Rapid flood risk assessment and adaptation planning for climate resilient urban development

Supporting Flood Resilience in Rio de Janeiro

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UP2030

1 Introduction

HydroFlows and FloodAdapt

– rapid risk screening meets interactive adaptation planning

HydroFlows

Rapid and **automated** risk screening
allows for **continuous updates** when the city changes

+

FloodAdapt

Interactive screening of adaptation strategies and **what-if scenarios** using the same models and events

Objective for developing HydroFlows

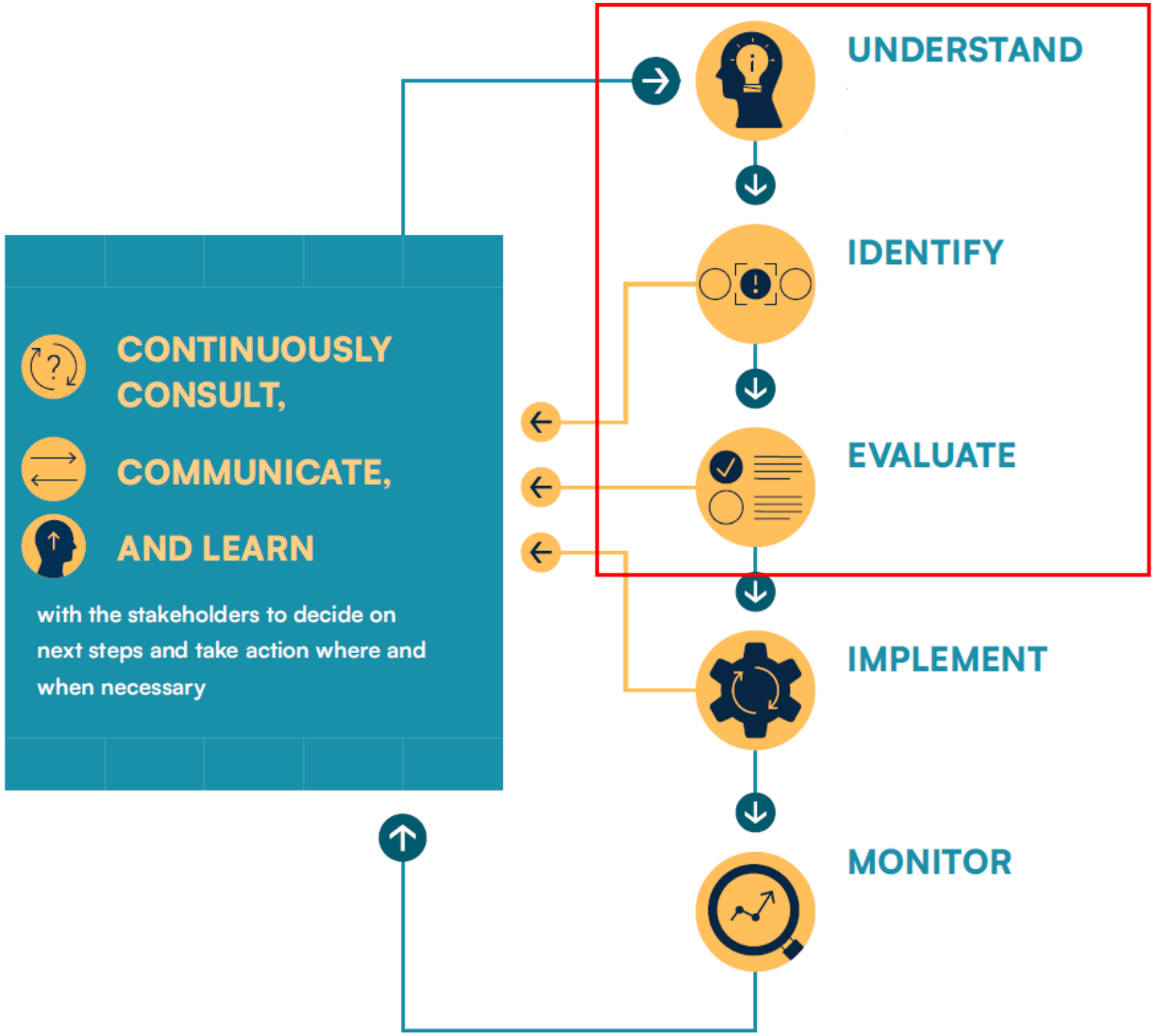
To *automate* and *standardize reproducible* workflow setups for flood risk assessments

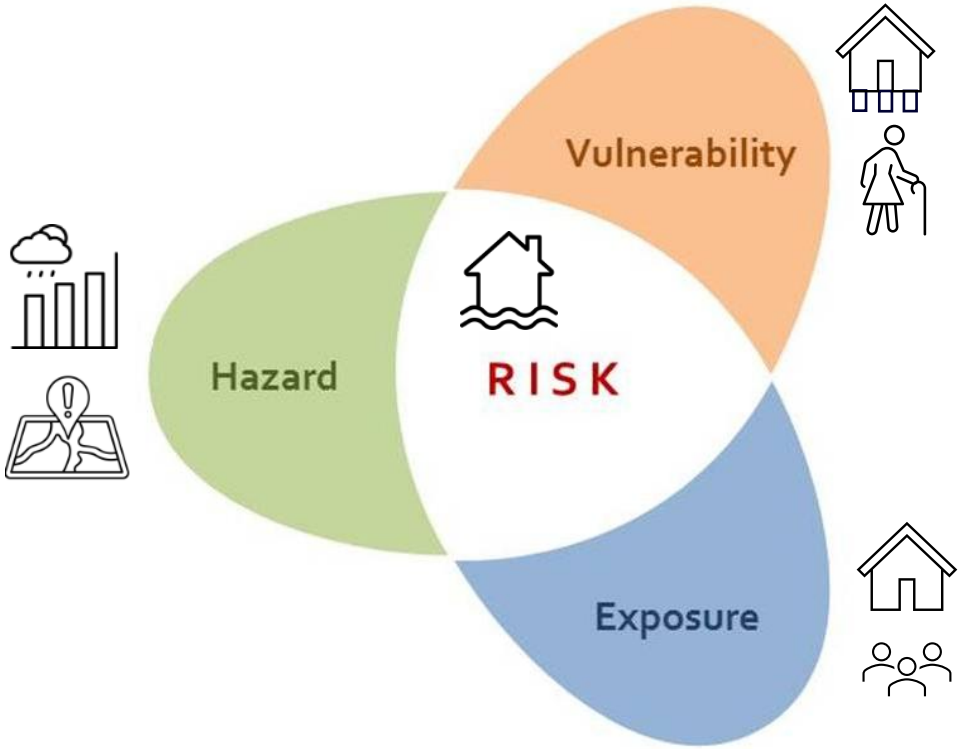
To enable rapid flood risk assessments with *global data* as a starting point for *local data driven* assessments.

To *democratize* flood risk assessment by moving knowledge and expertise to local professionals.

Deltares UP2030

Flood Risk Assessment and Adaptation Planning

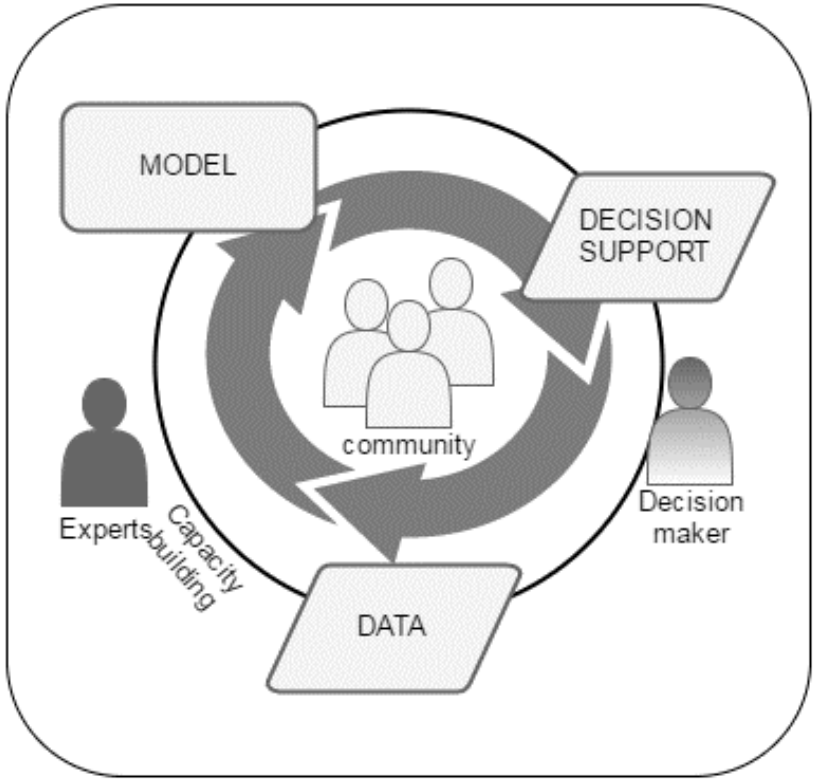




Source: World Bank (2023). Urban Flood Risk Handbook: Assessing Risk and Identifying Interventions

“Global-to-local” approach to accelerate flood risk management

- Rapid assessment anywhere based on global datasets
- As starting point for discussion with local stakeholders
- Continuously improve the model with better local data



➢ Requires automated and accessible flood risk assessments

➢ Two tools: HydroFlows and FloodAdapt

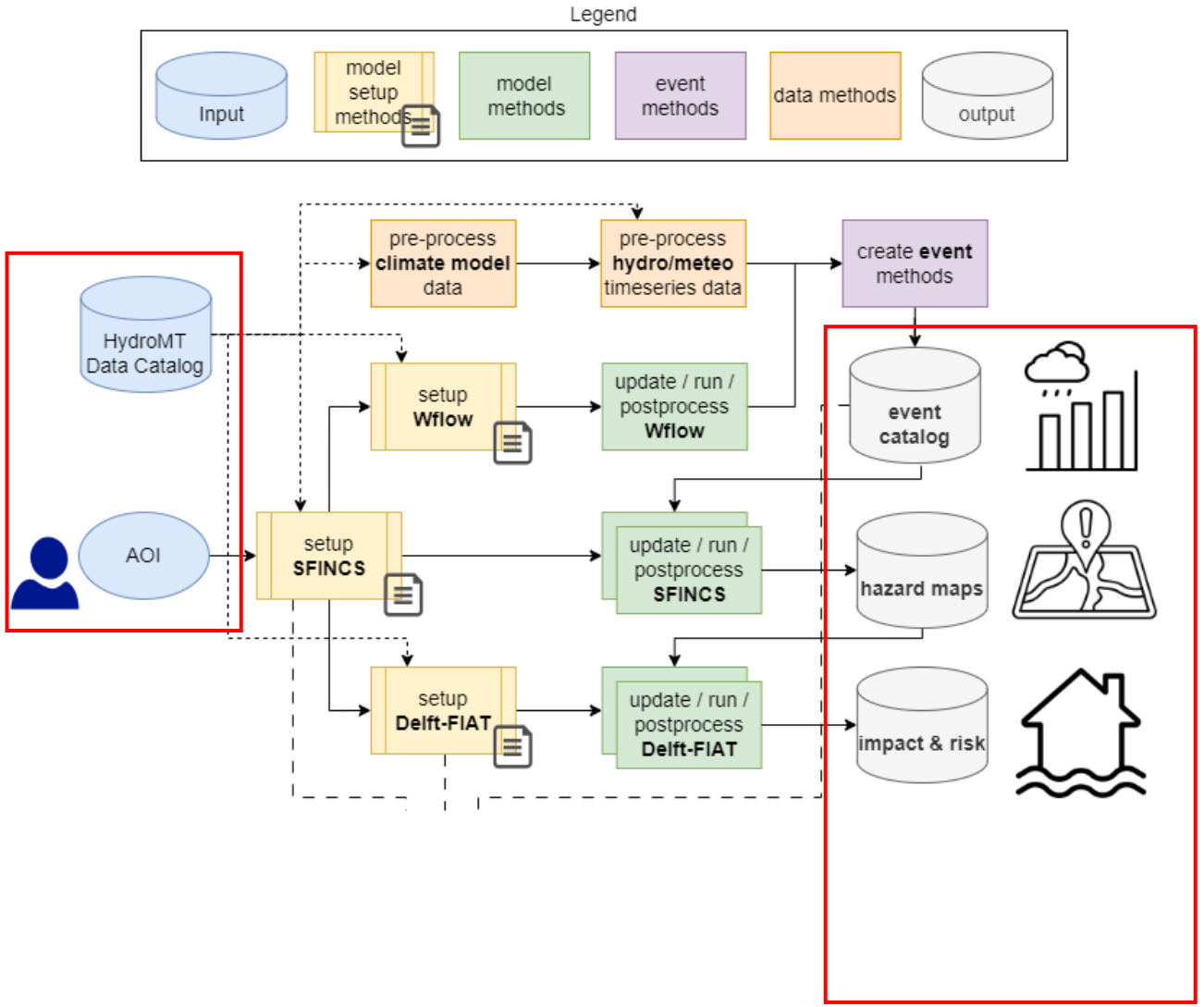
2 HydroFlows

HydroFlows: modular workflows

- Fluvial, pluvial, and coastal flood risk
- integrates statistical, hydrological, hydrodynamic, and impact models
- Based on >30 methods which can be combined into automated workflows

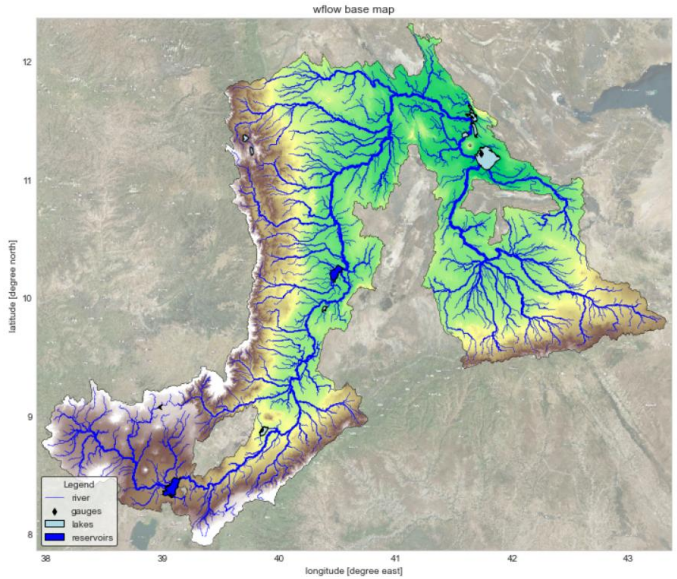
- User inputs:
  - Area of interest
  - Data Catalog (e.g. meteo, topography, etc.)
  - Model building configuration

- Output:
  - flood hazard maps
  - flood risk maps and indicators
  - *FloodAdapt for interactive what-if scenarios*

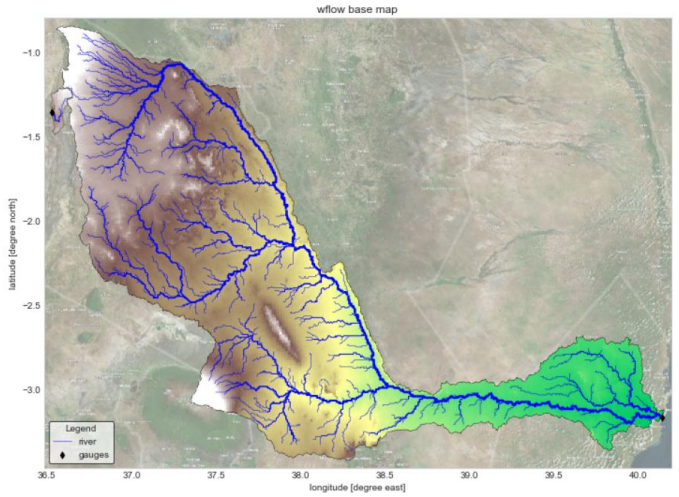


Hydrological model Wflow

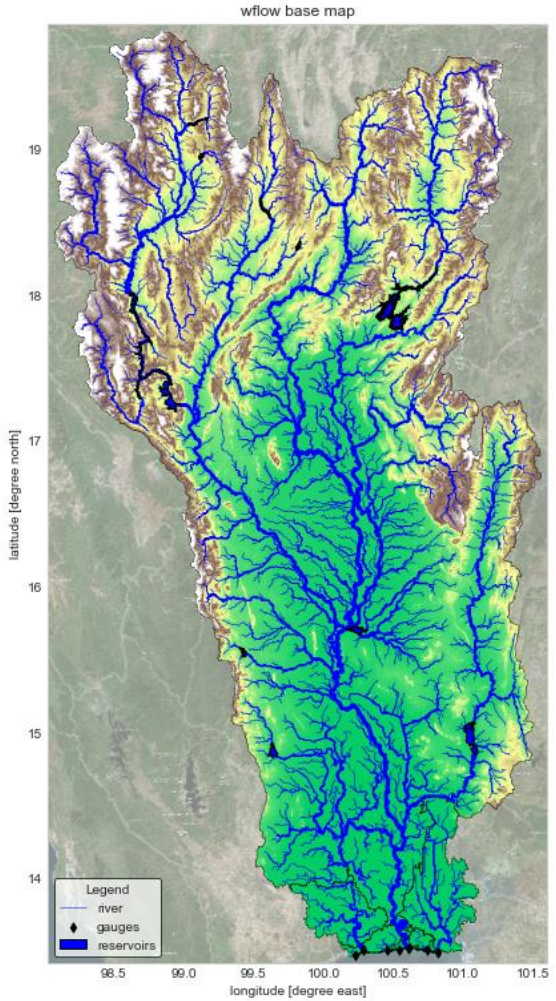
applied at the river basin scale to determine boundary conditions at the city scale



Addis Ababa



Nairobi



Bangkok

Hydrodynamic 2D flood model Sfincs

applied at the city scale to obtain hazard maps

Global datasets

- City polygons
- Physical boundary conditions
- HydroMet forcing
- (Climate forcing)

Base model

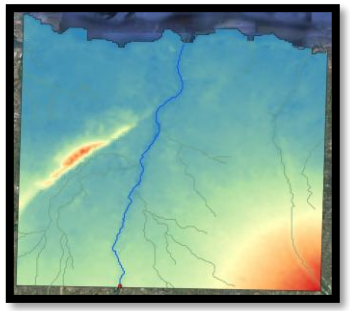
- DEM
- Infiltration rate
- Surface roughness
- Inflow/outflow boundaries

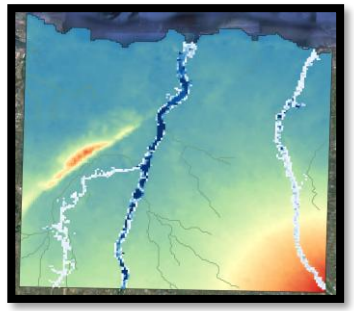
Flood simulation

- Coastal flooding
  - storm surge
- Fluvial flooding
  - Maximum river discharge
- Pluvial flooding
  - 3-hour rainfall intensity

Hazard maps

- Flood extent
- Flood depth





Combining Wflow, GTSM and Sfincs

for hazard assessment at the city scale

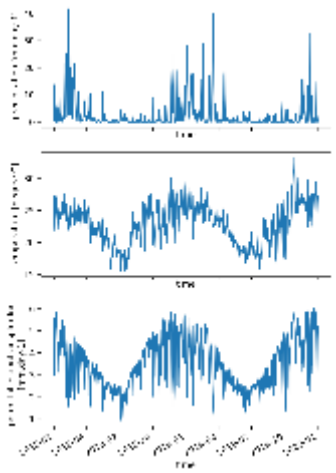
Global hydromet datasets

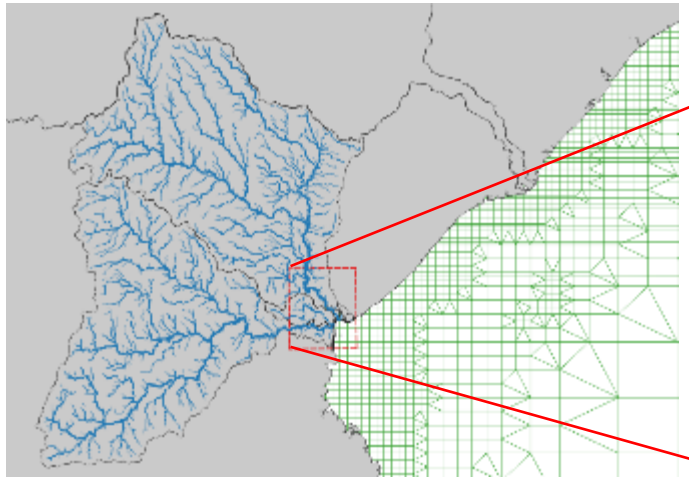
Wflow rainfall-runoff river basin model

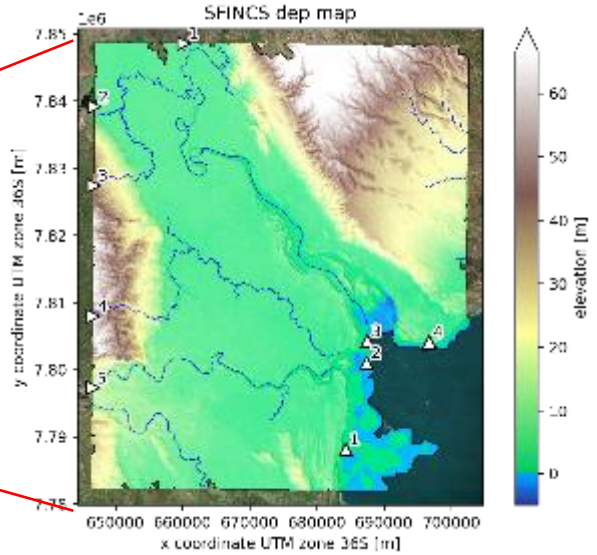
GTSM global tide and surge model

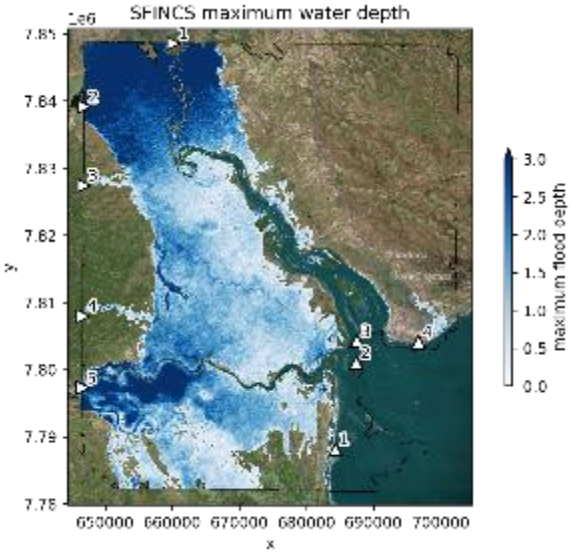
Sfincs 2D flood hazard model

Flood hazard maps for design storms at multiple return periods





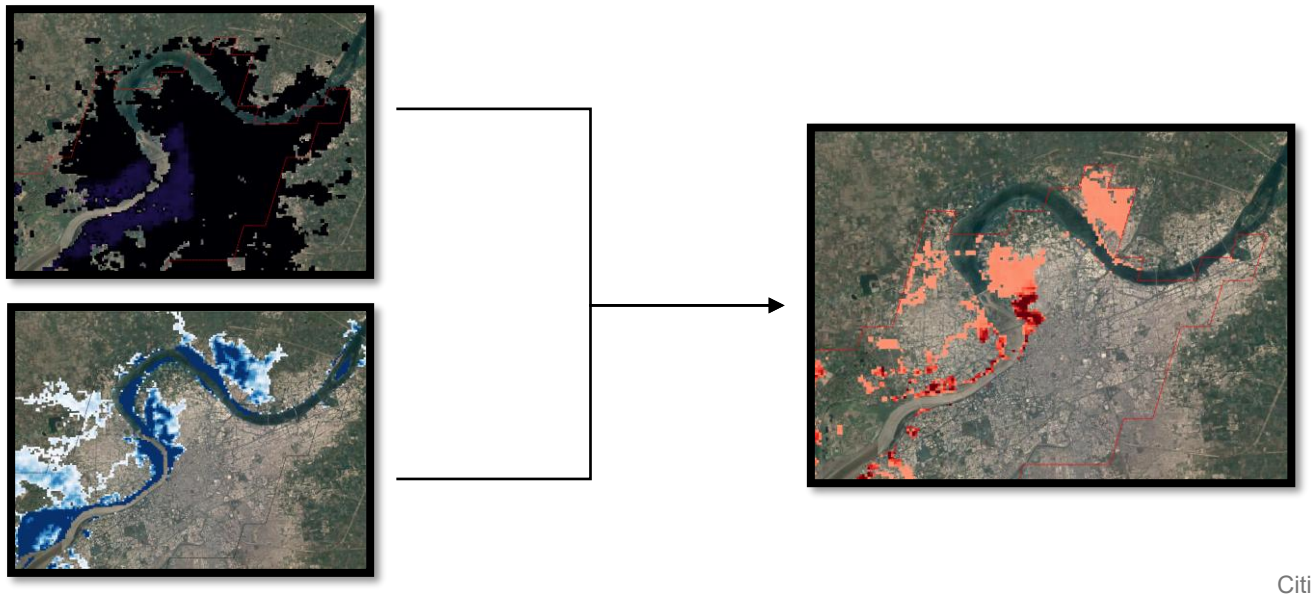




Meteo forcing on models → **Discharge and water levels** → **Hazard and risk maps**

Flood Impact Assessment Tool FIAT

for processing hazard maps to obtain impact and risk maps



3 Application to Acari Basin in Rio de Janeiro

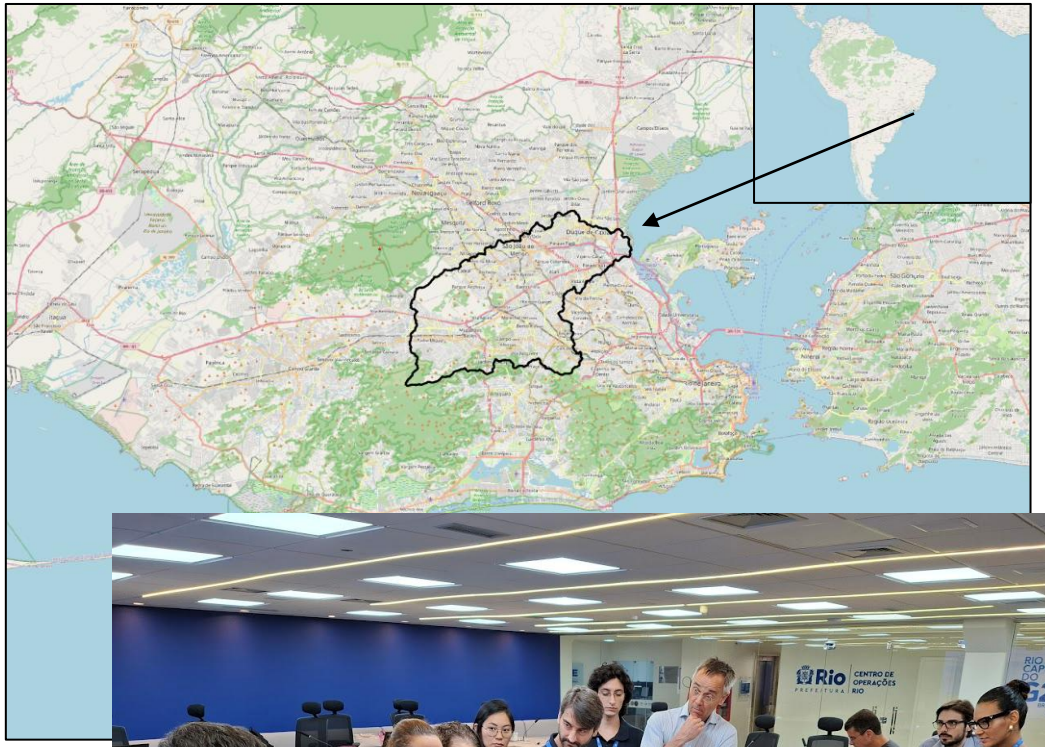
Rio de Janeiro

Local partner: Rio-Águas

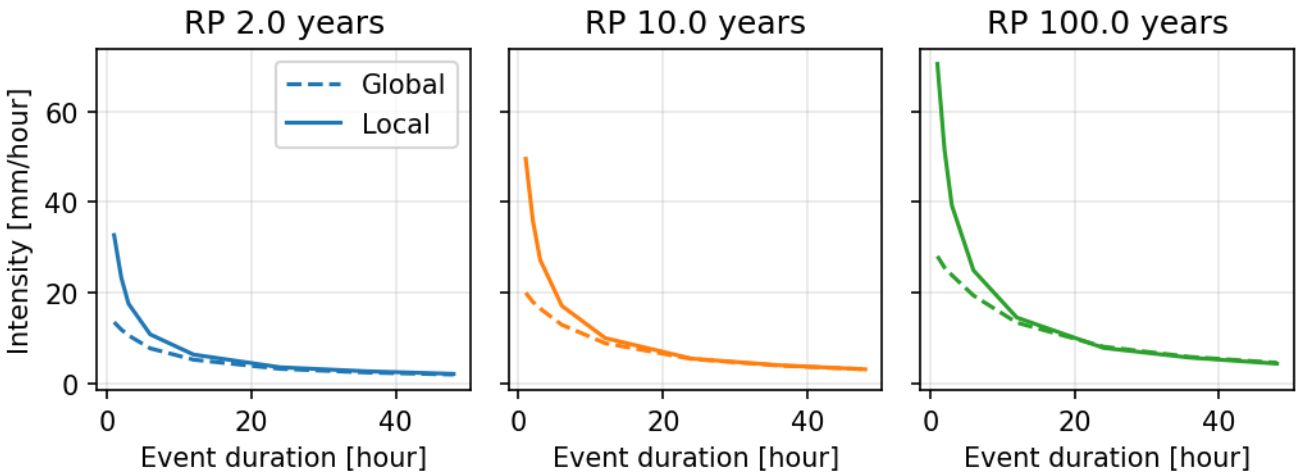
- Municipal department for urban drainage
- Has good data, but no flood risk models
- Workshop/training earlier this month

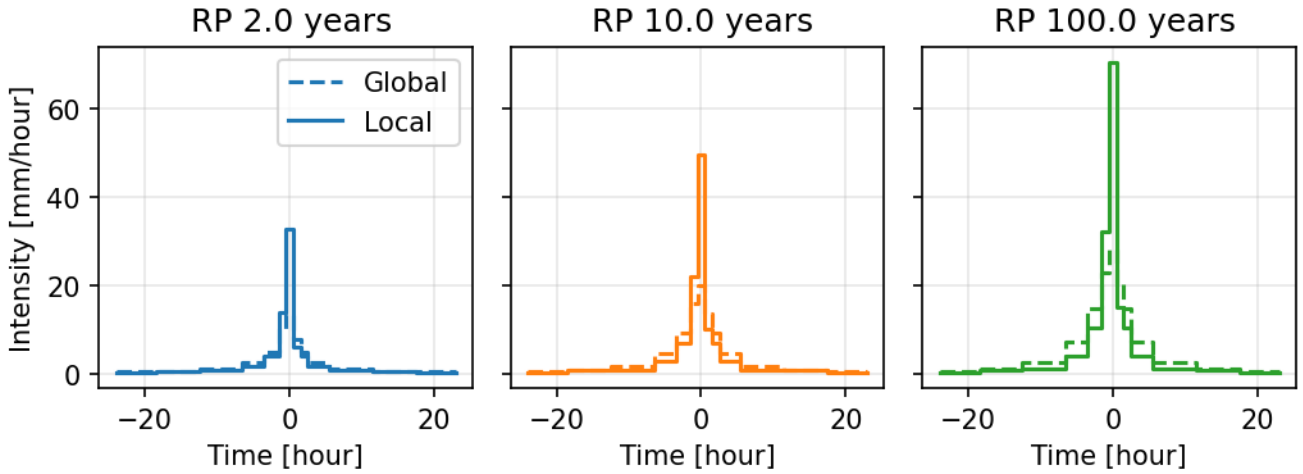
Study area: Acari river basin:

- Frequent pluvial flash flooding
- Large flood event Jan 2024
- Worsened by poor infrastructure design & dense urban area
- Challenging socio-economic setting



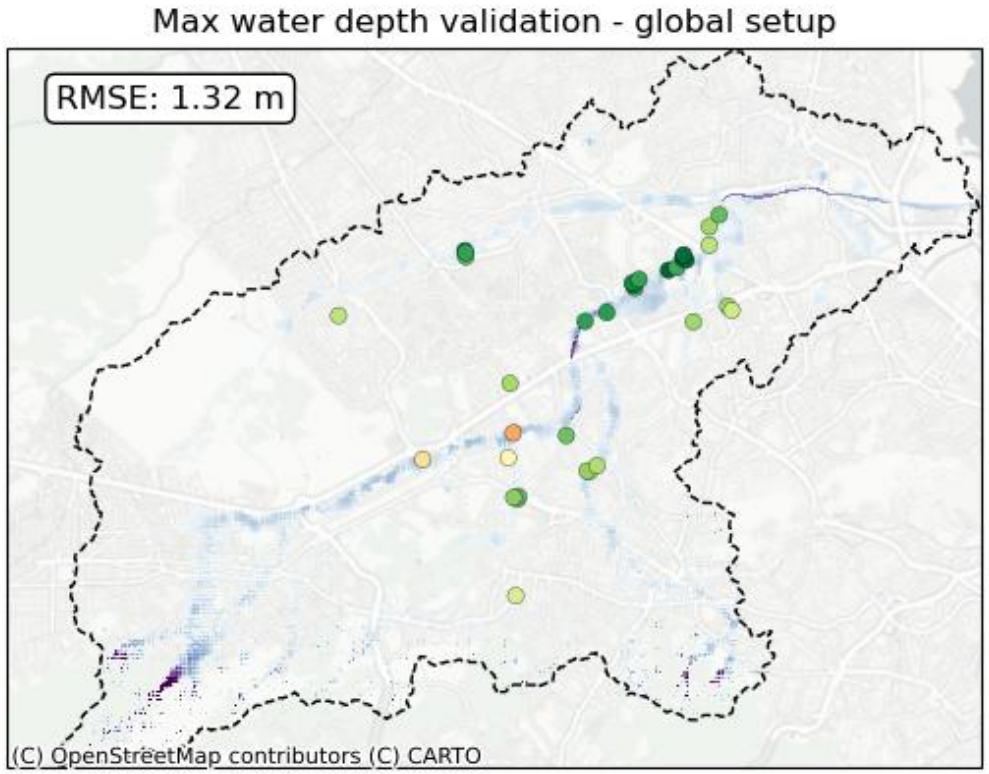
Global vs local rainfall





Preliminary results: “Global to local” flood hazard

Global dataset



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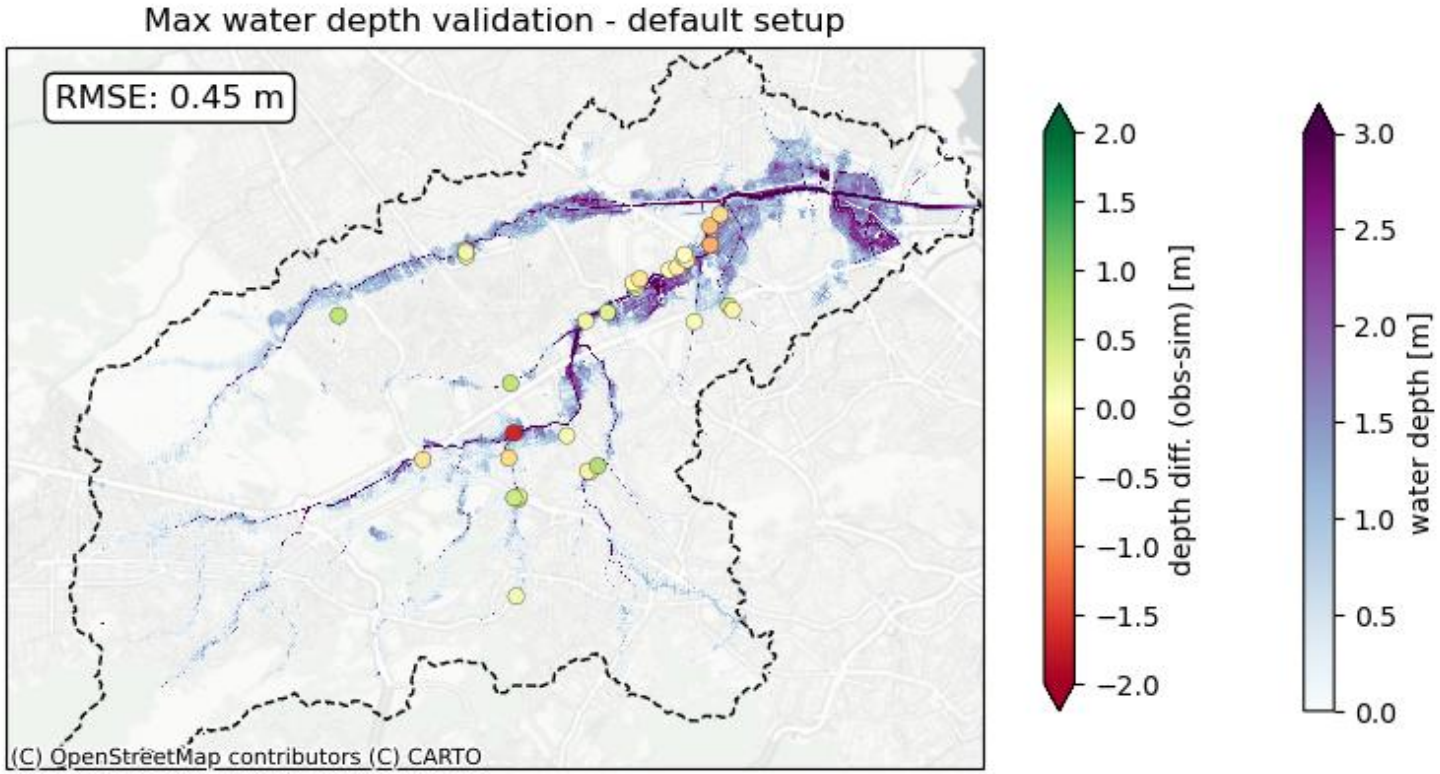
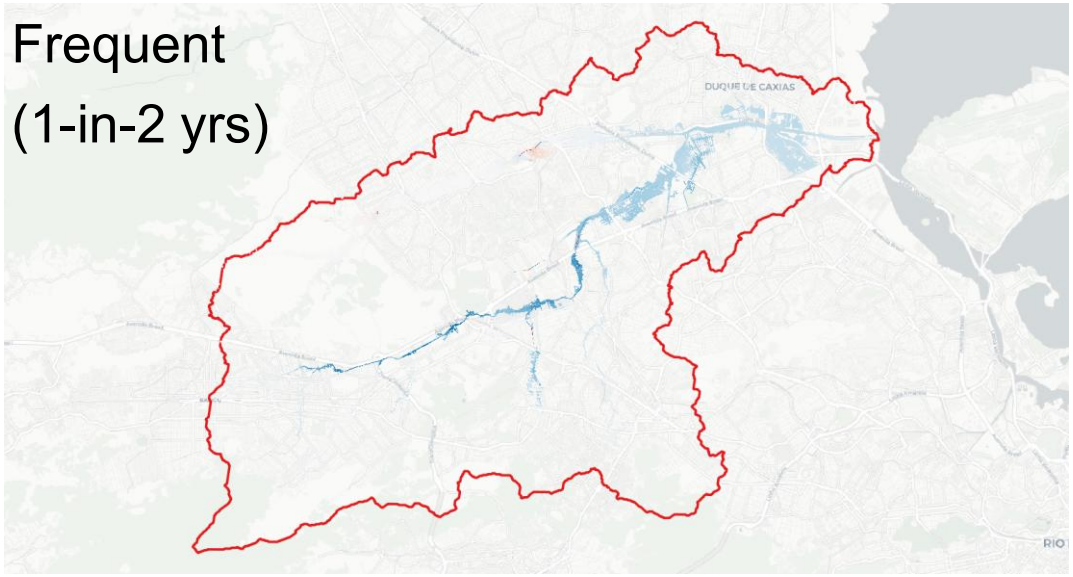
Local datasets

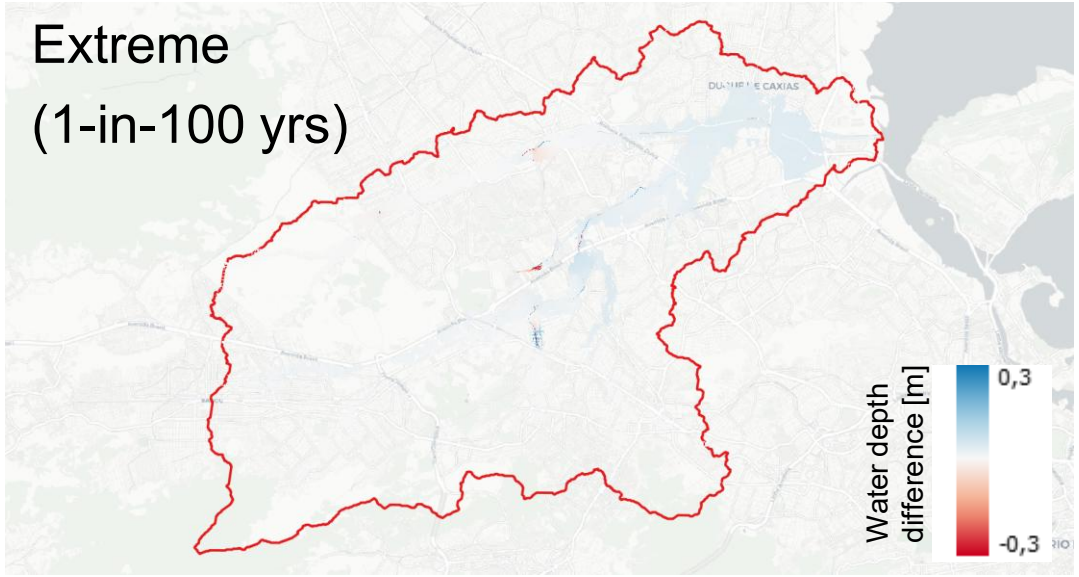


Local obs. 1m LiDAR DTM

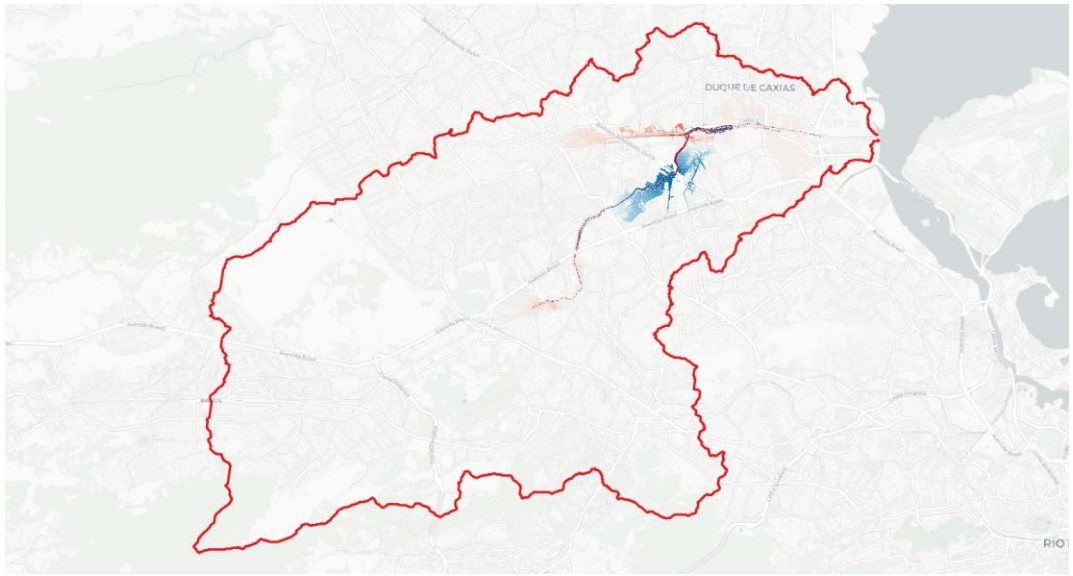
Preliminary results: flood adaptation strategies

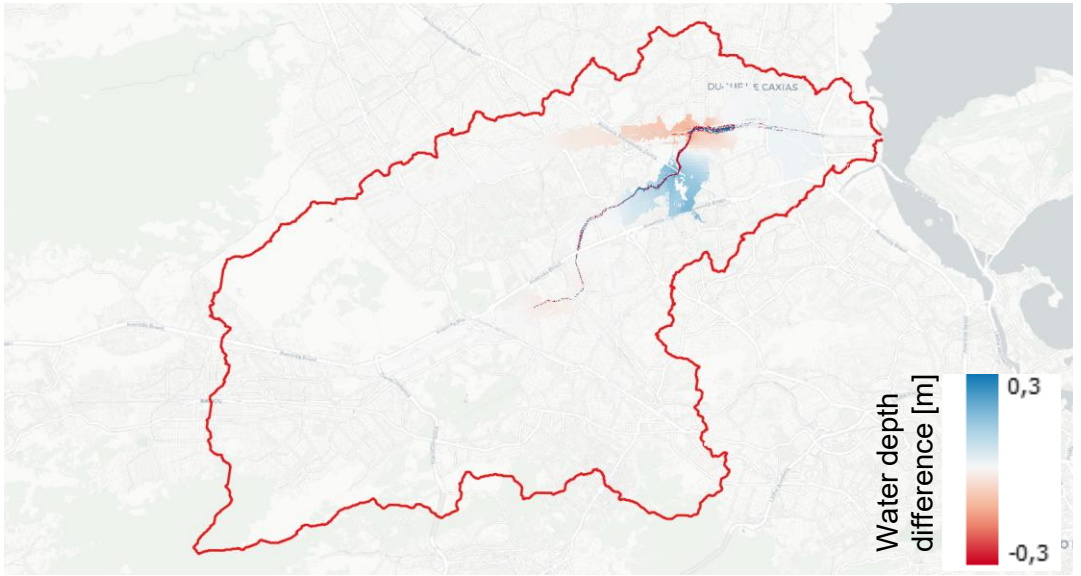
Reservoirs



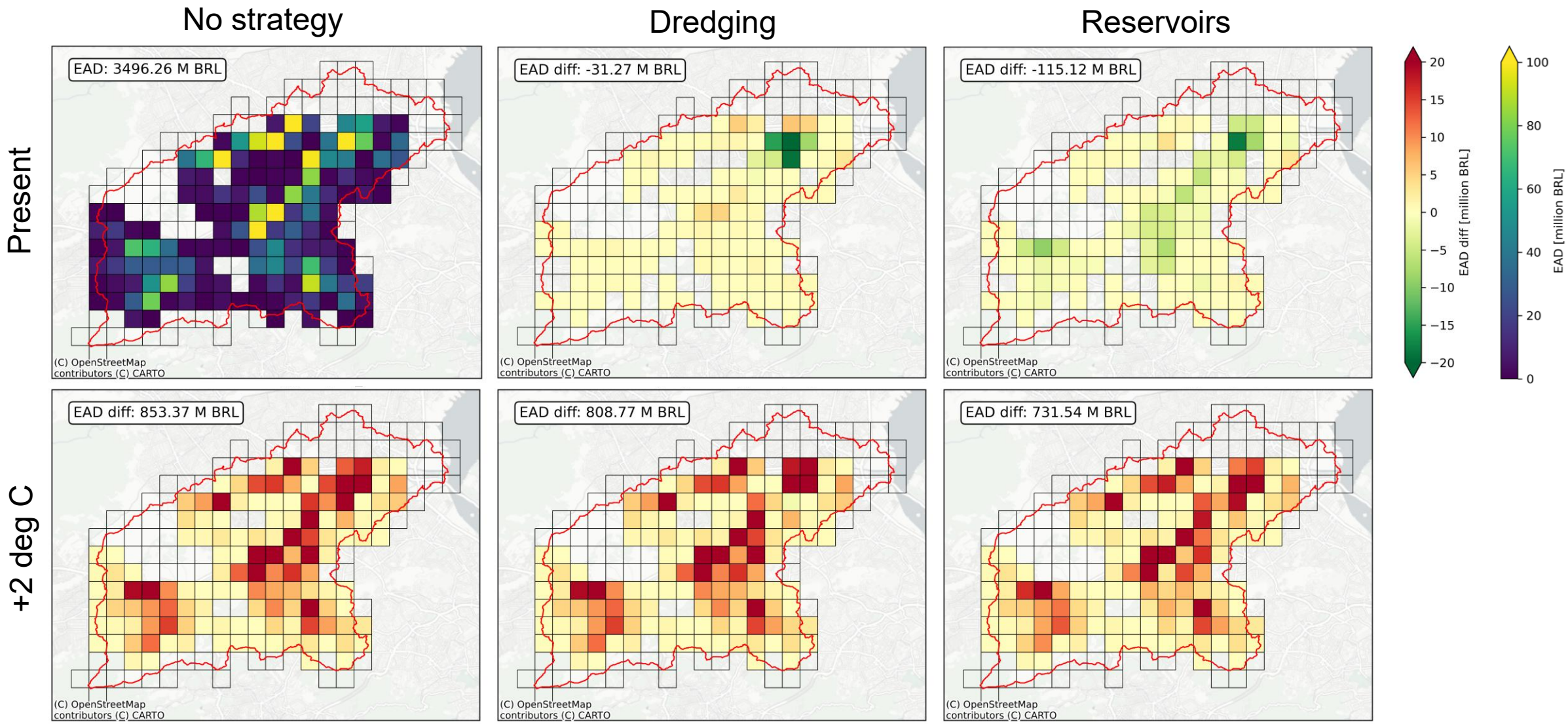


Dredging





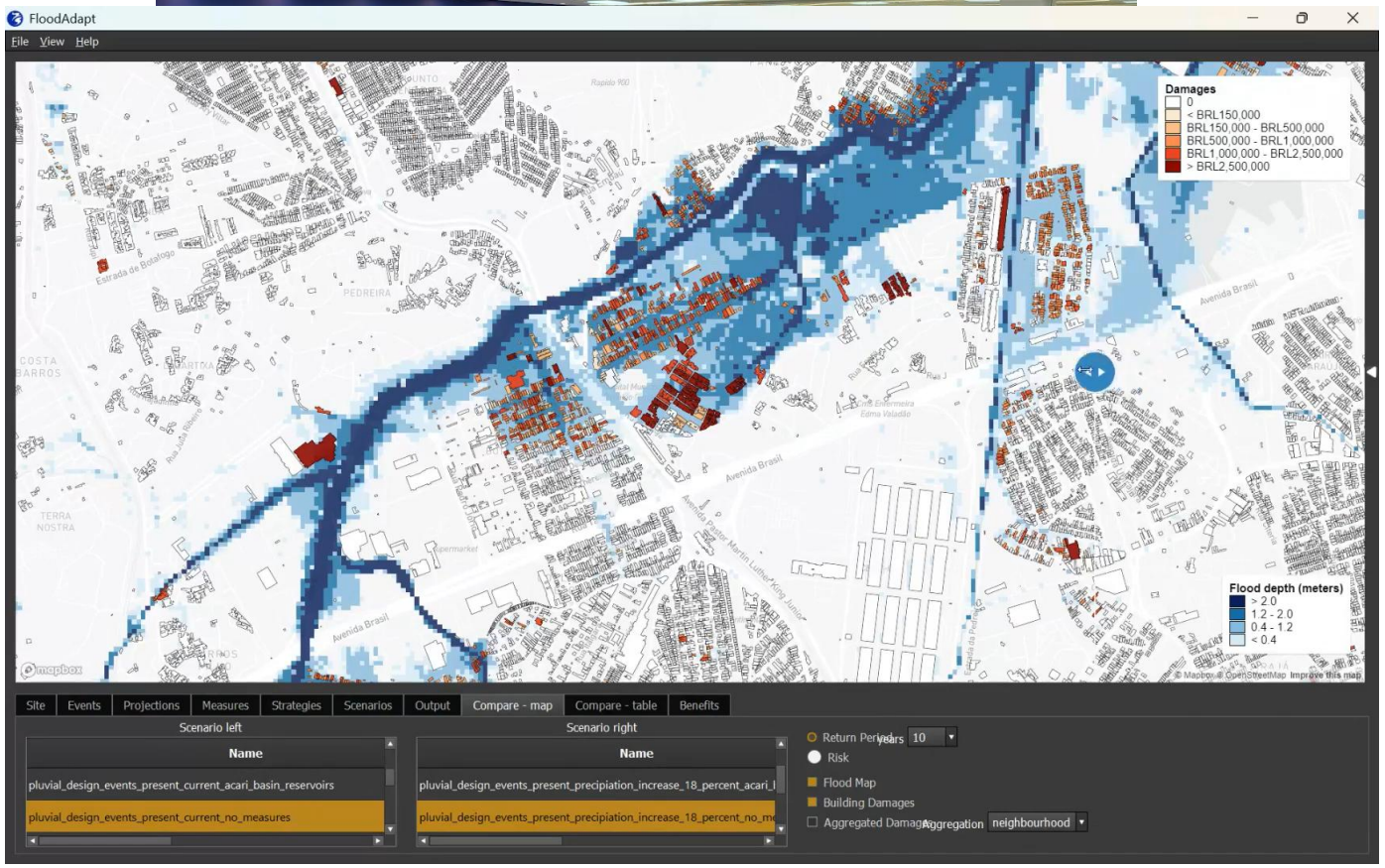
Preliminary results: flood risk



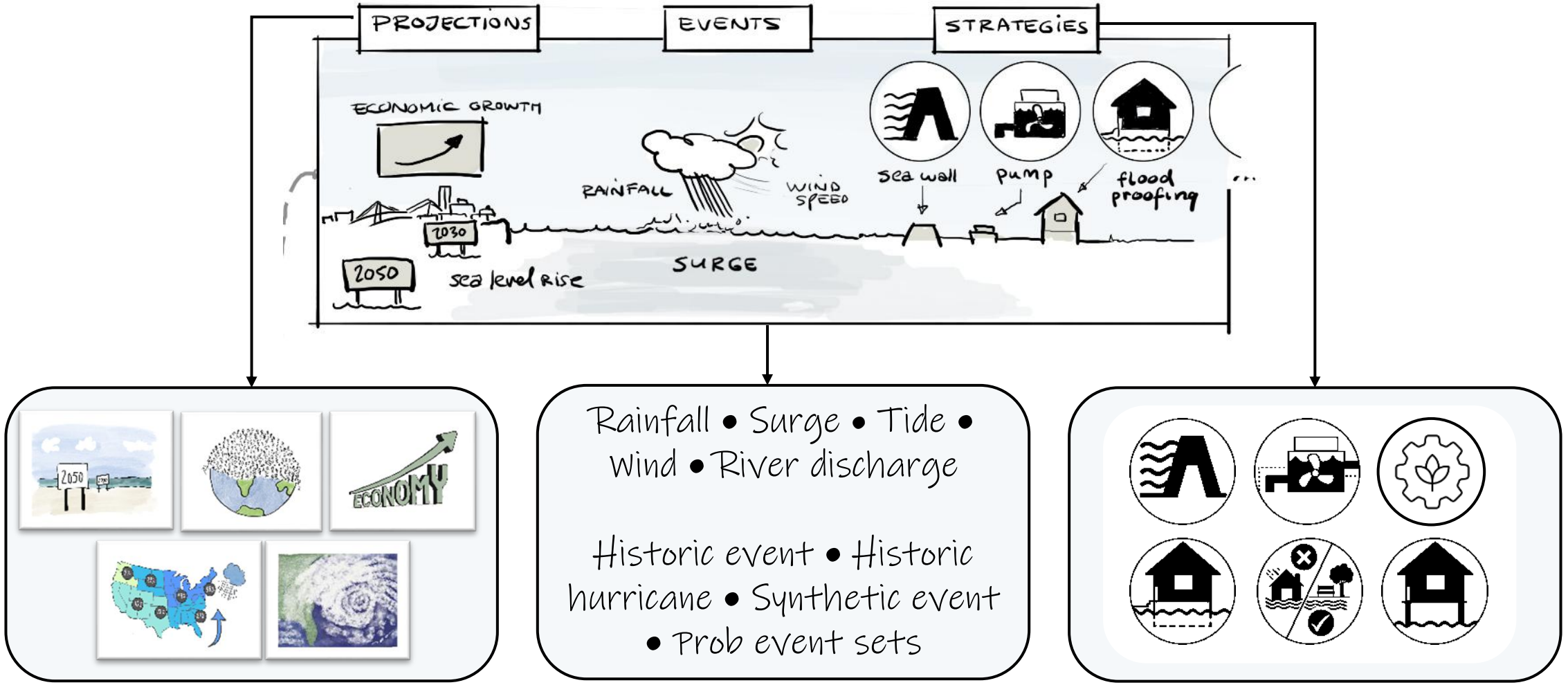
4 FloodAdapt for climate adaptation

FloodAdapt: interactive decision support

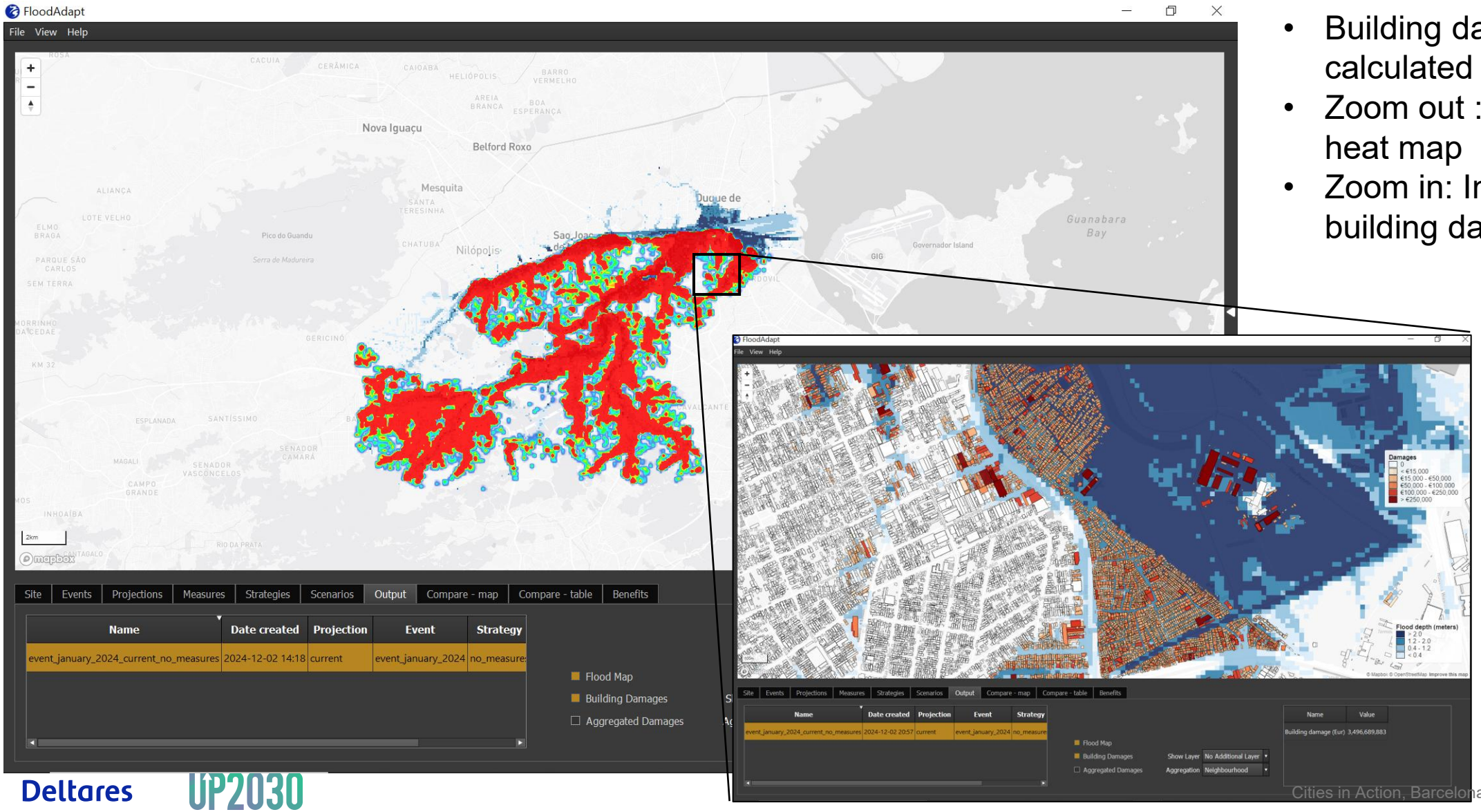
- Making flood risk assessments more accessible
- Specify actions the community can take and evaluate the effectiveness
- Insights into equitable impacts and benefits
- Visually compare flood hazard and impacts of “what if?” scenarios



What can FloodAdapt evaluate?

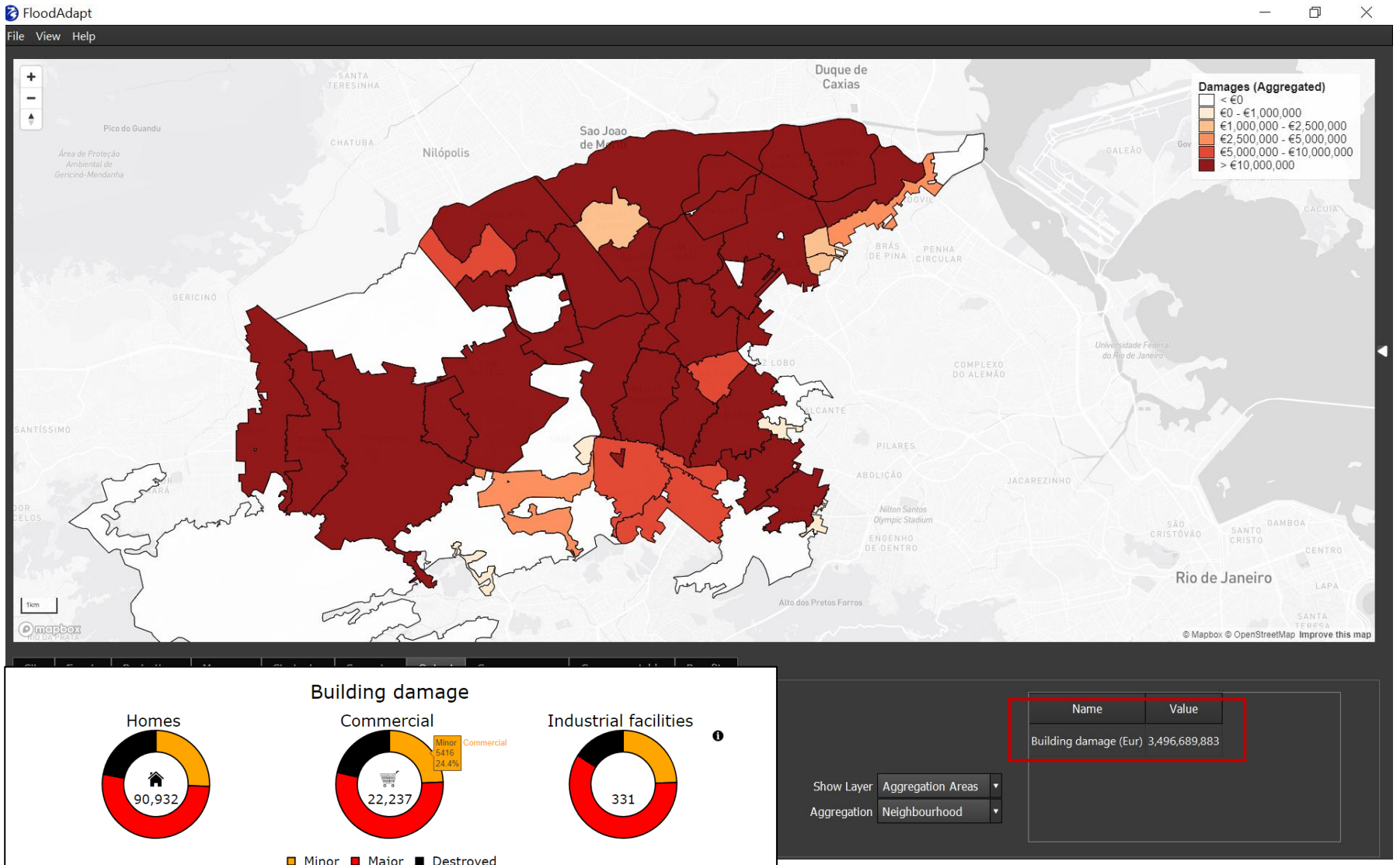


Damage to buildings



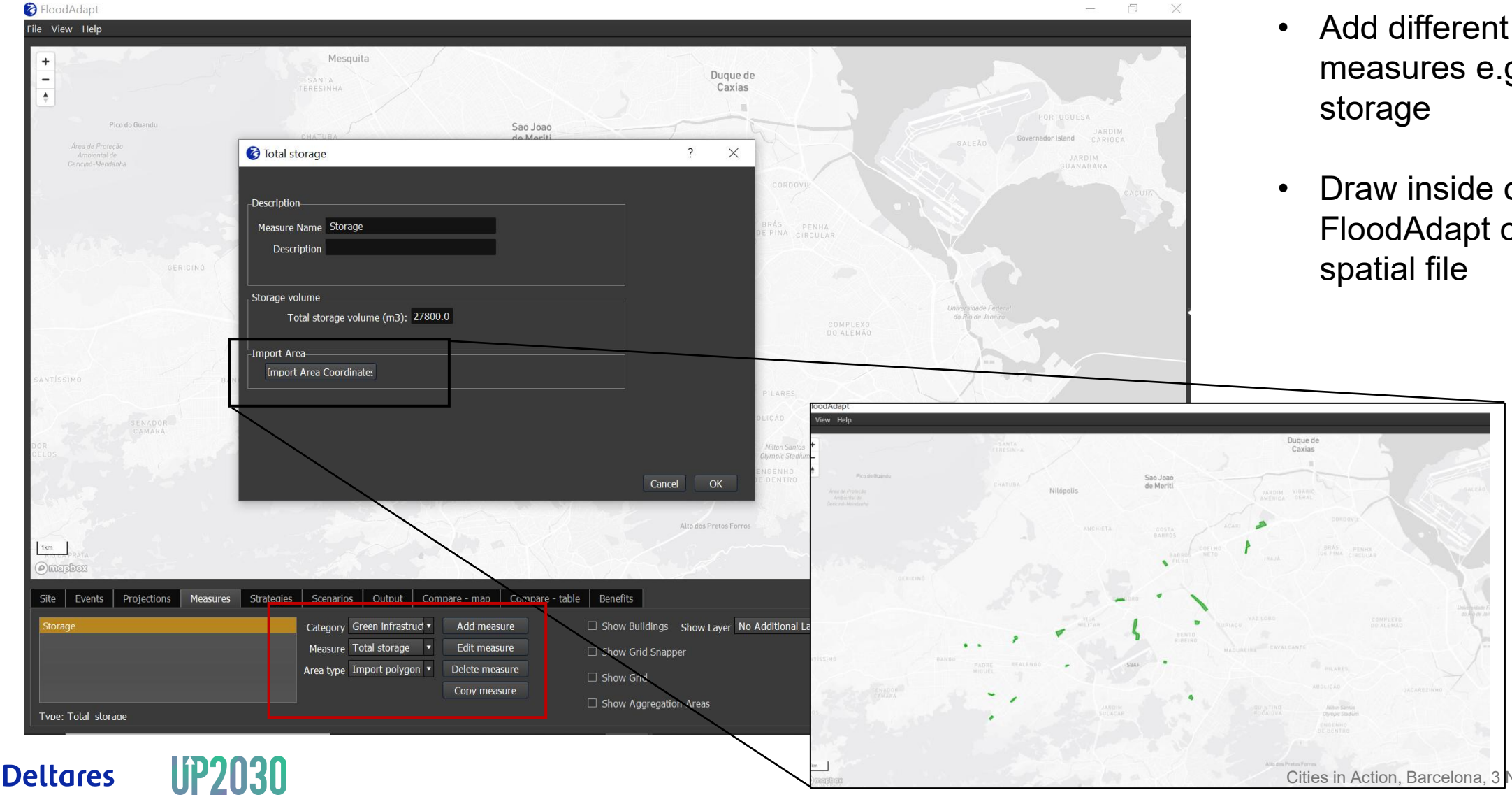
- Building damages are calculated by Delft FIAT
- Zoom out : Damage heat map
- Zoom in: Individual building damages

Damage infographics

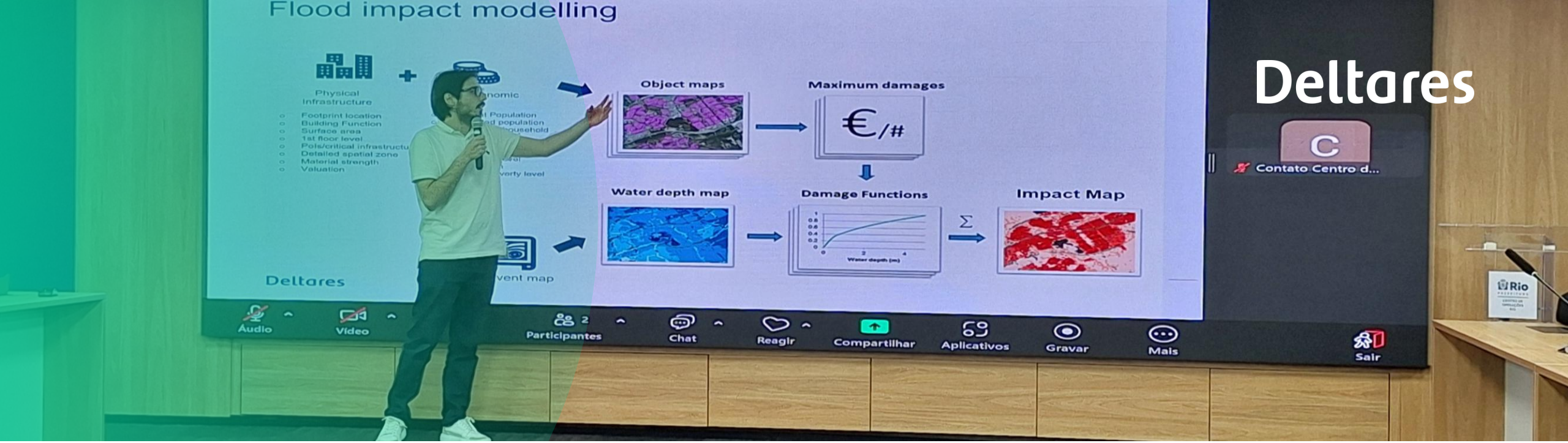


- Display aggregated damages
- Infographics summarize the damages in categories of building types and degree of destruction (threshold can be set by user)
- Can include affected roads
- Can include social vulnerability if information available

Measures: storage



- Add different types of measures e.g. water storage
- Draw inside of FloodAdapt or import spatial file



5 Key Takeaways

Take aways

- “Global-to-local” approach can accelerate urban flood risk assessments
- Continuous updates of flood risk are required as city and climate changes
- Interactive exploration of flood adaptation scenarios enhances accessibility to complex risk data

https://deltares-research.github.io/FloodAdapt/

Next steps:

- Further develop simulation of nature-based solutions
- Further develop equity metrics

HydroFlows

https://deltares-research.github.io/HydroFlows/

References

UP2030 website:

- https://up2030-he.eu/2025/04/14/hydroflows/

Blogs:

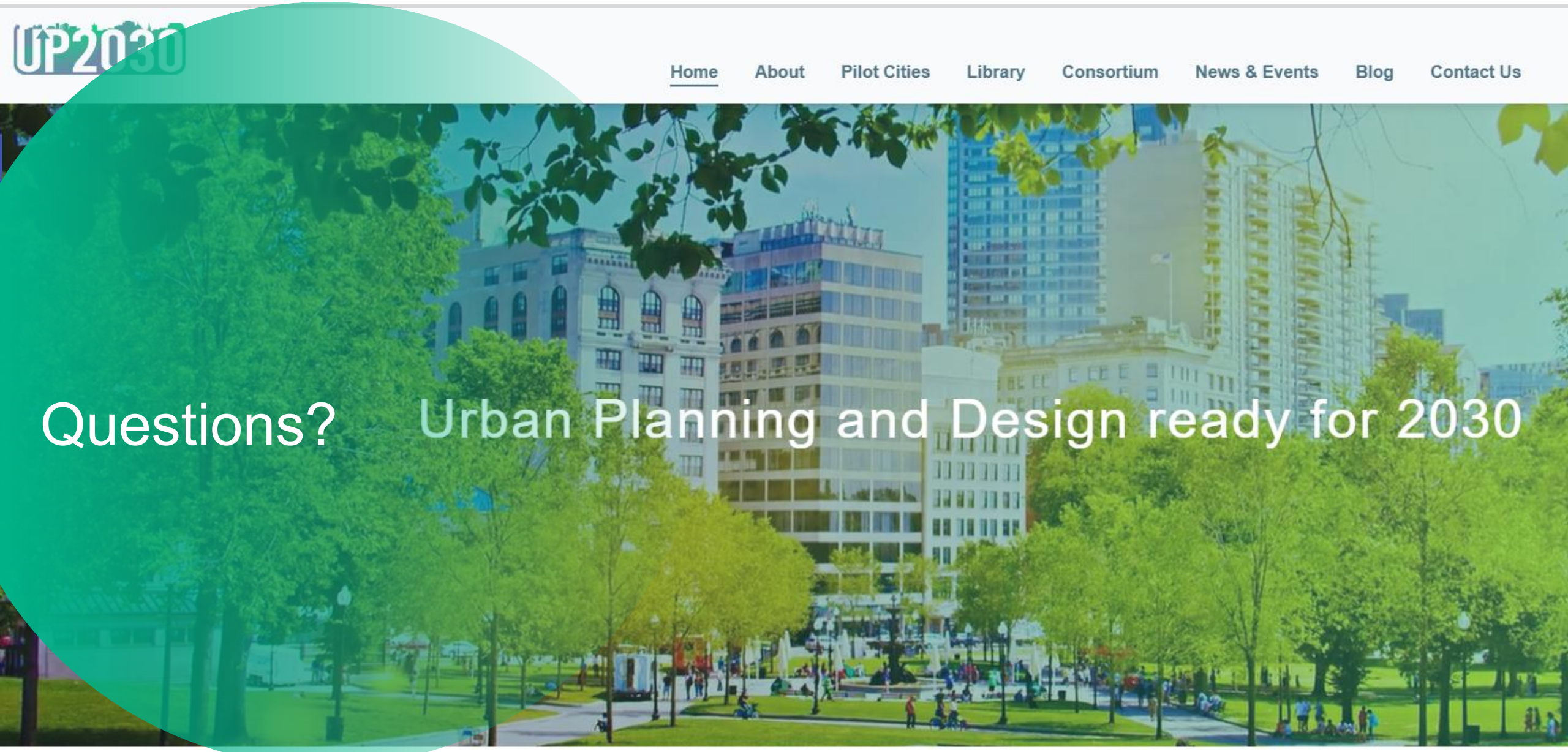
- https://up2030-he.eu/2024/12/23/rapid-and-continuous-flood-risk-assessment-and-adaptation-planning-for-rio-de-janeiro/
- https://up2030-he.eu/2025/05/19/training-workshop-on-advancing-flood-resilience-in-rio-de-janeiro/

GitHub with User Guide and Example Notebook:

- https://deltares-research.github.io/HydroFlows/index.html

Conference publications:

- Eilander, D., Gehrels, H., Tromp, W., Tsiokanos, A., Rautenbach, S., Roscoe, K., Fraga, J. P., and Ney de Montezuma, P. (2025). Rapid and continuous flood risk assessment and adaptation planning for climate resilient developments: a Rio de Janeiro case study. Conference presentation. 12th International Conference on Urban Climate, Rotterdam.
- Gehrels, H., Eilander, D., Tromp, W., Tsiokanos, A., Rautenbach, S., Roscoe, K., Fraga, J. P., and Ney de Montezuma, P. (2025). Rapid flood risk assessment and adaptation planning for climate resilient developments: a Rio de Janeiro case study, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-18351, https://doi.org/10.5194/egusphere-egu25-18351.
- Tromp, W., Eilander, D., Winsemius, H., De Jong, T., Dalmijn, B., Gehrels, H., and Backeberg, B. (2025). Flexible and scalable workflow framework HydroFlows for compound flood risk assessment and adaptation modelling, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-8114, https://doi.org/10.5194/egusphere-egu25-8114.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