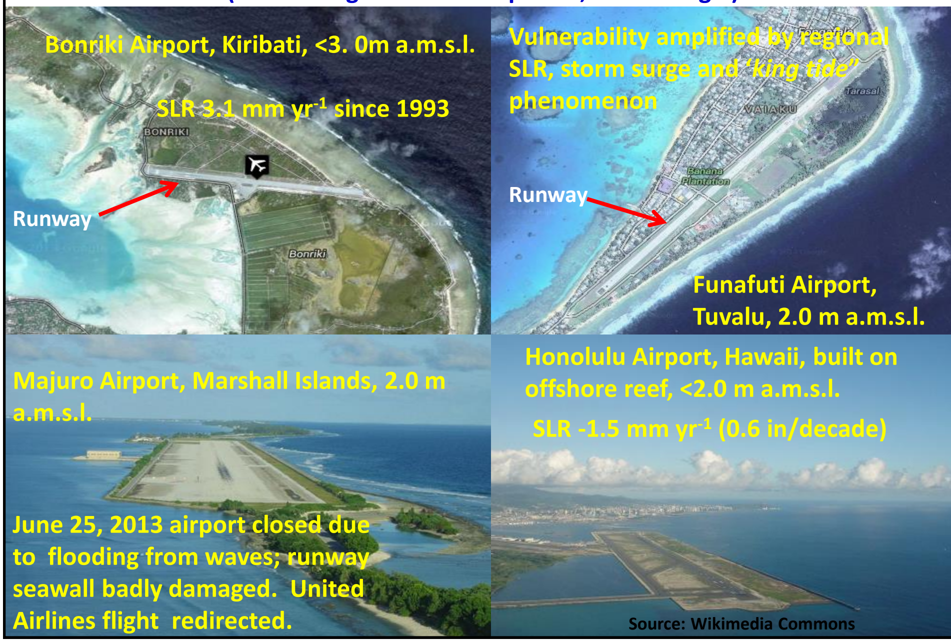
(Source:http://www.regenboogadvies.nl)

Airport at current elevation relative to mean sea level


Simulation showing airport completely inundated with sea level rise of 88 cm

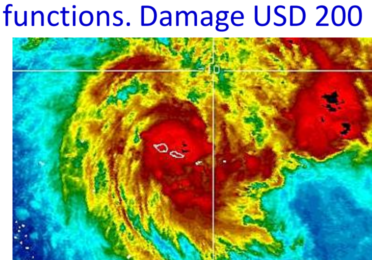
## Examples of Vulnerable Pacific Island Airports

**(Source: Digital Globe Map Data, 2014 Google)**




## Port of Apia, Upolu Island, Samoa

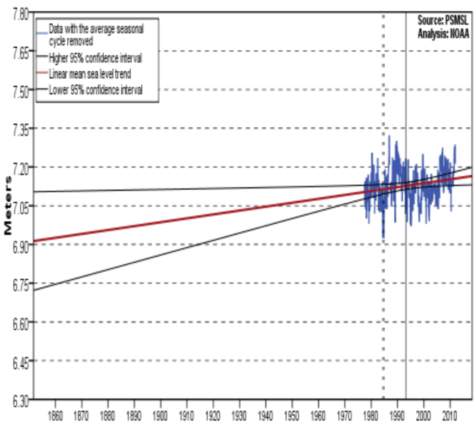
- Only commercial port, handles >98 of foreign cargoes
- Berthing, warehousing, container storage, stevedoring, health & quarantine services
- December 13, 2012 cyclone Evan → Storm surge 4.5 m → major dislocation to services, coastal infrastructure, port functions. Damage USD 200 M.



# Island of Rarotonga, Cook Islands

SLR – 1.51 mm $yr^{-1;}$ high vulnerability to tropical cyclones:

- Minor impact every 2 yrs
- Moderate impact every 4 yrs
- Major impact every 9 yrs (de Scally, 2008)




Port of Avatiu is main sea port, handling >90% of all sea cargoes. Tourism accounts for >50% of GDP in Cook Islands; >75% of goods supporting the industry are cleared through the Port of Avatiu.


# Transport & Infrastructure Damage - Hurricane Lenny, Nov. 1999


Northwestern & southern tip of the island most affected - landslides, severe beach erosion, airport flooded; 65% of Barbuda flooded, sanitary & water storage facilities overflowing; USD 51.3 M damages.

Damage & interruption at both airports
•Pottersville to Rockway highway closed; flooding at air & seaports; Roseau severed from petroleum storage facilities; west coast sea defenses breached; USD 21.5 M damages.

Most damage at Soufriere , waterfront, Gros Islet, Anse La Raye, Choiseul; severe erosion on NW coast, housing & tourism damage; damage to seaport, flooding at airports; hospital cut off from town; USD 6.6 M.

Seawall & other coastal defenses at Airport facilities damaged; structural failure and boat damage at St. George's Port; much damage to roads linking main settlements to air- & seaport; heavy damage to tourism plant; USD 94.3 M damages.

**Building Resilience at Ports – The Necessity for Adaptation in SIDS**

- Almost all air- and seaport operations face heightened risks as a consequence of climate change & climate variability. For SIDS, implementation of a suite of adaptation options will be the only choice, given their high dependency on these facilities, juxtaposed against following realities:
- Past global GHG emissions & current trajectory guarantee that warming of atmosphere & oceans, and SLR will continue for decades (‘*climate inertia*’ → volume of GHGs already emitted).
- No evidence that an enforceable post-Kyoto agreement will eventuate anytime soon → BAU scenarios likely.
- Air- and seaport infrastructure represent major investment → amortized over medium-to-long periods, e.g. minimum of 25-30 years, in some cases as many as 50 years → fall within the timeframe of current climate change projections.

**Potential Adaptation Strategies for Air- & Seaports in SIDS**

| | |
|---|---|
| **Engineering** | **Enhance the structural integrity and efficiency of critical facilities including sea defenses, berths, mooring facilities, runways, parking aprons etc, based on design criteria that reflect changing wind, sea level and wave conditions; recalculation of return periods for major events such as hurricanes and floods, so that more resilient structures can be engineered.** |
| **Technological** | **Invest in more climate-resilient technologies and equipment in planned expansion and upgrade programmes, e.g. gantry cranes that can operate at higher wind thresholds; solar photovoltaics to generate electricity more efficiently for both operations and administration.** |
| **Planning & Development** | **Internal capacity building and re-training that recognizes the magnitude and implications of the threat; building of *redundancy* into critical operations, wherever feasible; off-site warehousing and storage in less vulnerable areas, etc.** |
| **Management Systems** | **Various operational systems need to ‘*mainstream*’ climate change considerations into their procedures, e.g. ‘*shut down*’ and ‘*start up*’ operations; emergency protocols and evacuation; environmental management systems; occupational safety and health protocols, etc.** |
| **Insurance** | **Some risks cannot be avoided, therefore must be insured by third parties; ongoing collaboration with port management, climate scientists and** |

# *Thank You*

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Source: http://www.hellinikimeletitiki.gr/en/projects/energy/fotovoltaiko.html