Modelling the extent of coastal inundation on Majuro atoll, the Republic of the Marshall Islands

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Background

- How might projected rises in sea level and increased frequency of storm surge and king tide events impact on low lying coral atolls?
- GIS model which combines sea level rise and flood height in estimating inundation extent
- Scenarios can be created by changing the flood height and sea level rise values

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Background

- King tide events can be predicted
- When combined with storm surges such events become less easy to predict
- This combination of events has become increasingly common – this may be a result of human-induced climate change…

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Study site

- Rita (Djarrit)
- Densely populated area on the eastern end of Majuro Atoll, the Marshall Islands
- Low lying – average elevation of RMI is less than 2 metres
- A major storm surge/inundation event, associated with annual king tides, occurred in March 2014

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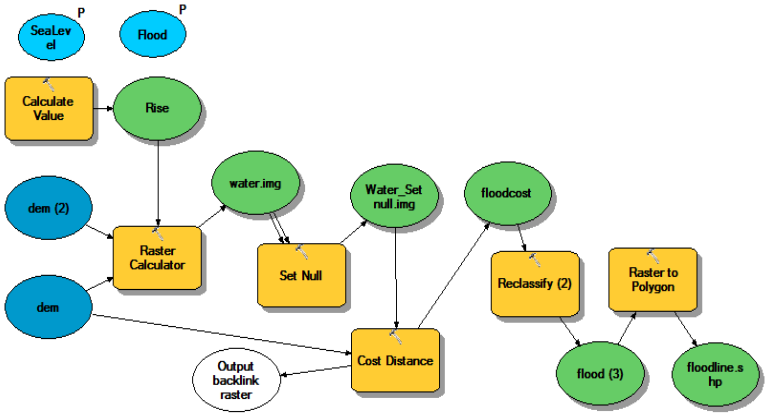
Location

Data

- 1 metre resolution terrain surface – interpolated from elevation point data using the *Topo to Raster* tool in ArcGIS
- Elevation point data
  - 1000+ points
  - 5-20 metres apart
  - Elevation range approx. zero to three metres
  - Collected using GPS rover and corrected with GPS base (RMI Government/ADB 2011)
  - Covering area approximately 300m x 1000m
- Roads layer digitised from 2011 WV2 image

Flood model

- Raster based model using ArcGIS model builder
- 'Bath tub' inundation model where user interactively enters SLR and flood level



Key model steps

- **SeaLevel** and **Flood** Parameters updated manually by the user depending on the inundation scenario
- The *Calculate Value* tool uses the expression **%SLR%** + **%Flood Level%** to add **sea level rise** and **flood level** to calculate inundation in metres (Rise)
- **Raster Calculator** Con statement uses the Rise value with the elevation values in the DEM to produce an output raster displaying areas of inundation and no inundation
- End result is a binary output where the value 1 represents the area of inundation (water) and the value 0 no inundation (no water)

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Inundation scenarios

- Elevation range on Rita, Majuro Atoll, is 0.1m to 2.98m
- Five scenarios of inundation extent (SLR + Flood): 0.5m, 1m, 1.2m, 1.5m, 2m and 2.5m
- 0.5m – no noticeable change

- Following slides:
  - Polylines = roads
  - Points = schools

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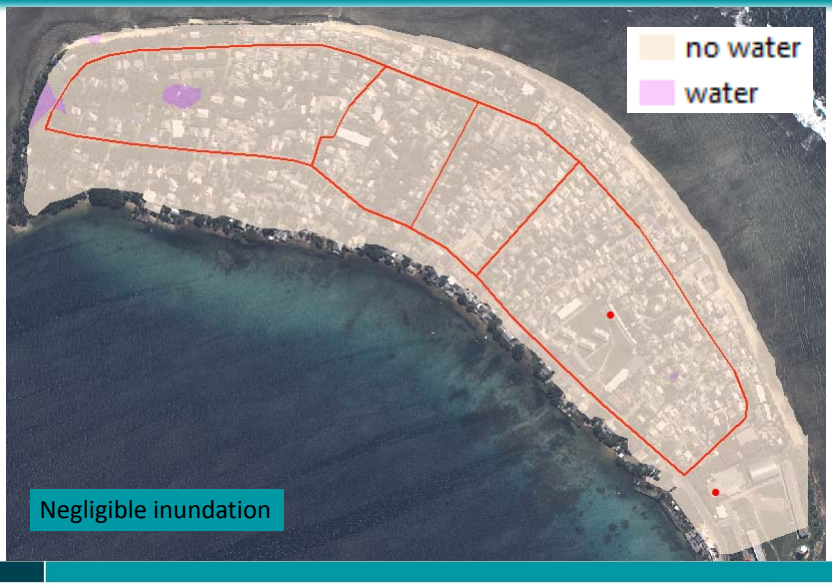
1 metre inundation



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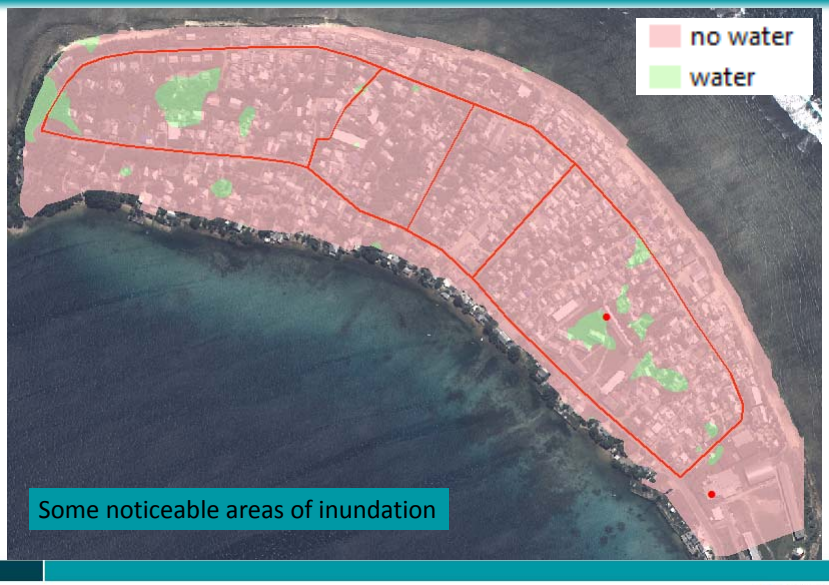
1.2 metre inundation



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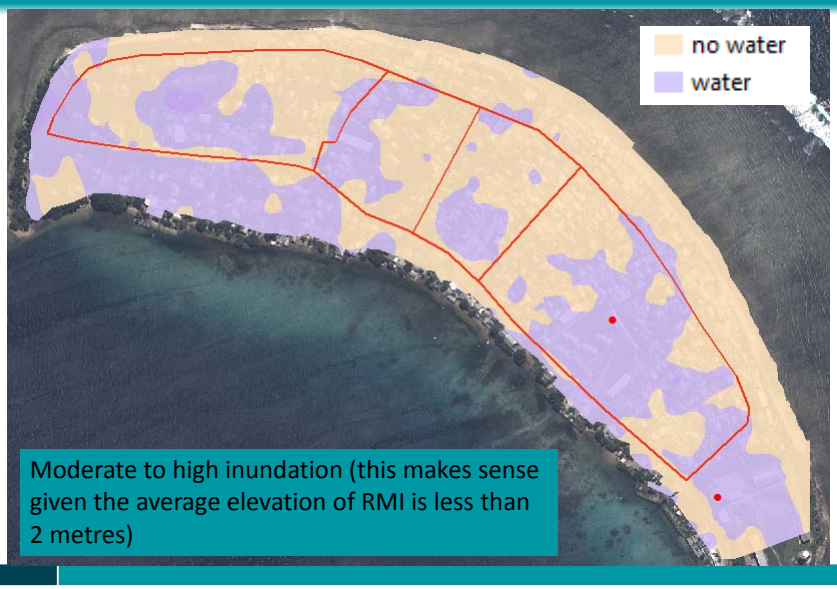
1.5 metre inundation



Moderate to high inundation (this makes sense given the average elevation of RMI is less than 2 metres)

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2 metre inundation

Mostly inundated except for the coastal zone

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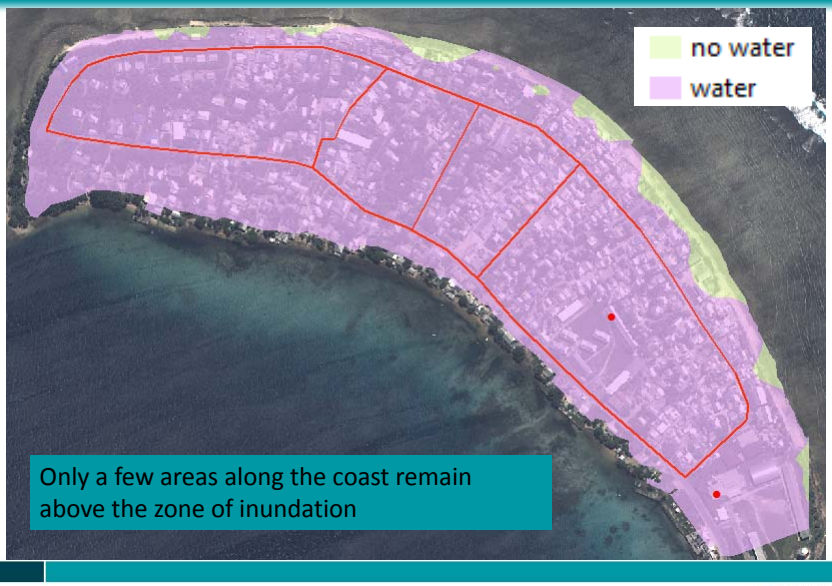
2.5 metre inundation



Sea level rise projections

- Three sea level rise scenarios projected for 2100:
  - Low (0.5m): sea-level rise by likely to be unavoidable
  - Medium (0.8m) - upper end projection in line with global emissions and sea-level rise observations
  - High (1.1m) - high end risk based on scenarios of recent warming trends from ice sheets
- When combined with increased levels of flooding these SLR projections are potentially worsened…

Discussion and limitations

- Looking at the scenarios – an inundation event of 1.5m would have a significant impact on infrastructure and residents
- Can expect increased frequency of inundation events given SLR and increase in extreme weather events
- Scenario modelling can contribute to planning for disaster management and monitoring
- The model does not account for barriers
- Low lying atoll - challenge to create a hydrological correct terrain surface

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Future research

- Calculate area of inundation
- Incorporate qualitative data to map social vulnerability to inundation-related
- Hazards - variables such as population location and density, age of population
- and socio-economic disadvantage
- LiDAR acquisition for Majuro (USAID funded) – use to create accurate terrain
- surface
- Students from RMI USP in furthering the research activity in December 2015 – field survey including oral history data
- Apply to other locations in RMI such as neighbouring Delap

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Questions and comments?