# 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



# Introduction

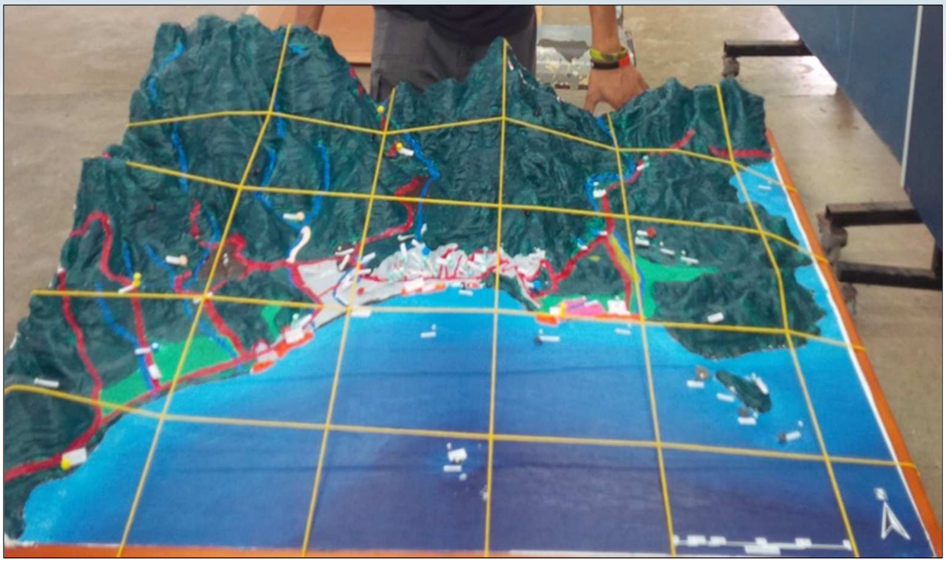
- Three case studies reviewed – (i) Roxborough, Tobago, (ii) Grande Riviere, Trinidad, (iii) Bequia St. Vincent & the Grenadines
- Employed sea level rise projection models to assist in assessing potential socioeconomic and physical impacts
- Short term tidal data used as reference for current sea levels

# Roxborough

- 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



# Roxborough



Roxborough P3DM model showing local knowledge

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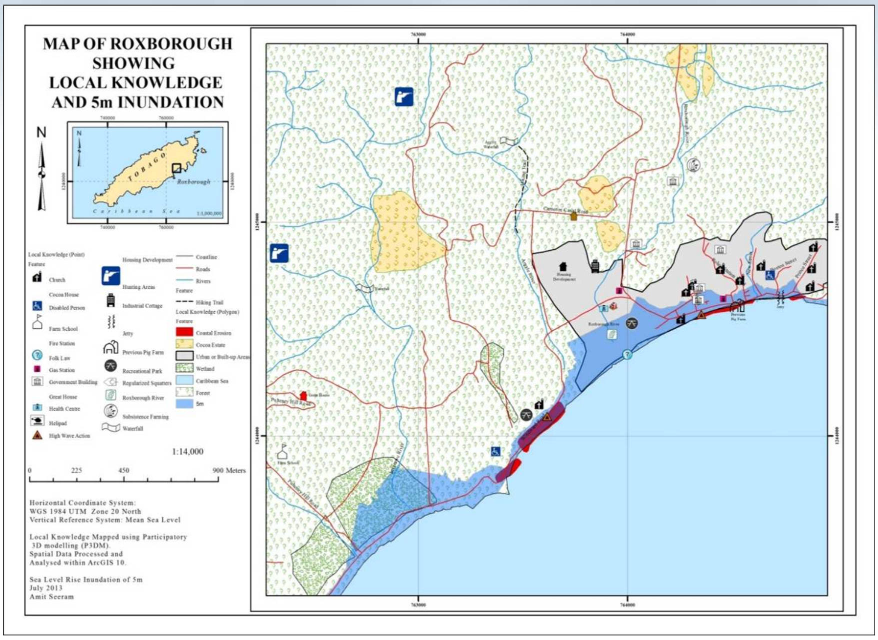
# Roxborough

- 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



# Roxborough




Local knowledge feature inundation by projected 5m SLR

# 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 focusses on impacts on coastal communities



# Grande Riviere

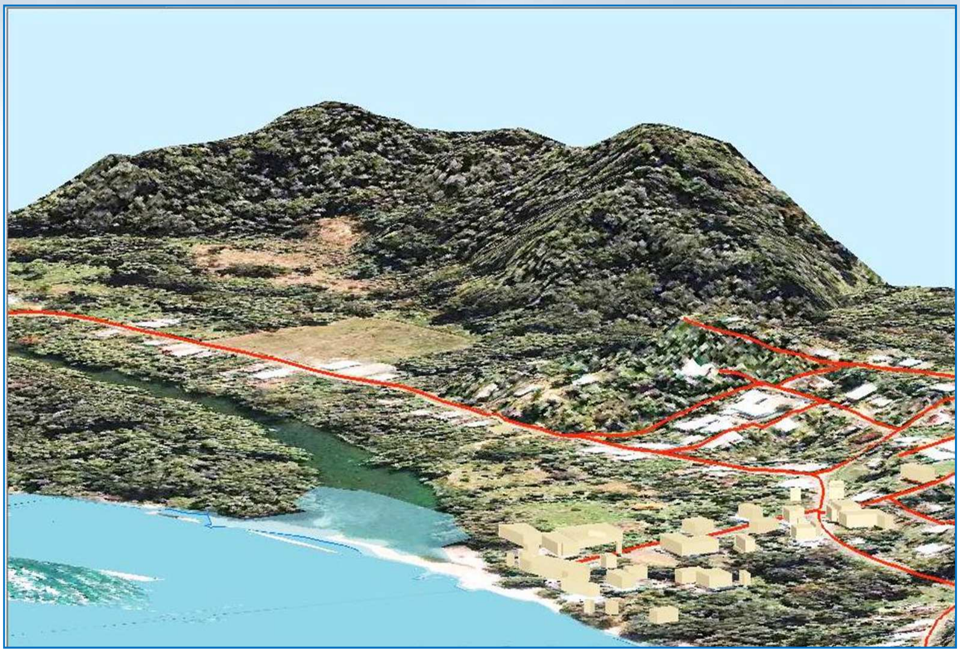
- Grande Riviere beach is exposed to Atlantic swells and subject to high energy wave action
- Local knowledge critical in tracking changes in coastline morphplogy and helped identify specific features under threat
- Sutherland & Seeram (2011) and Seeram (2011) describe the development of GIS SLR models for the area
- Primary data collected for model included topographic surveys, GPS spot heights and short term tidal data from nearby Toco station

# Grande Riviere

- 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



# Grande Riviere



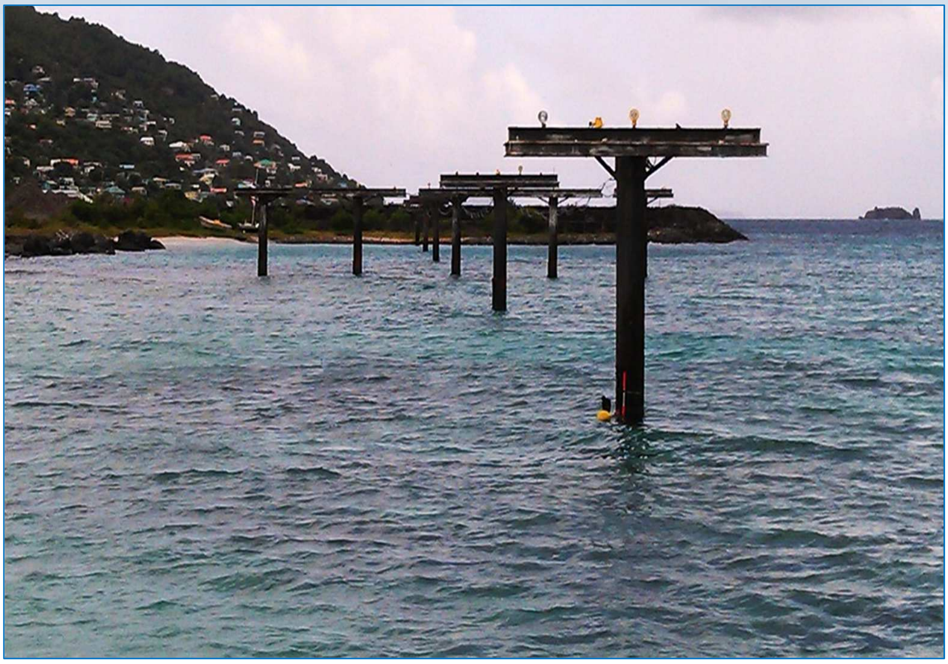
GIS model of 0.4m inundation at Grande Riviere

# Bequia

- 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



# Bequia



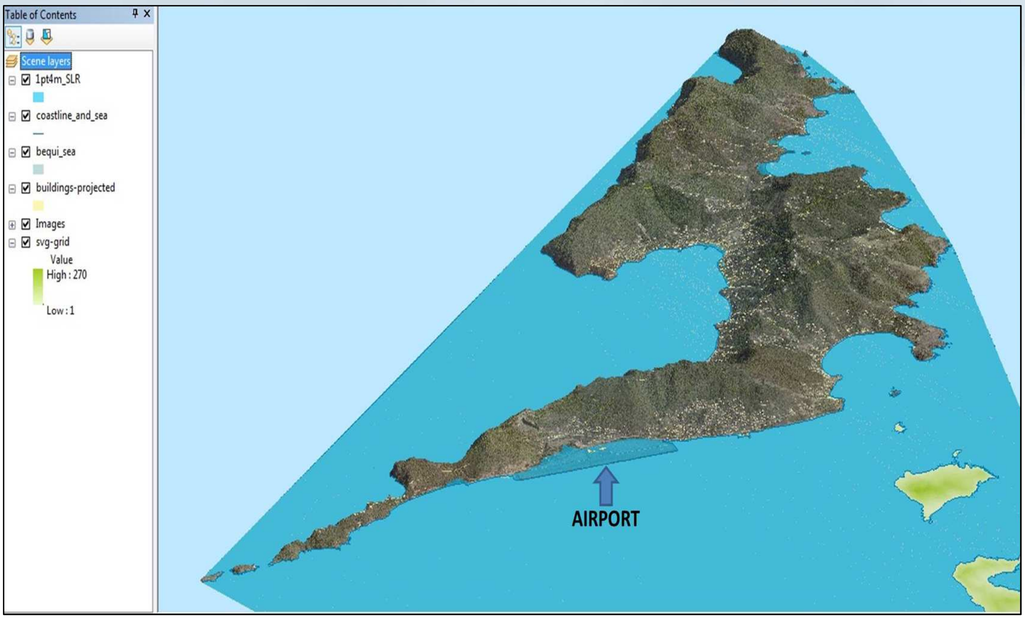
Tide Gauge installation at Adams Bay

# Bequia

- 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



# Bequia




SLR model for Bequia (1.4m above MSL)

# Is it worth it?

- 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



# Is it worth it?

- <u>Context 1: SLR rates</u>
  - While SLR is generally recognized and accepted, rates are and 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

## Is it worth it?

- <u>Context 2: Topographic Relationship with MSL</u>
  - SLR models are in conjunction with existing topography, and topography itself measured relative to MSL
  - Comparisons are therefore easy <u>IF</u> 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)



## Is it worth it?

- <u>Context 2: Topographic Relationship with MSL</u>
  - 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)

# Is it worth it?

- 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



# Is it worth it?

- Other Considerations
  - Community Involvement
  - Coastline morphology

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# 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



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# Thank You

# Questions

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