Modelling Projections of Potential Sea Level Rise Impacts on some Caribbean Communities: Is it worth the effort?

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Overview

- Introduction
- Case Studies
- Is it worth it?
- Conclusion
Introduction

• The Caribbean has a history of dealing with ‘event’ disasters – hurricanes, earthquakes, volcanoes etc – short term threats
• No real policy/strategy for long term threats such as sea level rise
• Lack of information eg long term tidal & coastal deformation data, hinders decision making process
• Lack of information also impacts development of inundation models and mitigation/adaptation strategies

Three case studies reviewed – (i) Roxborough, Tobago, (ii) Grande Riviere, Trinidad, (iii) Bequia St. Vincent & the Grenadines
• Employed sea level rise projection models to assist in assessing potential socioeconomic and physical impacts
• Short term tidal data used as reference for current sea levels
• Participatory 3-Dimensional Model (P3DM) developed for Roxborough through the engagement of the community
• Critical process in gaining relevant local spatial knowledge
• Physical model of region constructed (H-scale 1:5000, V-scale 1:2000)
• Estimates of sea level obtained from 5 weeks of tidal measurements and precise levelling
• High resolution digital camera used to capture images of P3DM model, which were digitized and geo-referenced to be put into ArcGIS.
• Thematic local knowledge features converted to shapefiles
• Inundation polygons for various sea level rise projections overlaid onto local knowledge features to assess potential impacts
Grande Riviere

- Grande Riviere is the largest nesting site for leatherback turtles in the Caribbean
- Significant natural, ecological and socioeconomic impacts of loss of nesting site through inundation
- SSHRC & IDRC funded projects produced sea level rise models for area and focuses on impacts on coastal communities

Grande Riviere

- Grande Riviere beach is exposed to Atlantic swells and subject to high energy wave action
- Local knowledge critical in tracking changes in coastline morphology and helped identify specific features under threat
- Sutherland & Seeram (2011) and Seeram (2011) describe the development of GIS SLR models for the area
- Primary data collected for model included topographic surveys, GPS spot heights and short term tidal data from nearby Toco station
• ArcGIS used to process collected data and develop SLR scenarios based on IPCC projections
• 0.4m, 0.5m, 0.6m, 0.8m, 1.0m SLR inundation simulated
• From these models at 0.4m inundation levels, there is some loss of turtle nesting habitat
• Reported horizontal and vertical accuracy for DTM used reported at ±0.02m and ±0.20m respectively
• Models developed for Bequia through same projects as Grande Riviere
• Methodology for producing models was similar
• Two sites used: Port Elizabeth and Adams Bay
• One month short term tide gauge data collected
• Bequia is a volcanic island, so the land mass rises fairly steeply out of the sea and low lying areas
• Local knowledge of the Adams Bay area did indicate significant impacts due to inundation
• The steep nature of the topography meant that the airstrip located at Adams Bay was built on reclaimed land

• SLR models for the area suggest that the reclaimed land would be reclaimed by the sea with a 1.4m rise in sea level
• 50% of Caribbean population live within 2km of the sea – high dependency on coastal activity, as displayed in each case study
• Different impacts seen in each case study area, which will lead to different mitigation/adaptation strategies
• Results need to be taken in context

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• Context 1: SLR rates
  – While SLR is generally recognized and accepted, rates are an area of dispute and variations in models give different trends
  – Flood hazard mapping and inundation therefore cannot depend on archive sea level data
  – With various theories on causes of SLR, complexities of environmental issues and numerous modelling dimensions and parameters, these relationships are yet to be fully understood

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• Context 2: Topographic Relationship with MSL
  – SLR models are in conjunction with existing topography, and topography itself measured relative to MSL
  – Comparisons are therefore easy IF sea levels are accurately determined
  – In the Eastern Caribbean, the tidal range is a maximum of 1.4m for the northern islands to a minimum of 0.6m
  – There is an annual variation of ±0.1m and random variations of up to 0.3m also occur for periods of up to 2 weeks (Miller, Hart, Sydney, 2012)

• Context 2: Topographic Relationship with MSL
  – This potentially introduces errors ~ 0.15m using short term (30 day) tidal data.
  – Many vertical datums in the Caribbean were designed using short term data (typically 3 months), but were established several decades ago.
  – Mistakes in records and changes in sea level relative to land mass have also been identified (Miller 2012)
• **Context 3: Land Mass Deformation**
  – In addition to SLR, land masses are also deforming.
  – The study areas are located in fault zones, where vertical deformation of the land mass can change considerably in a few kilometers.
  – Long term GNSS measurements to extract vertical land movements would be required in conjunction with simultaneous sea level measurements be to effectively implemented into SLR models.

• **Other Considerations**
  – Community Involvement
  – Coastline morphology
Conclusion

• Importance of sea and coastal activities necessitates an informed treatment of SLR issues
• Scarcity of data relating to detailed topography of coastal regions
• Quality of data critical to decision making process
• Progressive improvement in the quality of data