Smart Control of the Climate Resilience in European Coastal Cities

<u>Webinar</u>



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)



lstituto per la BioEconomia

ATU

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007142

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)



4.1 Download and install HEC-RAS

HEC-RAS 6.5 Beta Windows:

The setup package includes HEC-RAS 6.5 Beta

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

Alternate Download Site: Lownload 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: Lownload 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: Lownload HEC-RAS 6.1 for Linux (245 MB) [Release Notes]

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EC-RAS	user to perform or	e-dimensional st	teady flow, one	and two-dimensior	nal unsteady flo	w calculations, see	diment transport	/mobile
HEC-RAS	bed computations.	and water temp	erature/water	quality modeling.	•			
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4.2 Build the computational grid



4.3 Build the computational grid

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File

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- 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





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 Models for downscaling – step 2 : urban scale or "last mile" downscaling 4.6 Setup a simulation HEC-RAS 6.3 \times Create boundary and initial Edit Run View Options GIS Tools Help ♥ 😸 ᆂ 🗝 🛸 🛩 🔎 🗠 🗠 🗠 🖽 🖽 📾 🖙 oss $|\underline{\mathbf{x}}|$ conditions I ₩₩ 法 Unsteady Flow Data - Q_rc45_2015_2065_TR200 \times River discharge upstream File Options Help Description: Q_rcp45_2015_2065_TR200 Boundary Conditions Initial Conditions Meteorological Data Observed Data 250 Boundary Condition Types triangular shape 200 Stage/Flow Hydr. Stage Hydrograph Flow Hydrograph Rating Curve with peak value (m3/s) Normal Depth Lateral Inflow Hvdr Uniform Lateral Inflow Groundwater Interflow 150 associated to a T.S. Gate Openings Elev Controlled Gates Navigation Dams IB Stage/Flow specific return 🔼 🖽 Rules Precipitation 100 period (TR200) Add Boundary Condition Location 50 Add RS Add SA/2D Flow Area .. Add Conn ... Add Pump Sta .. Add Pipe Node ... Select Location in table then select Boundary Condition Type River Reach RS Boundary Condition 1 Frigido 134 Frigido Flow Hydrograph 2 Frigido Water level at the coast (multiple data based on the Frigido Stage Hydrograph number of sections into which the shoreline has been Storage/2D Flow Areas Boundary Condition BCLine: bc_sea_north 1 north 01 Stage Hydrograph divided (water level is also associated to Return 2 sea bc BCLine: down sea bc Stage Hydrograph 3 south_01 BCLine: bc_sea_south Stage Hydrograph **Period** in dedicated simulations)



4.7 Setup a simulation

- Create the plan

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- Options about numerical aspects

HEC-RAS 6.3

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Plan: Q_rc45_2015_2065_TR200	Short ID: Q_rc45_2015_2065_TR200	-
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Unsteady Flow File: Q_rc45_	2015_2065_TR200	•
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- Options about marching and output time steps

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:

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

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

i = beach slope, L = wave length



Extreme Value Analysis



4.9 Visualize model output





0.50

Depth [meters]

4.10 Massa study case in SCORE

River discharge simulation



RCP45 2045-2095 TR200



Difference





4.11 Villanova study case in SCORE

River discharge simulation





Wrap-up

- 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.
- 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.

