A Regional scale Assessment of Coastal Flooding in South Africa

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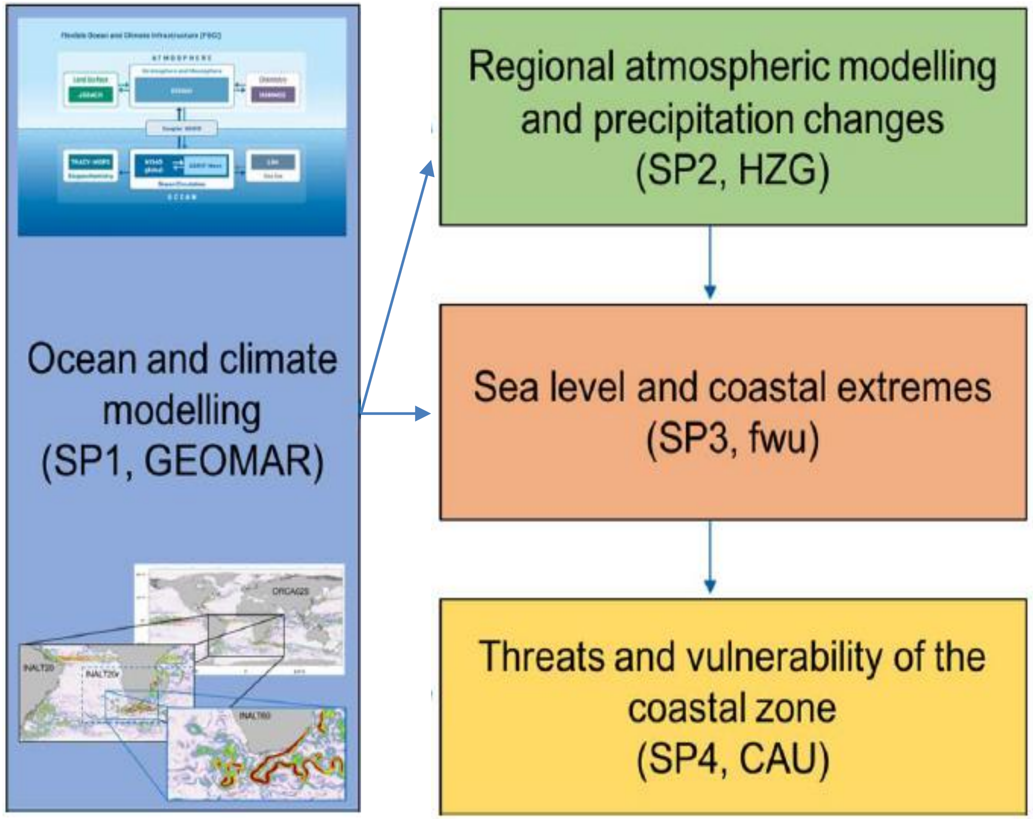


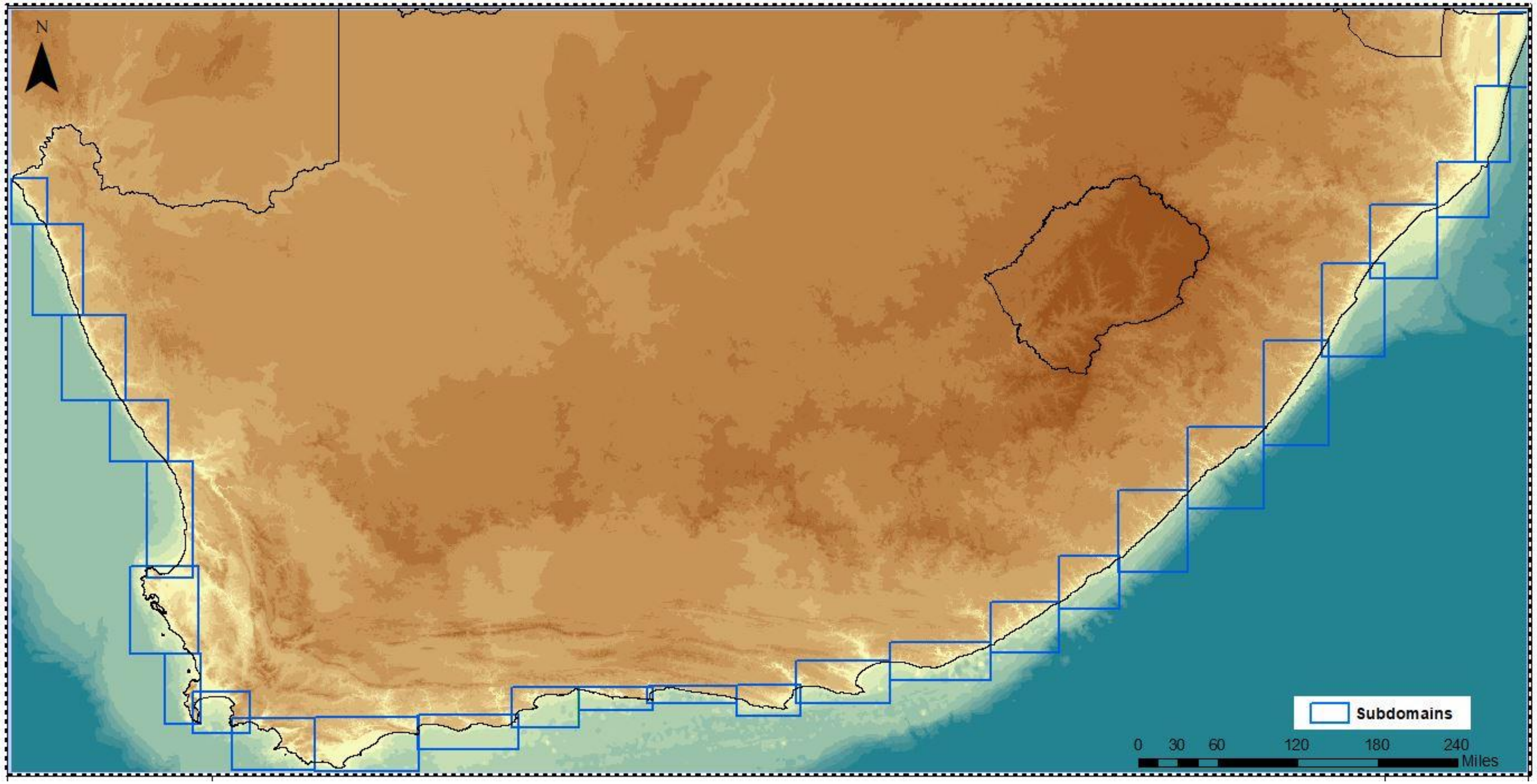
- **SP1 The Changing Agulhas Current System**
  - High resolution modelling of potential changes in the Agulhas System due to changes in atmospheric conditions (CO_2, Ozone and Winds)
- **SP2 Impact on Regional Climate of southern Africa**
  - Modelling of changes in rainfall and temperatures
- **SP3 Changes in sea levels and wind waves**
  - Regional changes in sea-level & Multivariate statistics of all flood drivers (wind waves, surges, river discharge and precipitation)
- **SP4 Impacts on the southern African coasts**
  - Regional Flood Impact assessment
  - Local Flood Impact assessment for 2 hot-spots including compound events (Sunna Kupfer)

Regional Flood Assessment

- Regional Flood Assessment of present and future Climate scenarios
- Dynamically simulated hazard scenarios by project partners
- Flood Model: LISFLOOD
- Elevation MERIT

  90m Horizontal

  1cm Vertical

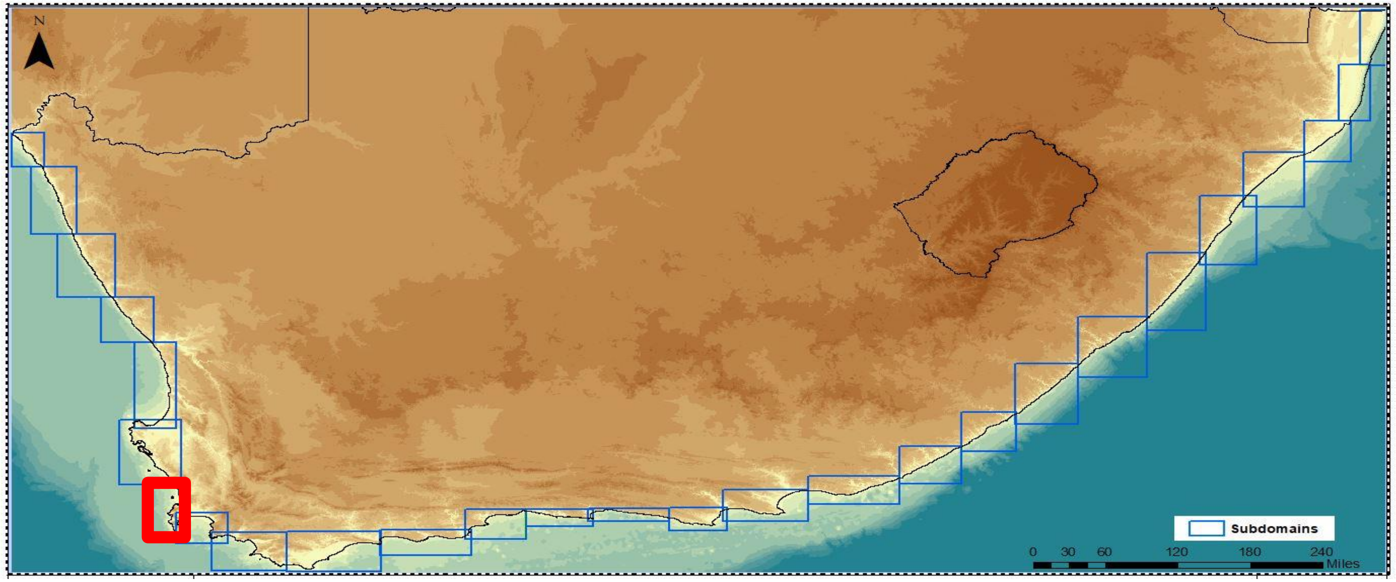


Motivation & Objective

- **Limitations in broad-scale flood modelling:**
  - **Computational capacity & lack of Validation data**
- **Comparison of Broad scale Flood Models** (different complexity) in order to assess the **uncertainties** related to the flood model
- **LISFLOOD model**: Uncertainties related to Water Level curve

- Table Bay
- Scenarios CSIR for DEA

No SLR **(10y Storm surge, MHW, 100y Waves)**	**6.59 m**

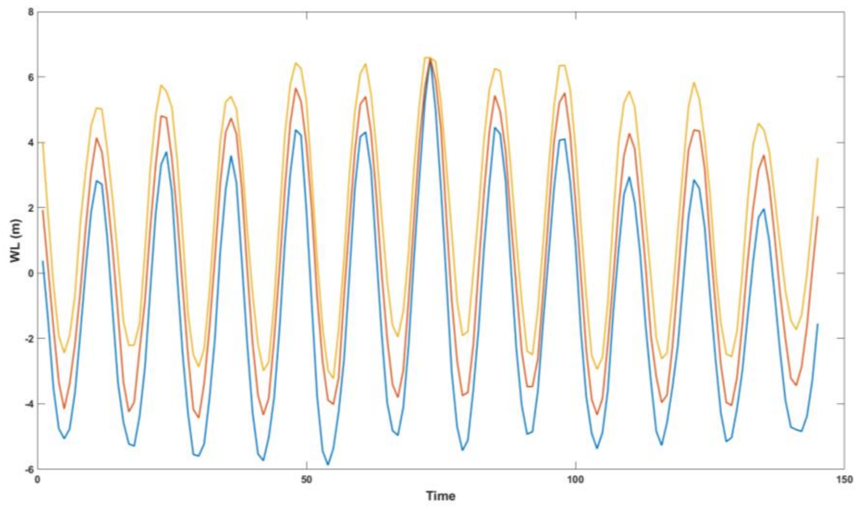


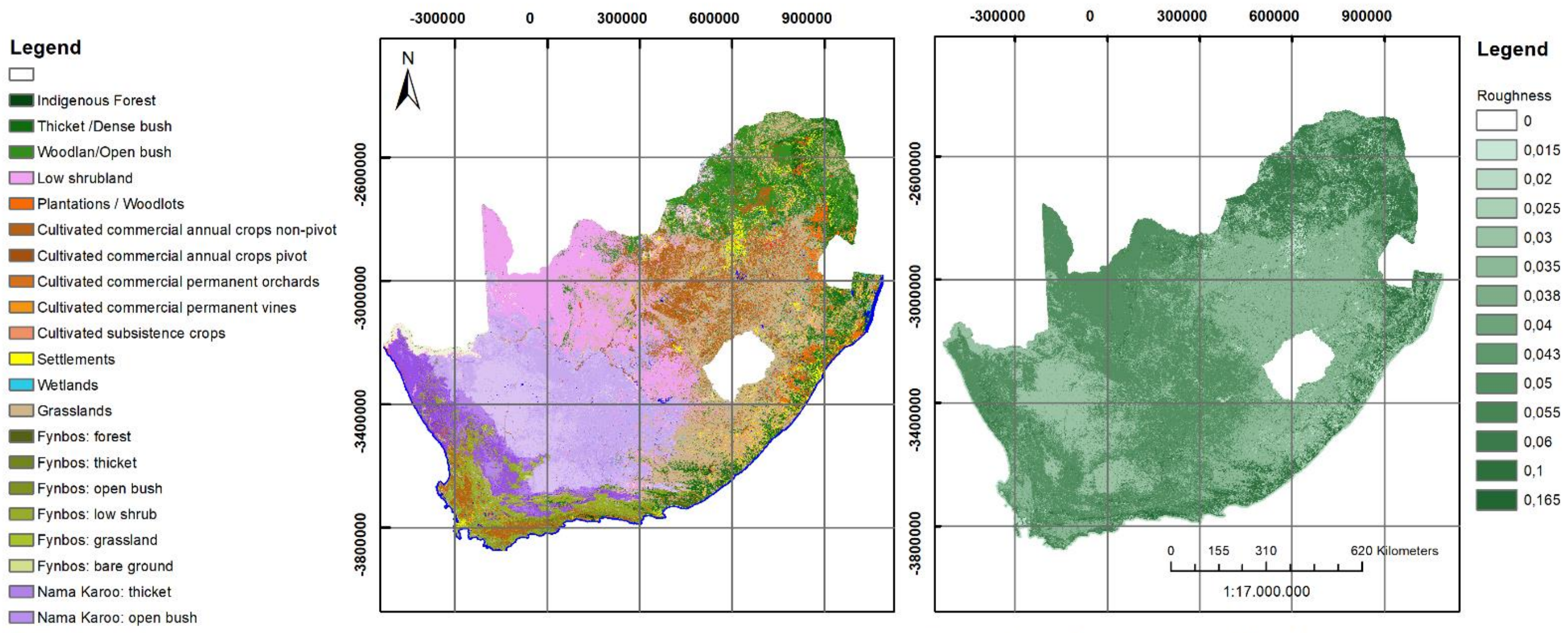
Broad-scale Flood Models

1. **Simple Bathtub Model (sBTM)**
   - Areas with an elevation below the water level & hydrologically connected to the sea are flooded
   - Advantage: Easy implementation & computationally efficient
2. **Enhanced Bathtub (eBTM) by Williams & Lück-Vogel (2020)**
   - Incorporates surface roughness & beach slope to estimate flow pathways and inundation (least cost distance from the coastline)
   - Advantage: Easy implementation & computationally efficient
3. **LISFLOOD**
   - 2D Simplified hydrodynamic model (based on continuity & momentum equations) that estimates water depths at each time step for each grid cell & accounting for surface roughness
   - Disadvantage: More difficult implementation & computationally expensive compared to sBTM & eBTM
   - Advantage: Accounts for water flow dynamics

LISFLOOD

- **DEM as model grid (MERIT)**
- **Surface Roughness raster**
  - **Created from Land Cover: Landsat-based (DEA National Land cover; 2014)**
  - **Manning's Coefficients: Literature review**
  - **Sensitivity analysis**
- **Water level time-series**





a) Land cover map including 35 classes

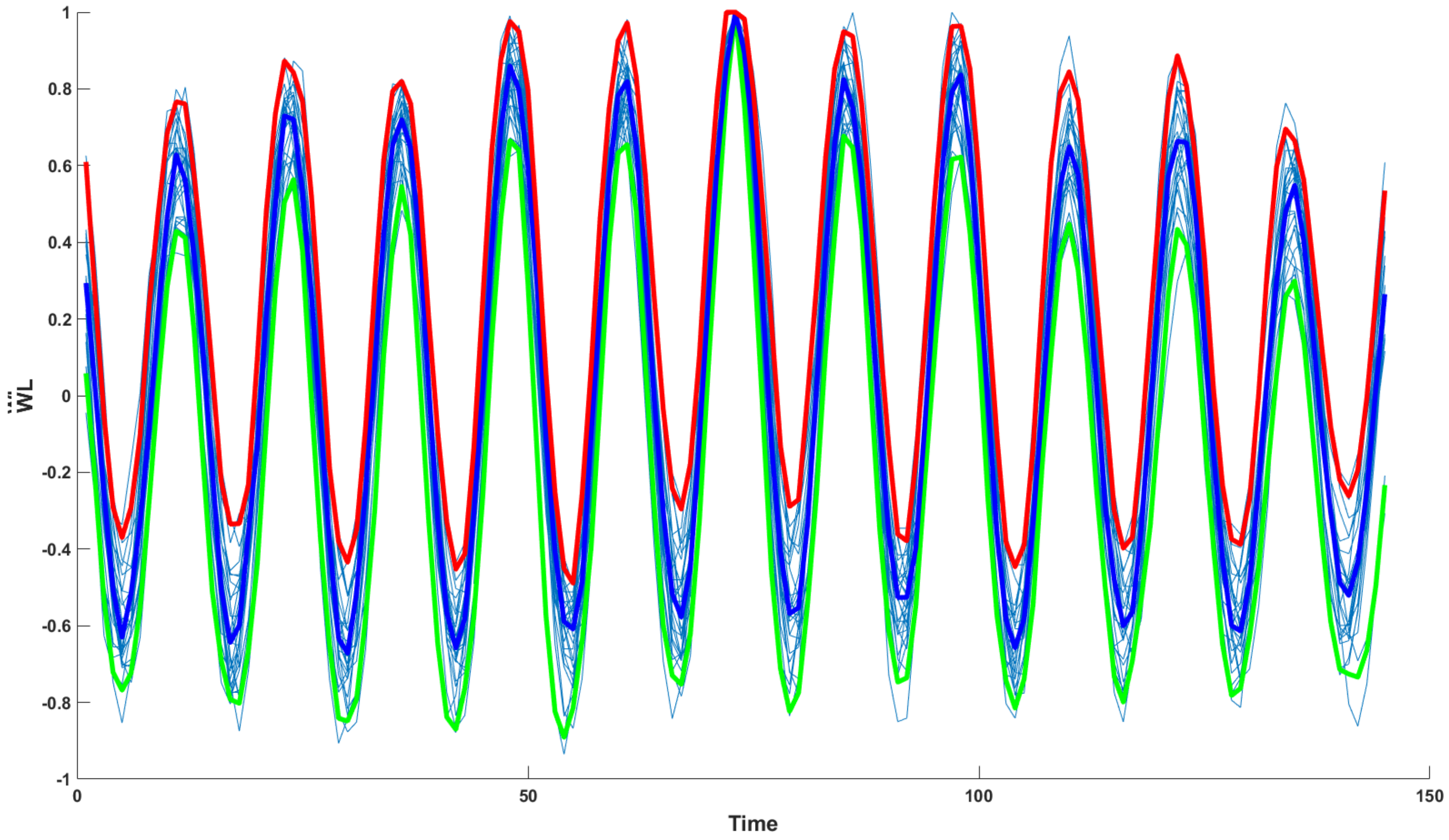
b) Roughness by Manning coefficent

Design of WL curves

- **Approach of Santamaria-Aguilar et al., (2017)**

1. **Extraction of all extreme events (AMAX)**
2. **Normalization of each WL curve by the storm peak level**
3. **Calculation of 5th (Lower), 50th (Median) and 95th (Upper) percentile at each time step**

4. **The normalized WL curves are re-scaled to the desire Storm Peak Level**



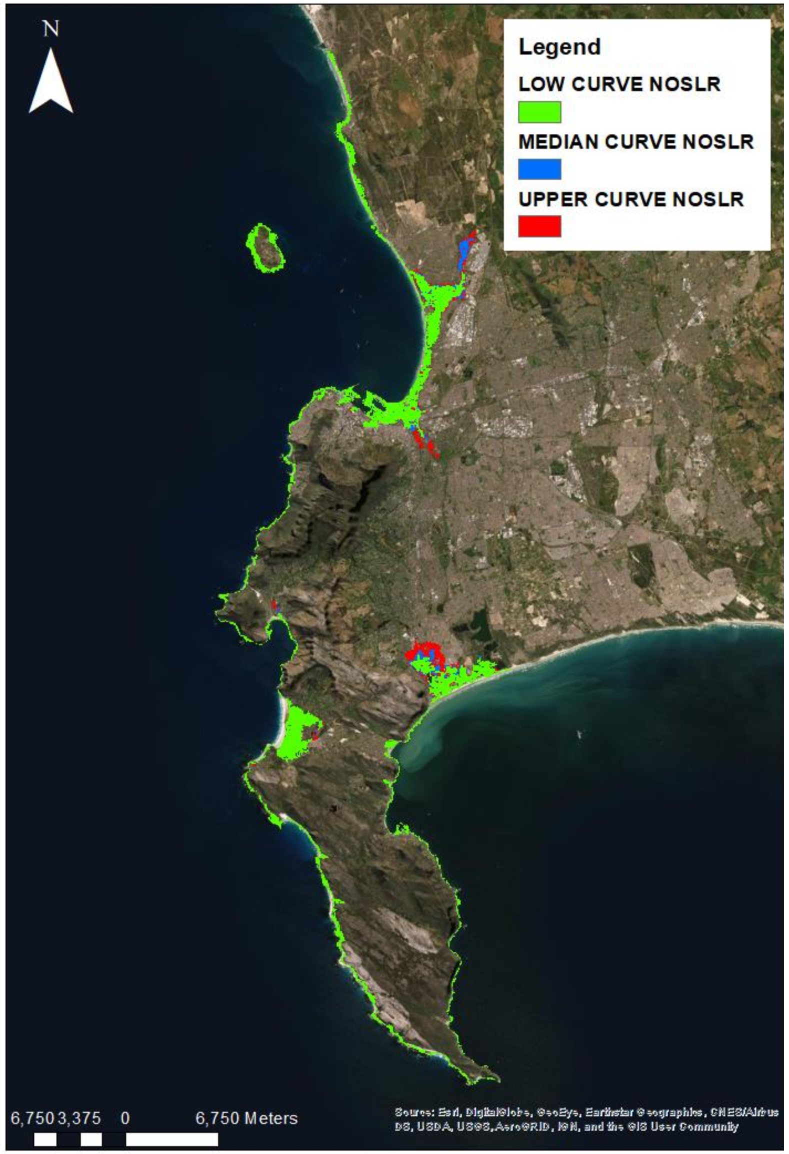
Uncertainties WL curve

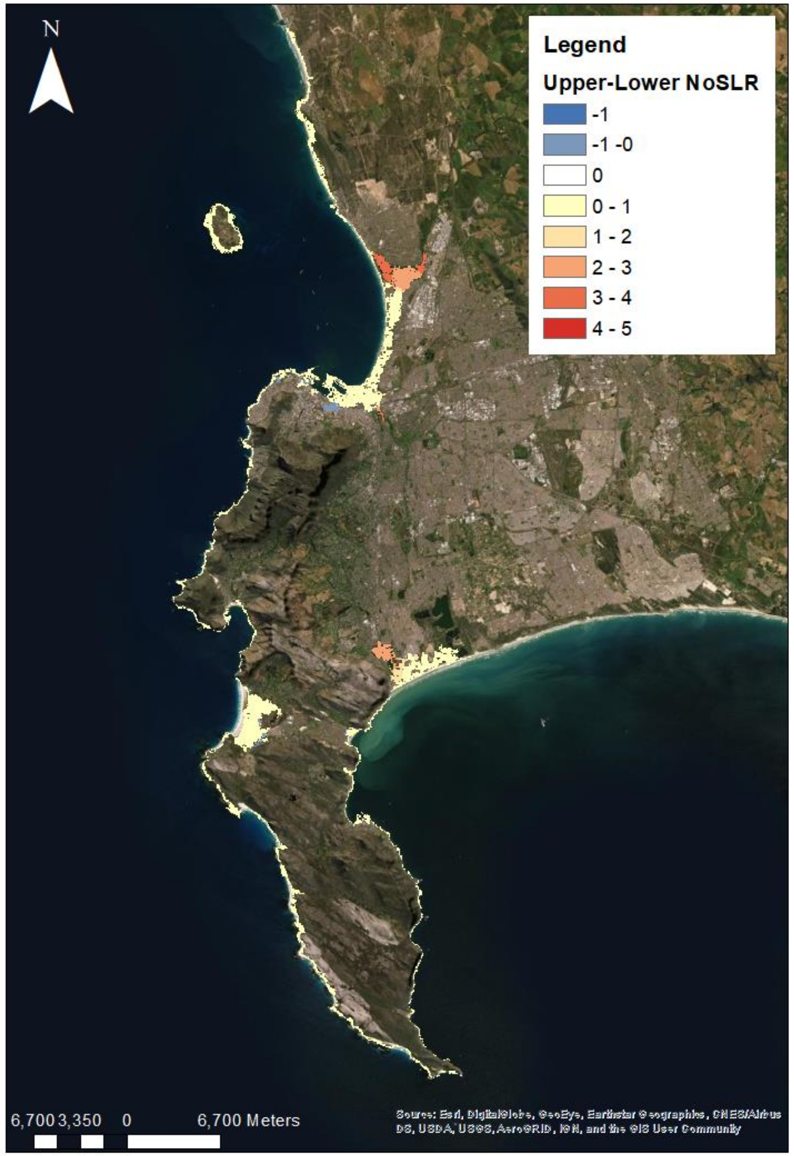
- **Same Storm Peak Level**

  (6.59 m)

- **Differences between Lower & Upper WL curves**
  - **Flood extent up to 16%**
  - **Mean water depth of 0.5 m**
  - **Max. water depth up 4.5 m**

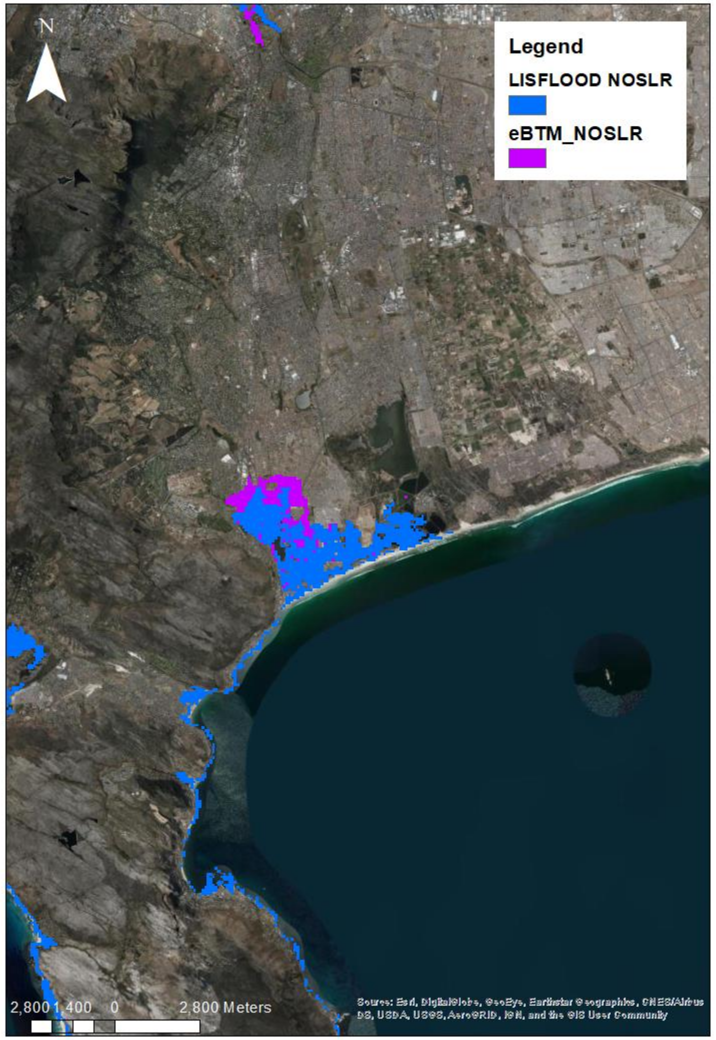
- **Shortening the event (3 days) produces small differences**

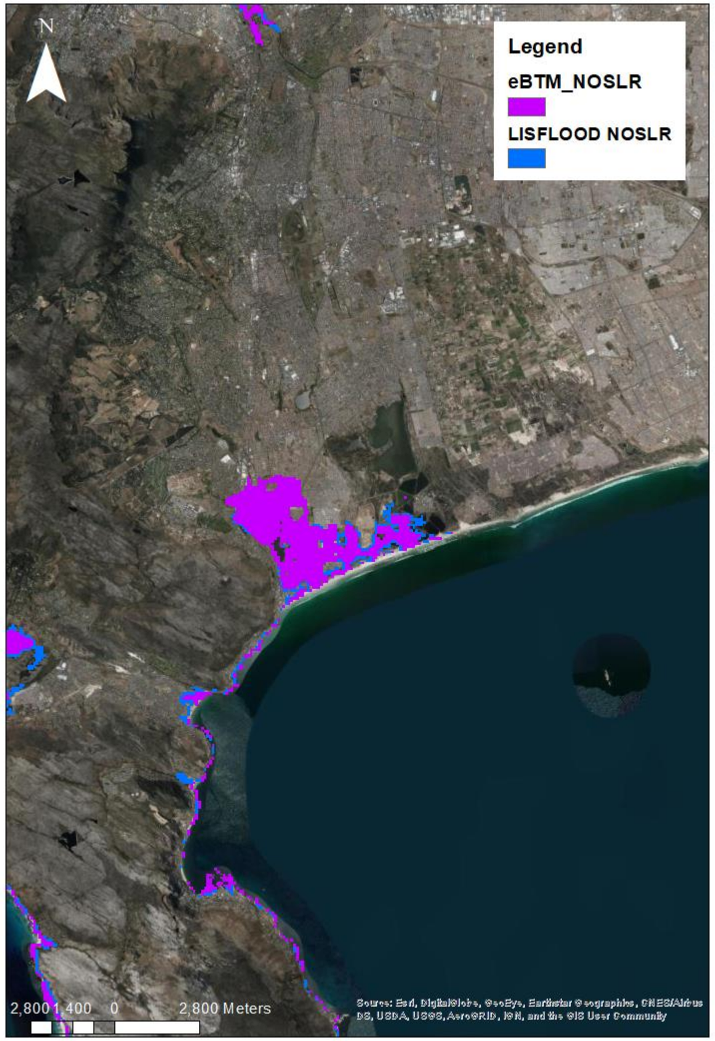




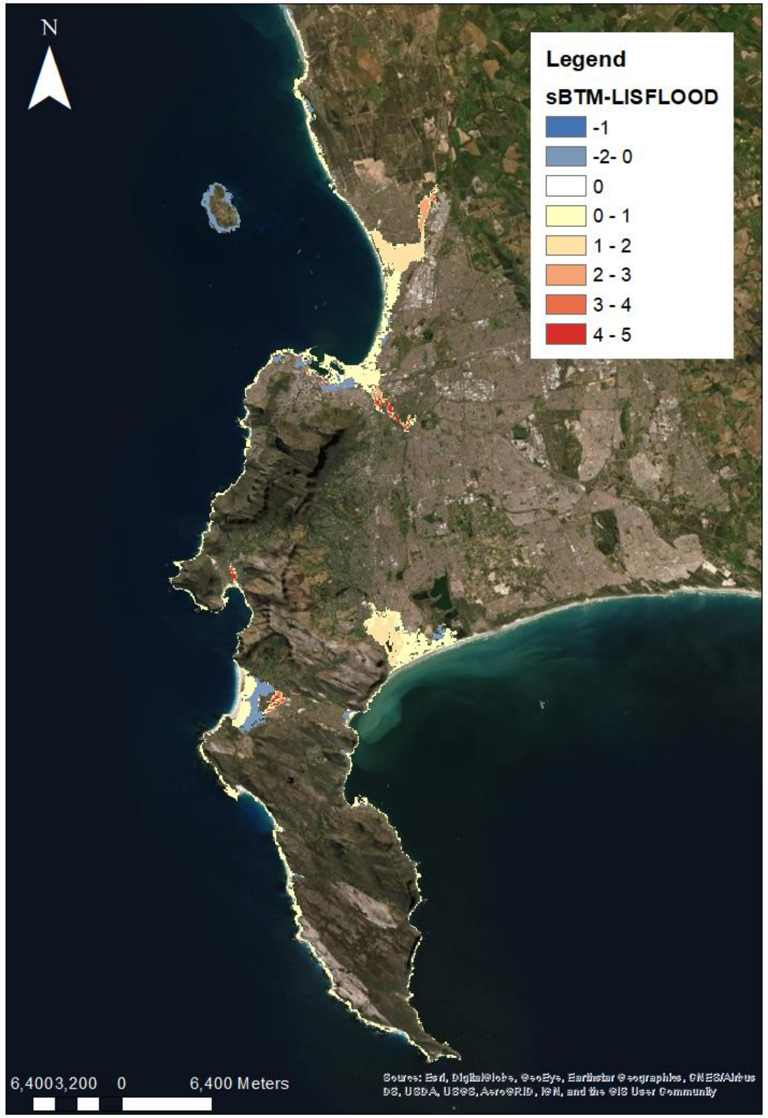
Uncertainties Flood Model

- **Differences in Extent**



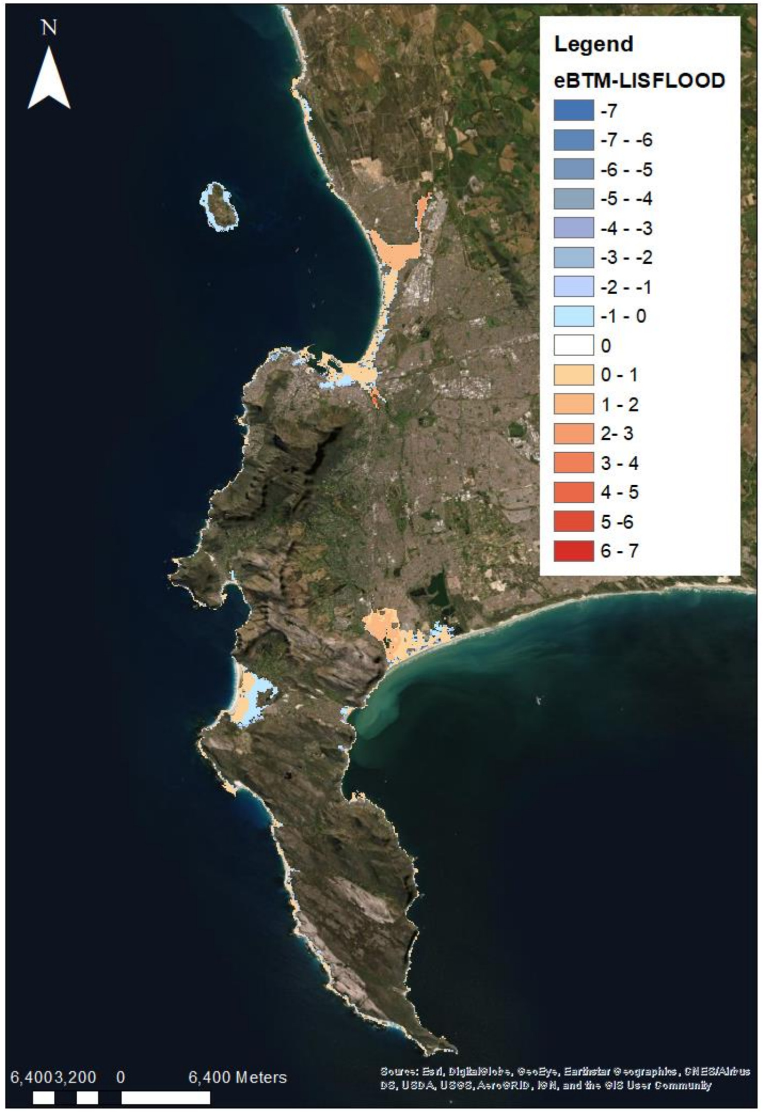


sBTM - LISFLOOD



- **sBTM overestimates by 14% the flood extent & by an average of 0.5m the water depth**
- **Maximum water depth overestimations of sBTM of almost 6m (regions not flooded in Lisflood**
- **In some areas (SW) Lisflood predicts larger water depths**

eBTM - LISFLOOD



- **eBTM produces smaller flood extents than Lisflood (up to 20%) and the spatial pattern varies**
- **eBTM produces larger flood depths (common flooded areas)**
- **Average water depth difference is negligible, but maximum differences in water depth are up to 6.6m**

Conclusions

1. **sBTM overestimates flood extent and depths (compared to the other two models)**
2. **eBTM generally produce smaller flood extents but larger water depths than Lisflood**
3. **Lisflood flood extents & depths depend not only on the WL peak, but on the WL curve with average differences up to 0.5m in water depth & 16 % in flood extent**

- **<u>The lack of validation data makes the comparison of the models very challenging</u>**
- **Similar patterns were found for a SLR scenario of 1m (7.59 m)**
- ***<u>Further steps:</u>***
  - **To perform these uncertainties analyses for the entire coast of South Africa (generalize results) using the extreme WL scenarios produced within CASISAC**