“Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in Caribbean SIDS”

LISCoAsT – Large Scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS (I)

By

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LISCoAsT – Large scale Integrated Sea-level and Coastal Assessment Tool: Application for the SIDS
UNCTAD National Workshop Jamaica
“Climate change impacts and adaptation for coastal transport infrastructure in Caribbean SIDS”

Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Luc Feyen

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Disaster Risk Management Unit
Directorate E, Joint Research Centre, EC

Activity on river floods:
European/Global Flood Awareness System (EFAS/GLOFAS)
Climate change projections (Alfieri L., Rojas R., Feyen L)

Coastal floods group:
Michalis Vousdoukas, Lorenzo Mentaschi, Evangelos Voukouvalas, Dimitrios Bouziotas, Tomas Montblanc, Georgia Kakoulaki, Francesco Dottori, Luc Feyen
Sea level rise

- The ocean absorbs >90% of the increase in energy
- Past sea levels under +1.5-2°C were 6-10 m higher than present
- Expansion of sea water per °C of warming is greater at higher temperature and higher pressure

Are SLR, erosion and flooding the problems?

http://www.greekhotel.com
Population growth

- 44% of global population lives within 100 km of the coast (UN Atlas 2010)
- A great proportion below 10 m elevation
- Population in Jamaica is increasing by 0.2%

![Coastal & Interior: Share of Growth](chart.png)

1 billion in 1800
2 billion in 1920
4 billion in 1975
7 billion now

www.dailymotion.com
Pressure on the coast: Population

Katrina 2005 1400 dead, 108 billion $
Rita 2005 120 dead, 12 billion $
Sandy 2012 2 dead, 0.7 billion $
Xynthia 2010 80 dead, 1.3 billion $

• 1980 Hurricane Allen (8 deaths, J$200 million)
• 1988 Hurricane Gilbert (45 deaths, US$800 million)
• 2004 Hurricane Charley (1 death, $7 million)
• 2004 Hurricane Ivan (17 deaths)
• 2005 Hurricane Dennis and Emily (Billions of dollars in damages)
• 2005 Hurricane Emily (Billions of dollars in damages)
• Nicole 2010 (16 deaths, 240 m $)
The LISCoAsT approach

HAZARD PROJECTIONS
Sea Level Rise and beyond

Land Ice
- Glaciers
- Ice sheet surface mass balance
- Ice sheet dynamics

Groundwater & reservoirs
- Global ocean mass
- Global ocean water volume

Gravity & solid earth effects
- Thermal expansion
- Density & circulation changes

Regional sea level
- Waves, tide & storm surges

Sea level extremes
- Sea level impacts, adaptation & vulnerability

IPCC 2013

Sea level extremes: Global Storm Surge Model

Model used: DFLOW
Simulated tidal, wind and pressure driven ocean circulation

Flexible mesh
Nearshore resolution 0.11° x 0.05°
Offshore resolution 0.94° x 0.42°
Sea level extremes: Global wave model

Model used: WaveWatch3 v4.18
Generates waves from wind fields
Resolves all wave directions and frequencies
Considers several parameters including temperature, ice concentration

Sea level extremes: Tropical cyclones
Global changes of extreme coastal wave energy fluxes triggered by intensified teleconnection patterns

Lorenzo Mentačhi, Michalis I. Vououdoukas, Evangelos Voukouvalas, Alessandro Dosio, and Luc Feyen

1Joint Research Centre, European Commission, Ispra, Italy. 2Department of Marine Sciences, University of the Aegean, Ermioni, Greece.

Abstract In this study we conducted a comprehensive modeling analysis to identify global trends in extreme wave energy flux (WEF) along coastlines in the 21st century under a high-emission pathway (Representative Concentration Pathway RCP8.5). For the end of the century, results show a significant increase up to 30% in 100-year return level WEF for the majority of the coastal areas of the southern temperate zone, while in the Northern Hemisphere large coastal areas are characterized by a significant negative trend. We show that the most significant long-term trends of extreme WEF can be explained by intensification of teleconnection patterns such as the Antarctic Oscillation, El Niño-Southern Oscillation, and North Atlantic Oscillation. The projected changes will have broad implications for ocean engineering applications and disaster risk management. Especially low-lying coastal countries in the Southern Hemisphere will be particularly vulnerable due to the combined effects of projected relative sea-level rise and more extreme wave activities.

Caribbean TWL projections: Waves

2020
Caribbean TWL projections: Waves and storm surge

Caribbean TWL projections: All components
Caribbean TWL projections: Changes in frequency

Climate tipping points: Thermohaline circulation
Climate tipping points: Thermohaline circulation

Coastal Inundation on continental scales

- TWL components estimated every 25 km of coast
- SRTM DEM
- Similarly coastline and all data divided in 25 km long segments, extending 50 km inland

\[ \eta_{TWL} = \eta_{MSL} + RSLR + \eta_{tide} + \eta_{storm surge} + \eta_{wave} \]
Flood extent projections for Jamaica

**SUMMARY AND WORK IN PROGRESS:**

METHODOLOGICAL GAPS, IDEAS, CRITICAL QUESTIONS

Closing Remarks

**SUMMARY AND WORK IN PROGRESS:**

METHODOLOGICAL GAPS, IDEAS, CRITICAL QUESTIONS
What is really at stake?

River floods
Heat waves
Cold waves
Draughts
Wildfires
Windstorms
Crops
Fisheries
Coastal floods

What is really at stake?

- The ocean absorbs >90% of the increase in energy
- Past sea levels under +1.5-2°C were 6-10 m higher than present
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Global temperature change (1850–2016)
What is really at stake?

- Projections indicate an order of magnitude increase of direct impacts by the end of the century
- Without considering tipping points
- Without considering indirect impacts
  - Business interruption
  - Ecology
  - Sector interactions
  - Criticality of transport hubs
  - Etc....

Intangible/indirect impacts

<table>
<thead>
<tr>
<th></th>
<th>Coastline (km)</th>
<th>GDP</th>
<th>Expenses</th>
<th>GDPratio</th>
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<tr>
<td>Jamaica</td>
<td>894</td>
<td>14</td>
<td>0.7599</td>
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<tr>
<td>NL</td>
<td>2000</td>
<td>752</td>
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Adaptation and social justice


• Need to acknowledge the challenging nature of coastal adaptation in view of climate change
• Urgency of moving towards the direction of a timely response, taking coordinated and fair measures

Thank you very much...