Smart Control of the Climate Resilience in European Coastal Cities

score

Webinar

From Global to Local scale: Predicting the effects of climate change on coastal cities

Thursday, 18 January 2024
11:00 a.m.- 12:00 p.m. (CET)

CNR ISMAR ISTITUTO DI SCIENZE MARINE

CNR IAS ISTITUTO PER LO STUDIO DEGLI IMPATTI ANTROPICI E SOSTENIBILITÀ IN AMBIENTE MARINO

igg Istituto di Geoscienze e Georisorse

Consiglio Nazionale delle Ricerche
Istituto per la BioEconomia

CONSORZIO LaMMA

ATU

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4 Models for downscaling – step 2 : urban scale or “last mile” downscaling

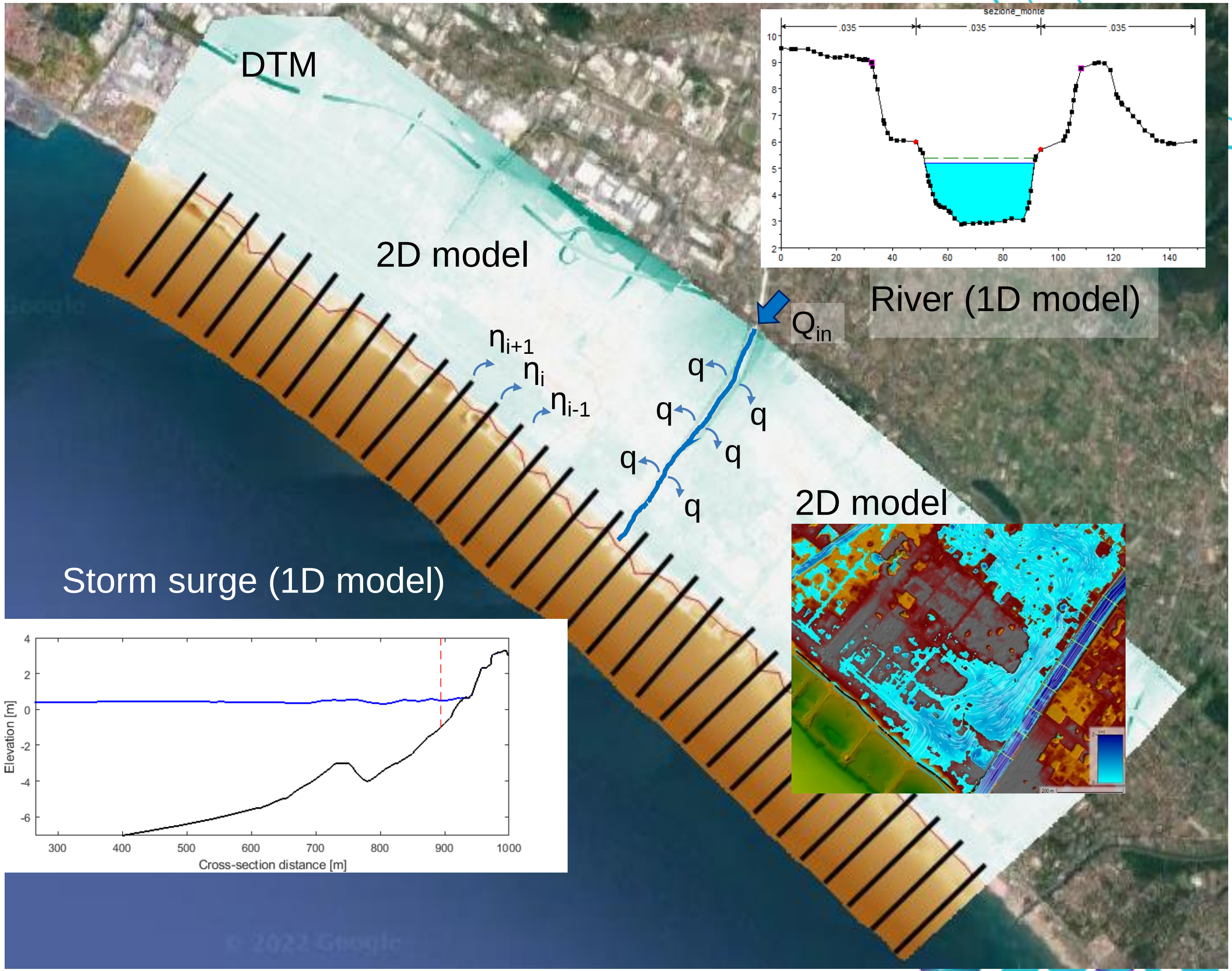
Approach:

- 1D simulation at coastal area
- 2D simulation on land
- 1D simulation in riverbed

Coupled

Water reaches the 2D area from:

- the river (flow rate due to bank overflow, **q**)
- the sea (water level as boundary condition **η**)



4 Models for downscaling – step 2 : urban scale or “last mile” downscaling

4.1 Download and install HEC-RAS

HEC-RAS 6.5 Beta Windows:

The setup package includes HEC-RAS 6.5 Beta

Primary Download Site:
Download HEC-RAS 6.5 Beta Setup Package (208 MB) [Release Notes]

Alternate Download Site:
Download HEC-RAS 6.5 Beta Setup Package (208 MB) [Release Notes]

Supported Operating Systems:
Windows 10/11 64-bit

HEC-RAS 6.4.1 Windows:

The setup package includes HEC-RAS 6.4.1

Primary Download Site:
Download HEC-RAS 6.4.1 Setup Package (205 MB) [Release Notes]

Alternate Download Site:
Download HEC-RAS 6.4.1 Setup Package (205 MB) [Release Notes]

Supported Operating Systems:
Windows 10/11 64-bit

HEC-RAS 6.1 Linux:

The Linux setup package (zip format) contains HEC-RAS 6.1 HEC is u
version of HEC-RAS beyond the scope of what is included in the pro

Current Version:
Download HEC-RAS 6.1 for Linux (245 MB) [Release Notes]

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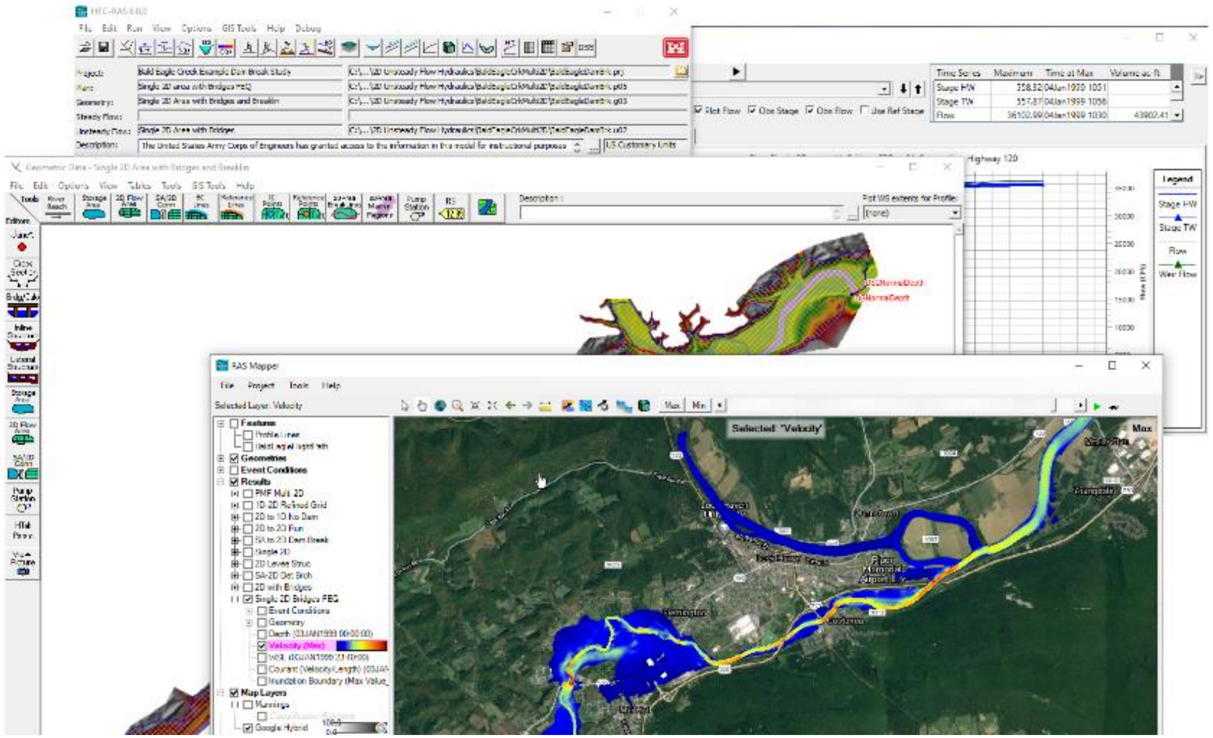
US Army Corps of Engineers Hydrologic Engineering Center

HOME > SOFTWARE > HEC-RAS

HEC-RAS

- HEC-RAS
- Features
- Downloads
- Documentation
- Training
- Known Issues
- Bug Report
- Suggestions
- Collaborators
- Support Policy

Welcome to the Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) website. This software allows the user to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling.

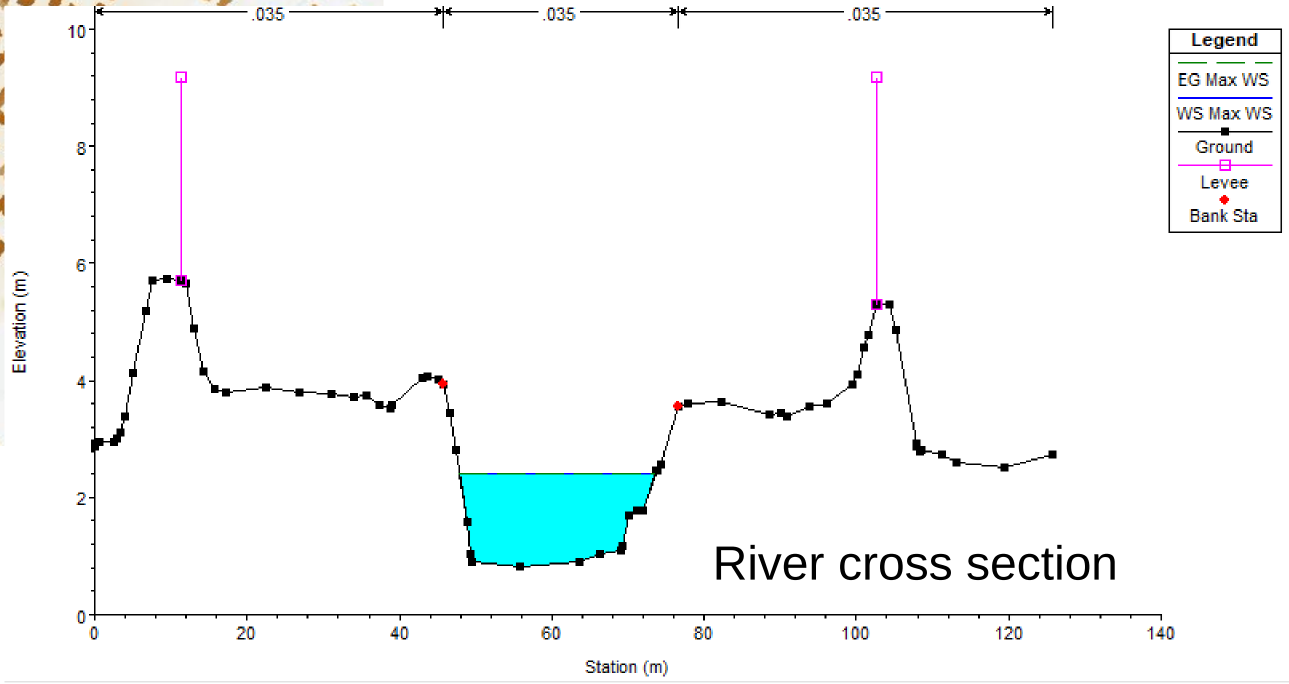


4 Models for downscaling – step 2 : urban scale or "last mile" downscaling

4.2 Build the computational grid

Massa DEM 2m x 2m

- A digital elevation model (DEM) is needed (with buildings and including the bathymetry of the coastal area)
- The geometry (cross sections, hydraulic structure and x,y coord) of the river



River cross section

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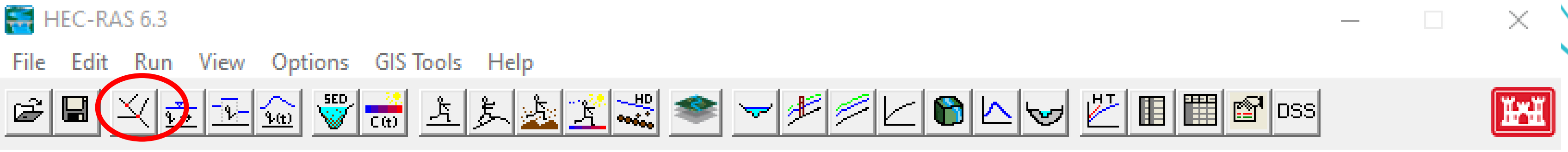
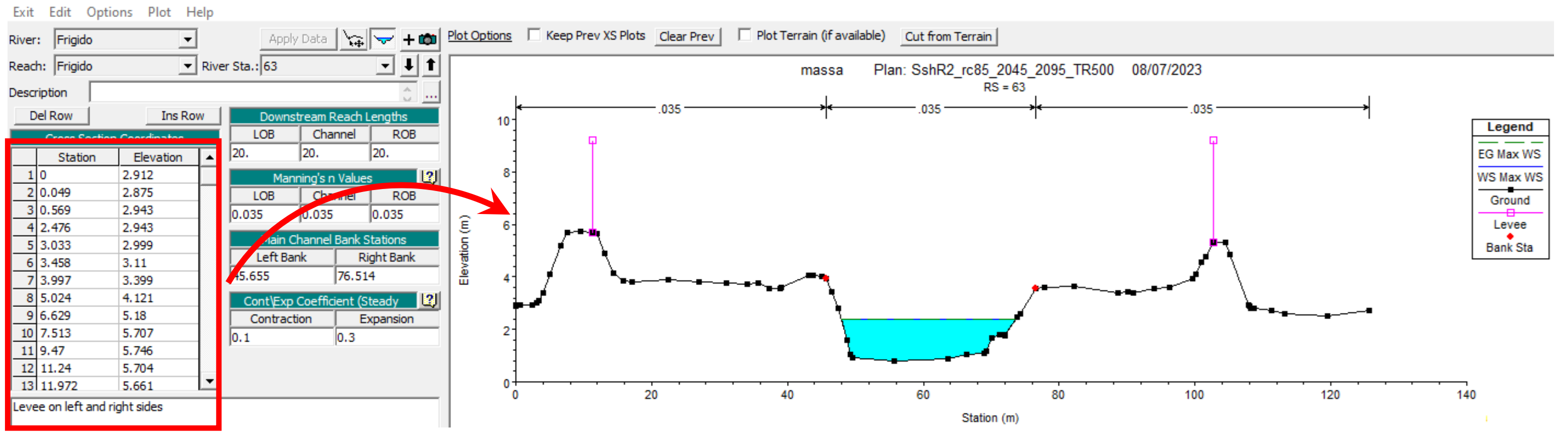
4.3 Build the computational grid

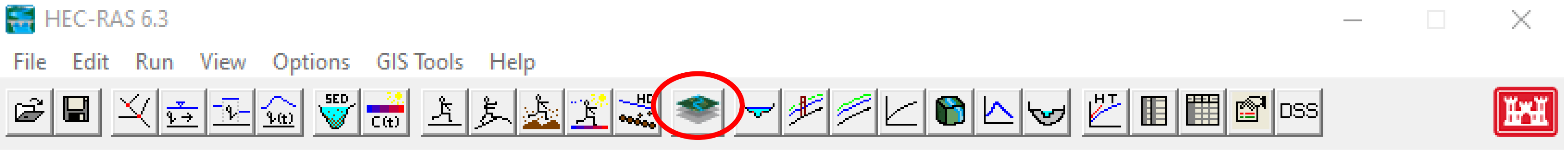
- Create a «geometry»

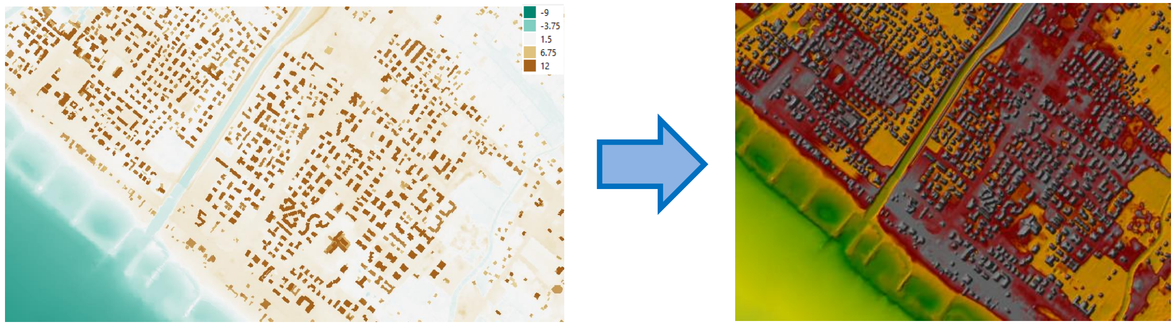


This means to insert information about the geometry of the river (path and cross sections)



- Create a «Terrain» (layer that can be read by the model) using HEC-RAS RasMapper and associate it to the geometrical data of the river («geometry»)





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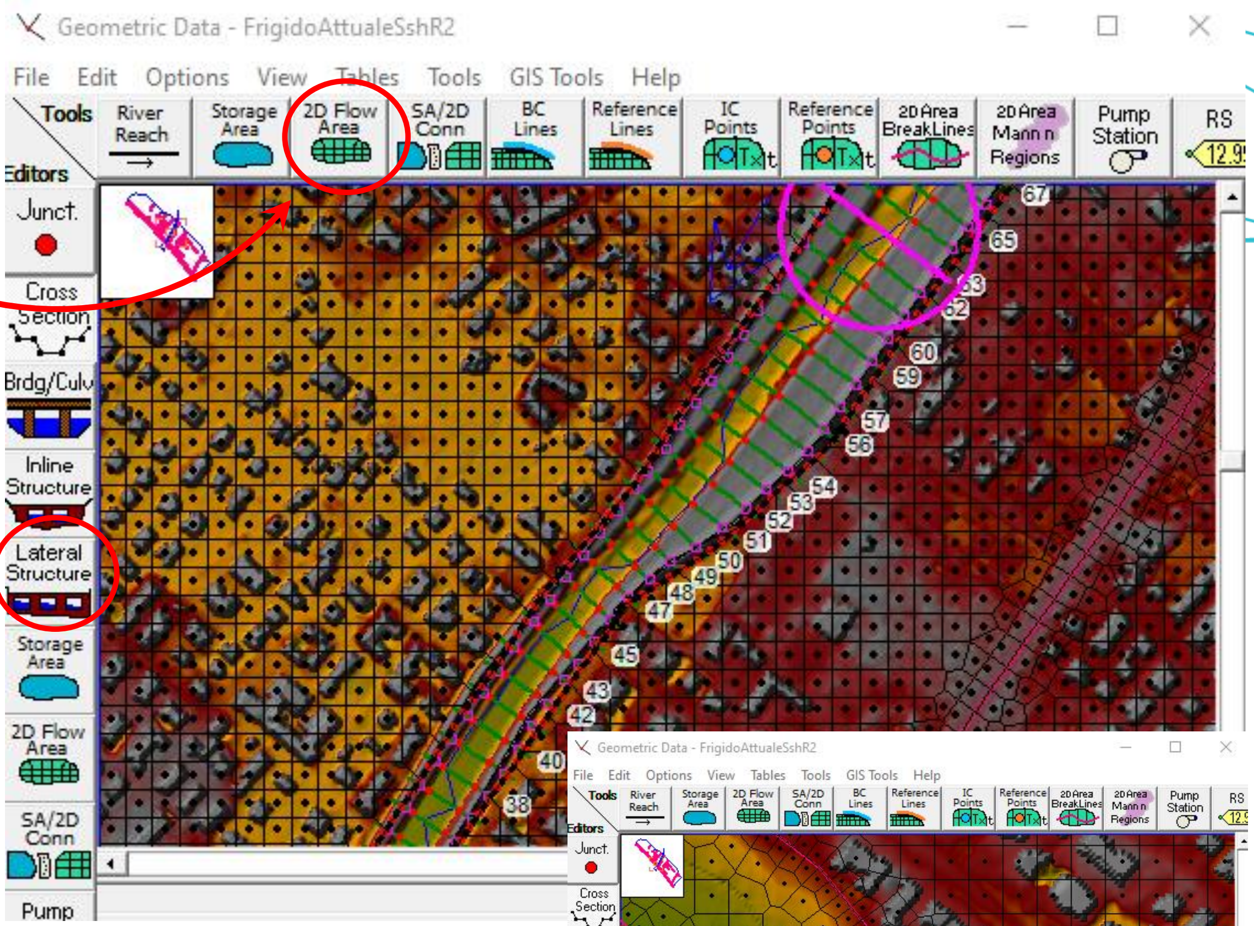
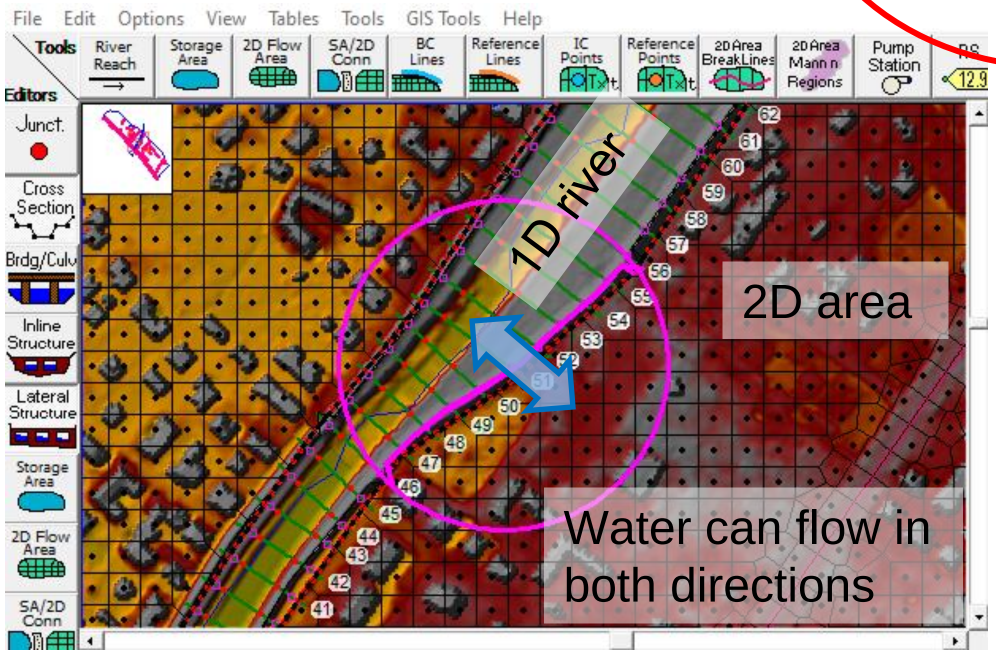
4.4 Build the computational grid

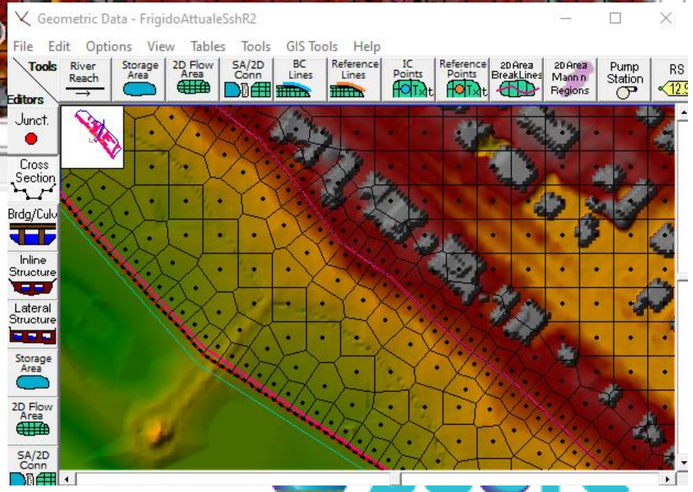
- Create the computational mesh overlying the Terrain

- Create the connections (Lateral Structures) between the 1D river and the 2D floodable areas





Increased resolution where needed

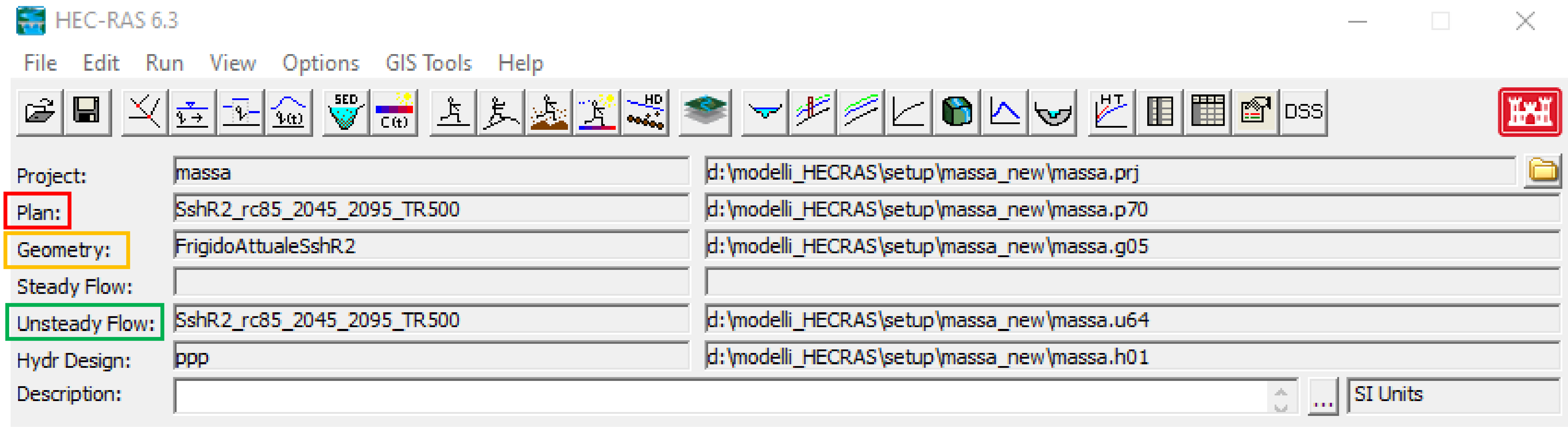


4 Models for downscaling – step 2 : urban scale or “last mile” downscaling

4.5 Setup a simulation

Files needed:

- geometry
- boundary/initial conditions
- plan (combination of geometry and boundary conditions and model parameters)



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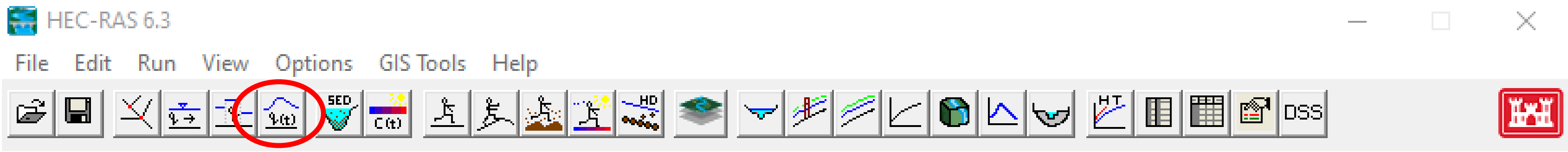
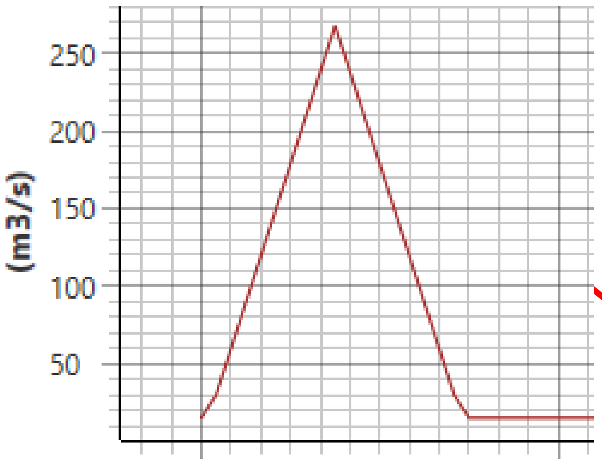
4.6 Setup a simulation

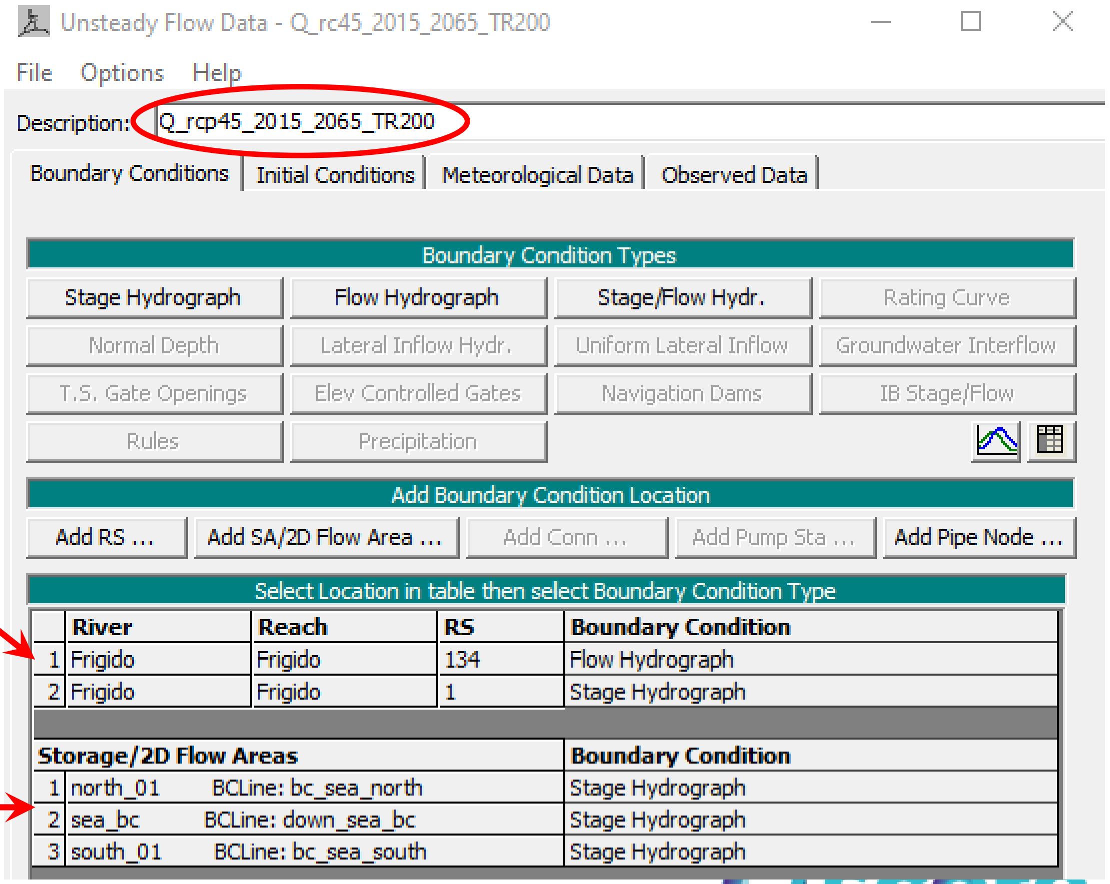
- Create boundary and initial conditions



- River discharge upstream

triangular shape with peak value associated to a specific return period (TR200)





- Water level at the coast (multiple data based on the number of sections into which the shoreline has been divided (***water level is also associated to Return Period*** in dedicated simulations)

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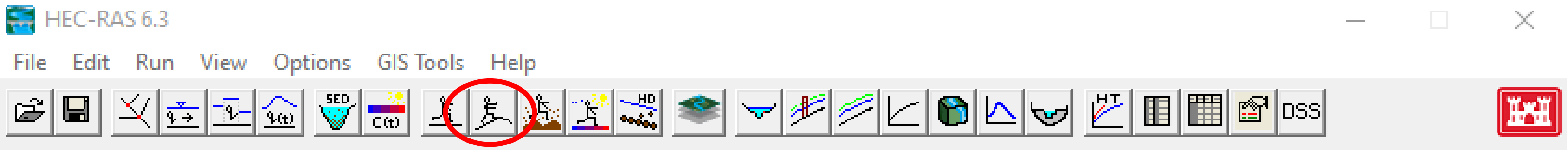
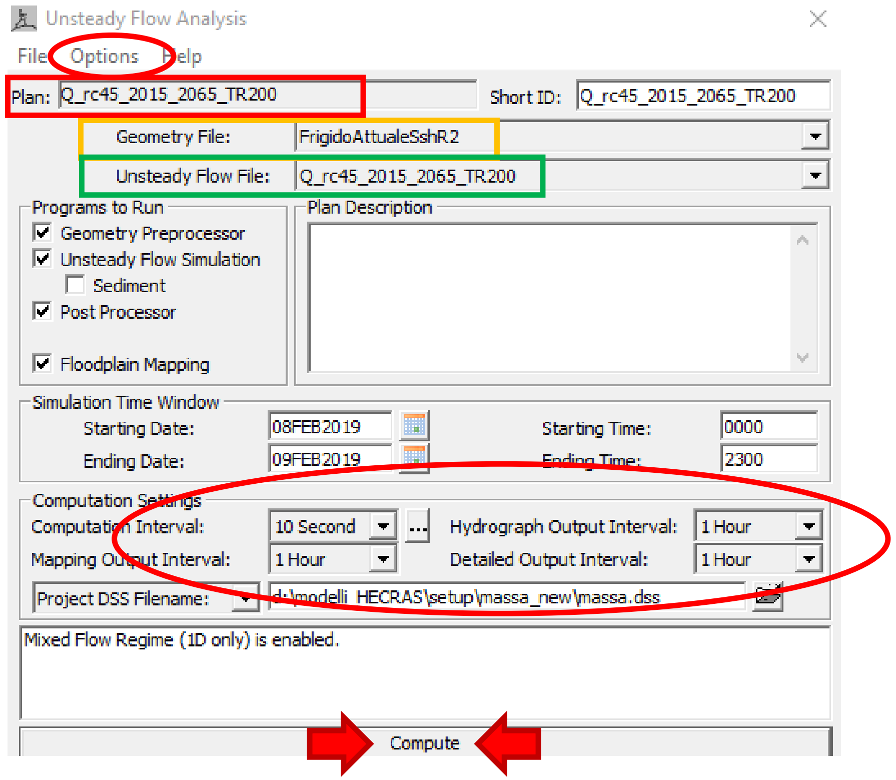
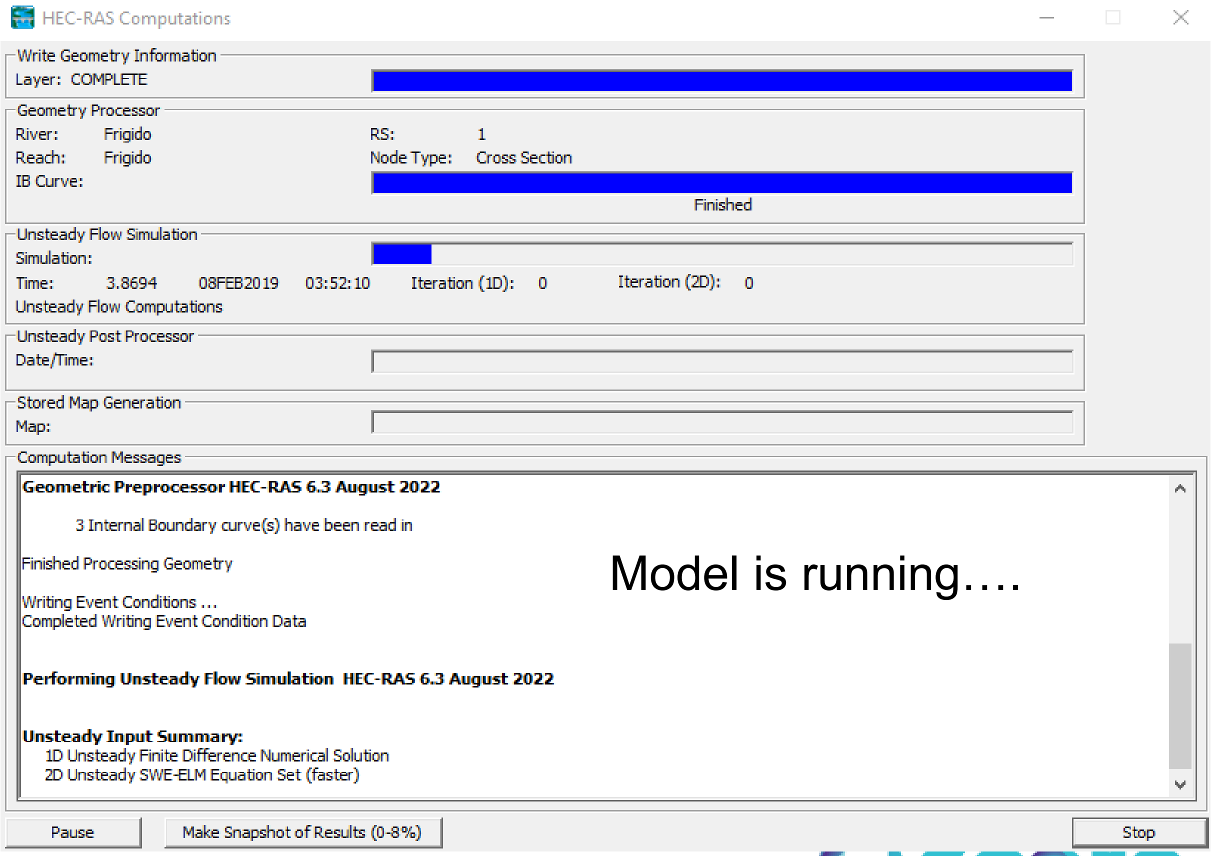
4.7 Setup a simulation

- Create the plan



  - Options about numerical aspects





Model is running….

- Options about marching and output time steps

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4.8 Setup a simulation

- Simplified approach for the storm surge to avoid the run of XBeach simulations

Two time series: wave heigth (H_s) and water level (η)

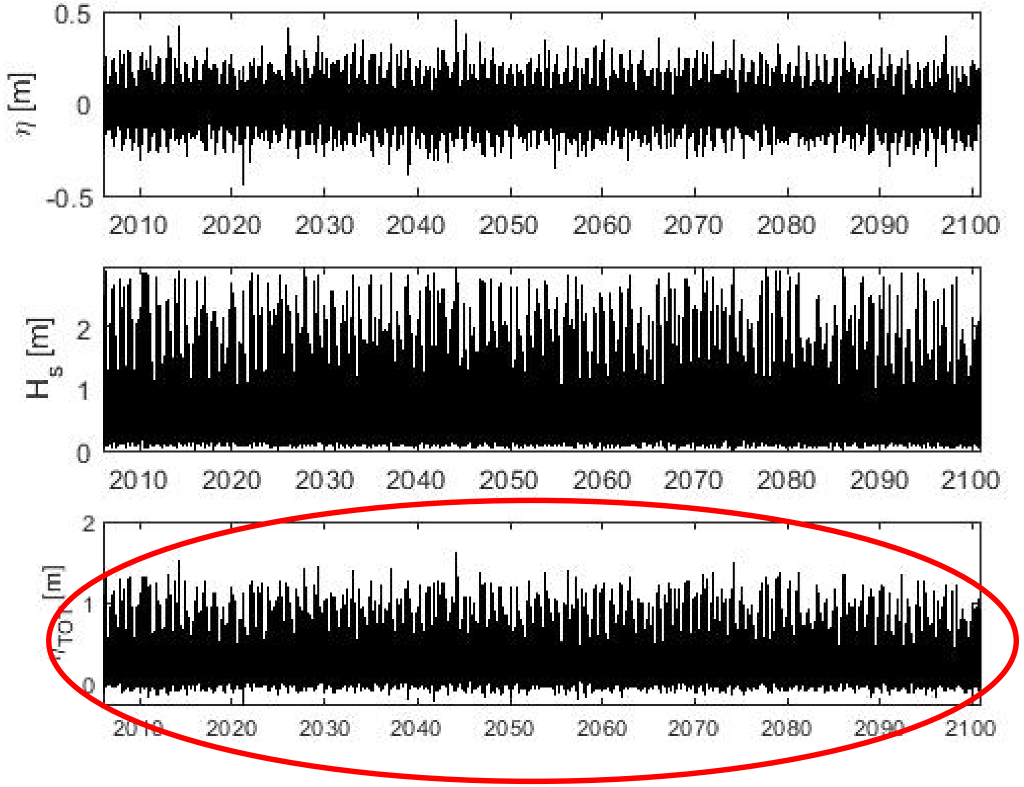
Sum of the contribution of wave runup $R_{2\%}(H_s)$ and η to total water level: $\eta_{TOT} = \eta + R_{2\%}(H_s)$

Runup $R_{2\%}$ determined via Stockdon et al. (2006) or Atkinson et al. (2017) formula:

$$R_{2\%} = 1.1\left[0.35i\sqrt{H_s\eta} + \frac{H_sL\sqrt{0.536i^2 + 0.004}}{2}\right]$$

$$R_{2\%} = 0.92i\sqrt{H_sL} + 0.16H_s$$

i = beach slope, L = wave length



Extreme Value Analysis

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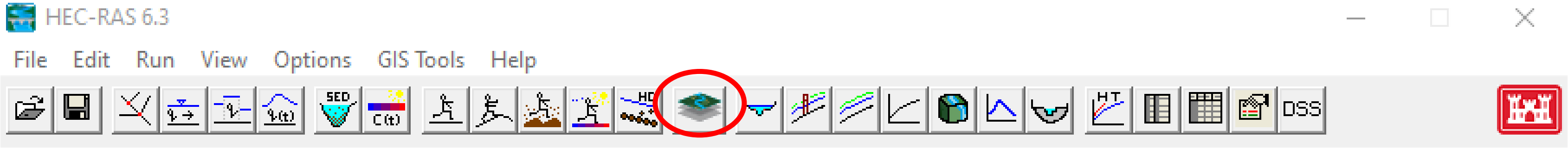
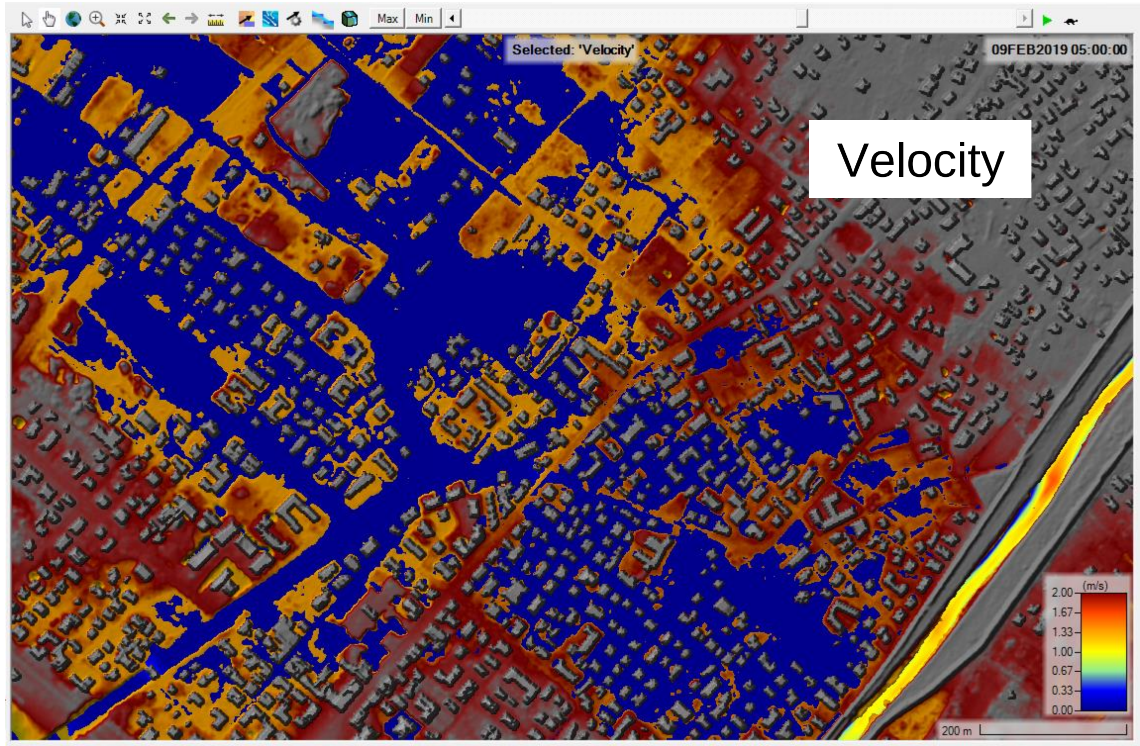
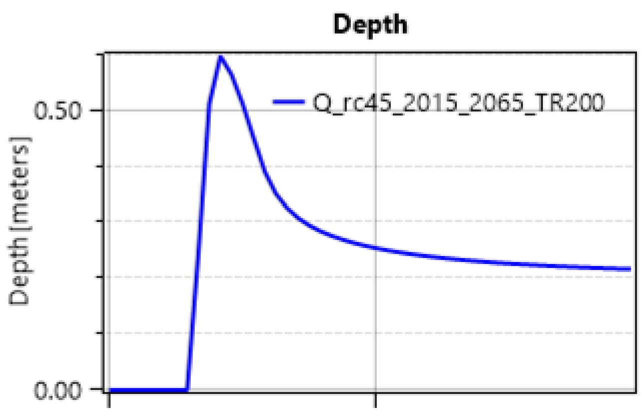
4.9 Visualize model output







Right click on a point to have the time series

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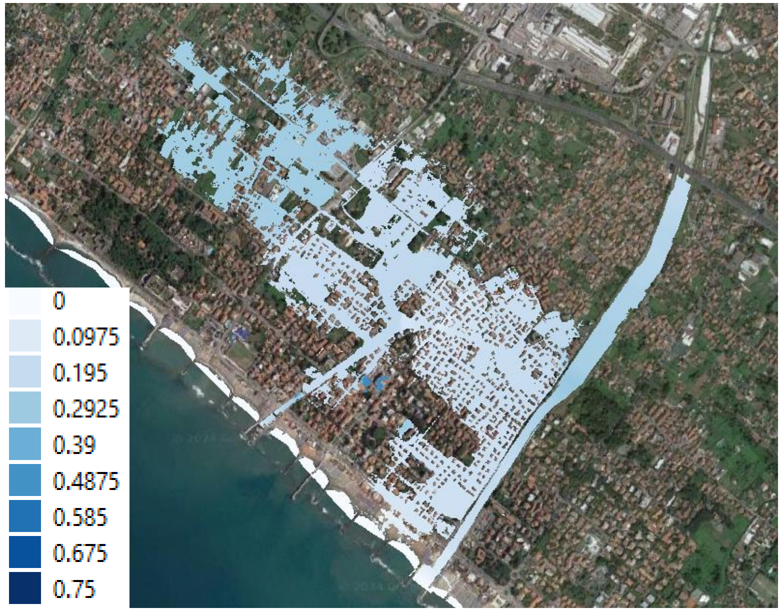
4.10 Massa study case in SCORE

River discharge simulation

Historical TR200

RCP45 2045-2095 TR200

Difference



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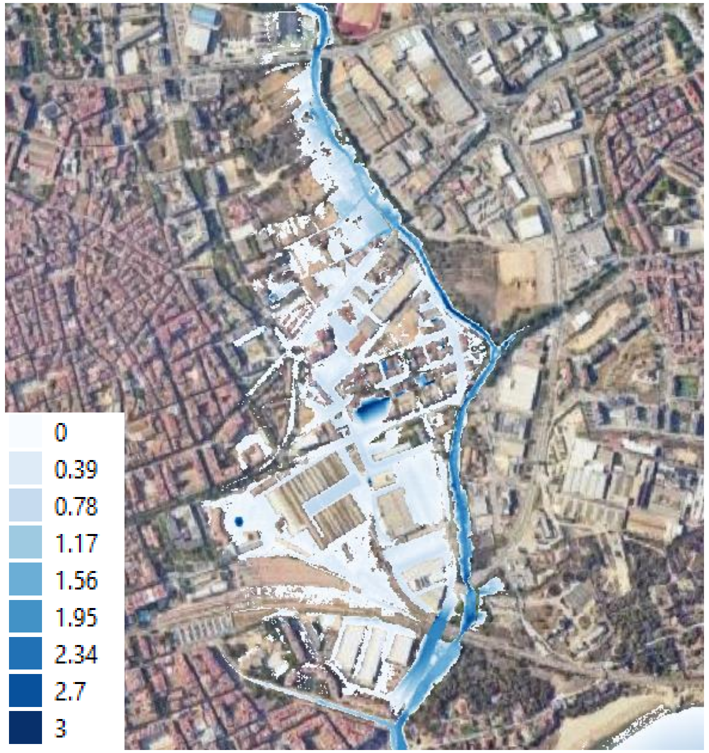
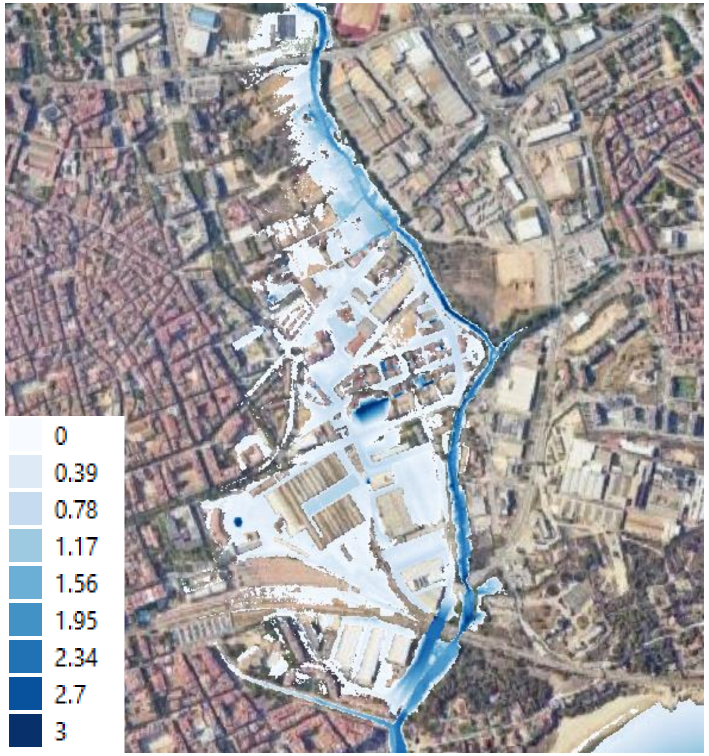
4.11 Villanova study case in SCORE

River discharge simulation

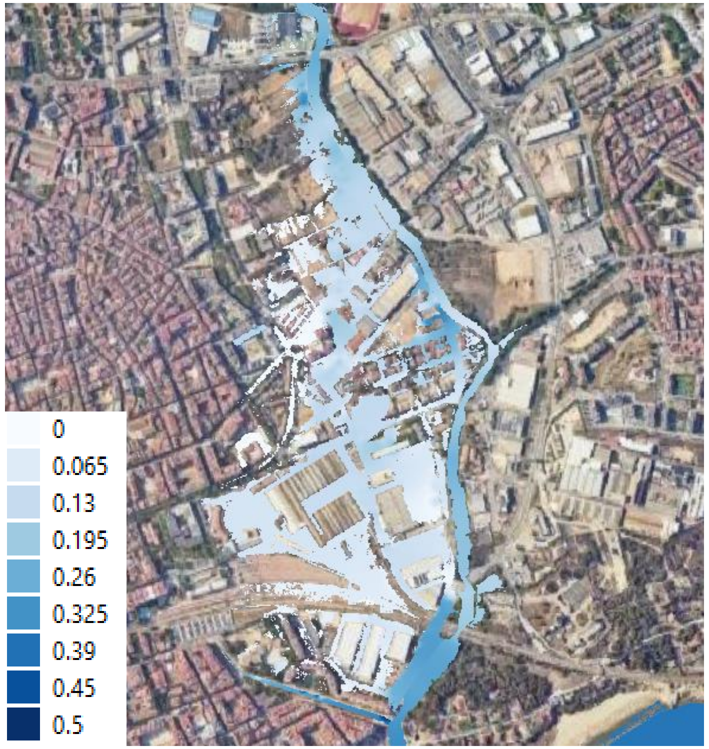
Historical TR200



RCP45 2045-2095 TR200



Difference



Wrap-up

1. In describing methods and models for understanding the effects of climate change at the scale of our everyday lives, we have made two journeys: one across scales, **from the global scale** where we measure effects due mainly to the sun-forced ensemble dynamics of the atmosphere and oceans, **to the local scale** where we observe the effects closest to us..

2. Actually through the models we also make **a journey through time**, to simulate, based on our current knowledge, what has happened in the recent past and what is supposed to happen by the end of this century, and beyond.

3. **Models** are an exceptional knowledge tool, they **are affected by uncertainty**. Even in an uncertain and error-filled environment, they remain the only way we can predict the long-term effects of climate change.

4. We have the **opportunity**, using models that are available to the entire scientific community and beyond (community models), to be able **to make plans** that affect our future lives and those of future generations, **design sustainable and socially acceptable adaptation solutions**, and **raise awareness** among all citizens.

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