Utilizing a Foundation of Model Integration

Examples of Coupled Coastal Flood Modeling

DHI Water & Environment

Tom Foster – Vice President of Coastal & Marine Infrastructure, Americas

Presentation Outline

- A 1 slide overview of DHI
- What DHI understand as the state of the art in coupled flood modeling
- A couple of US and global examples
- Some examples of benefit to stakeholders

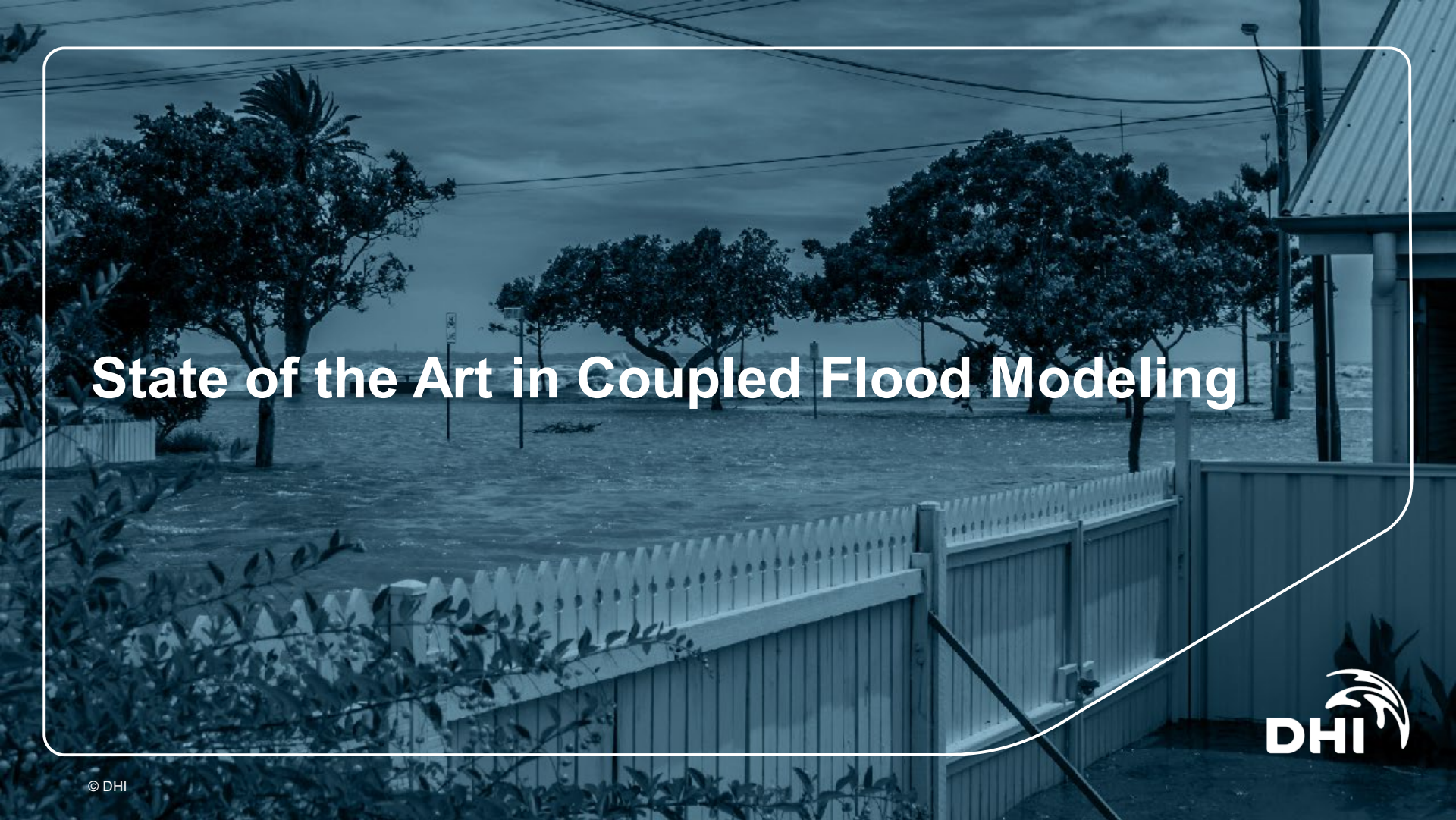
DHI Water & Environment

We are independent, research-based and not-for-profit

MIKE Powered by DHI
The most advanced water modeling tools

THE ACADEMY by DHI
Training and knowledge sharing

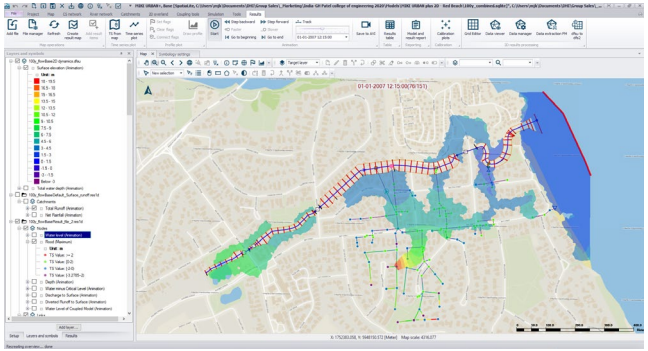
DHI is an independent, not for profit, research and consultancy organization and a world leader in consulting services and research in areas relevant to the water environment

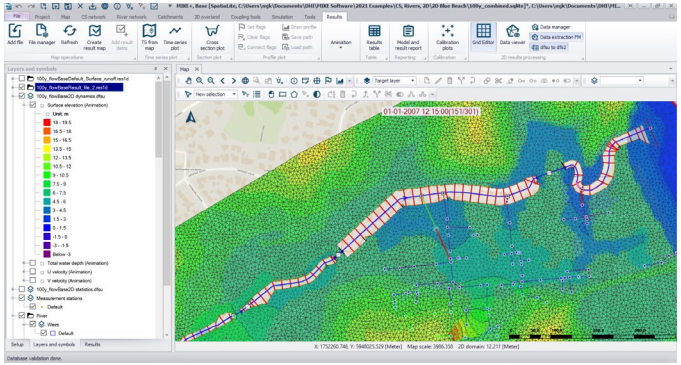


State of the Art in Coupled Flood Modeling

In 2021, Integrated Flood modeling is more than just coast and river

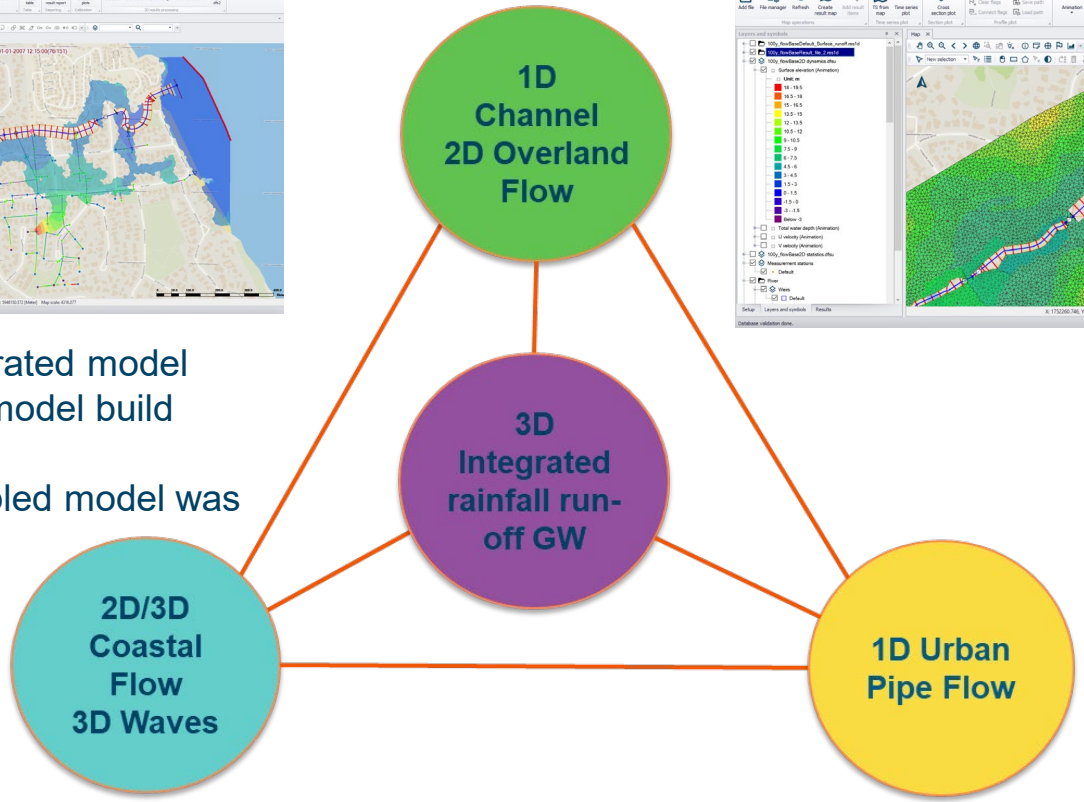
Three or even 4 way model coupling is the norm for high resolution forecasts and studies



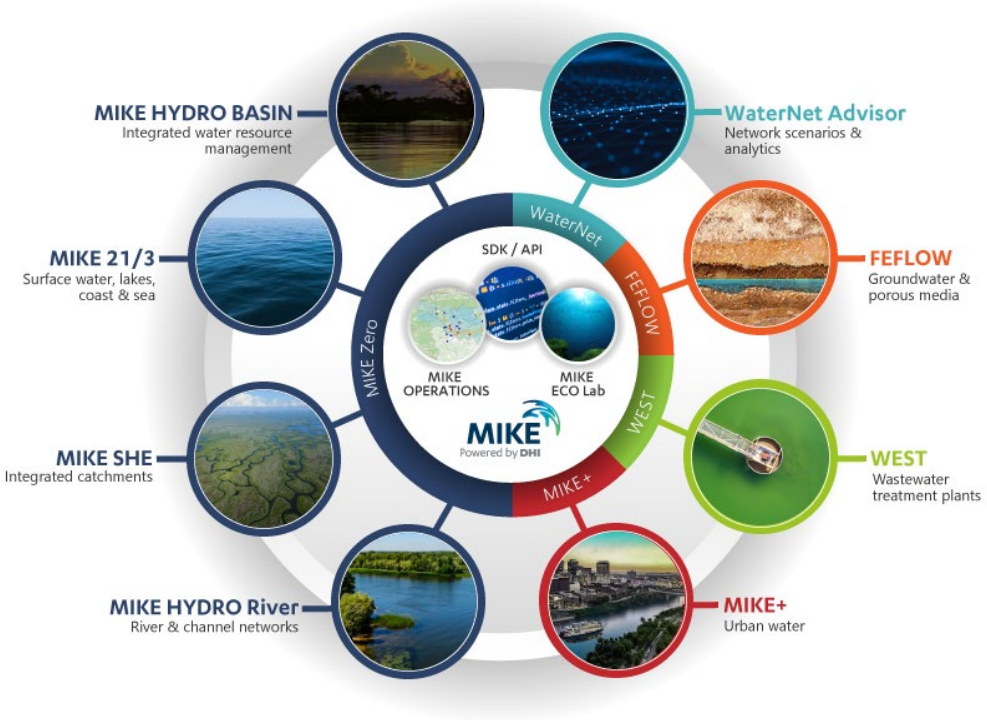


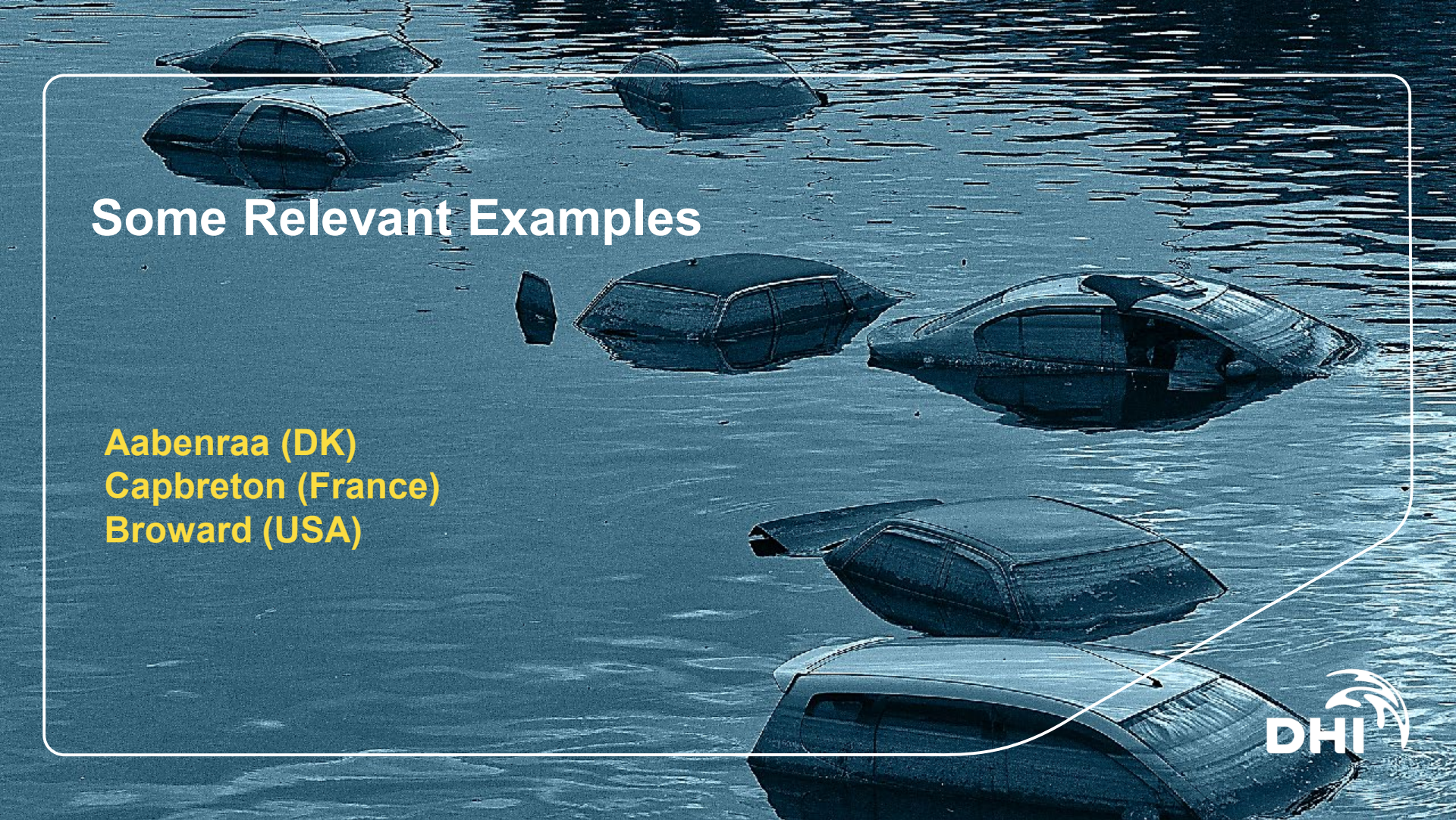
Requires a fully integrated model package to facilitate model build

DHI's first 3 way coupled model was in 2005



MIKE Modeling Framework for Integrated Modeling

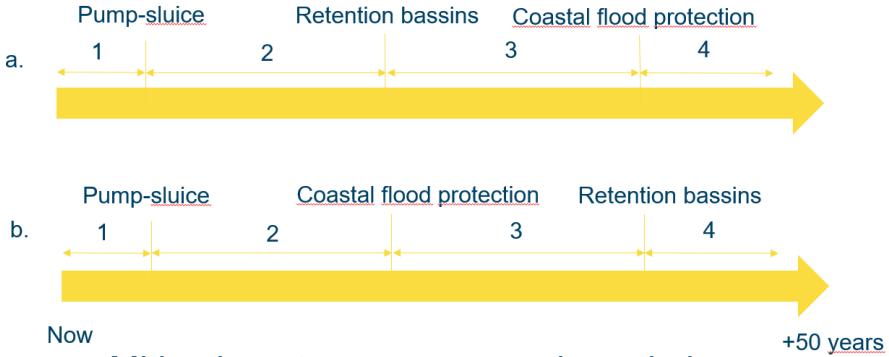




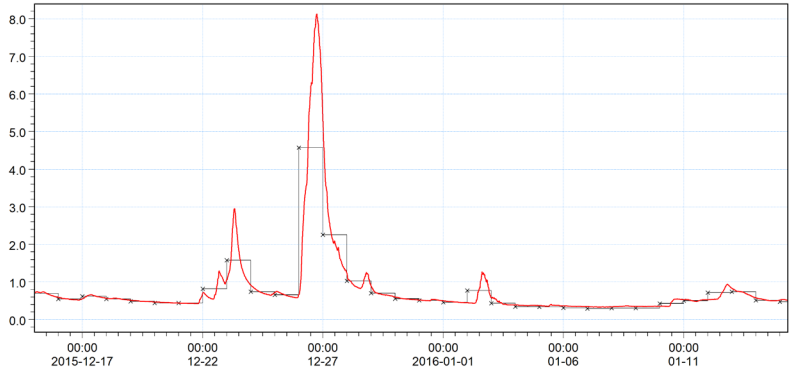
Some Relevant Examples

Aabenraa (DK)
Capbreton (France)
Broward (USA)

Aabenraa (DK) - Inland-Urban-Coastal Flooding



Mitigation - types – sequencing - timing



River discharges - 50 years event

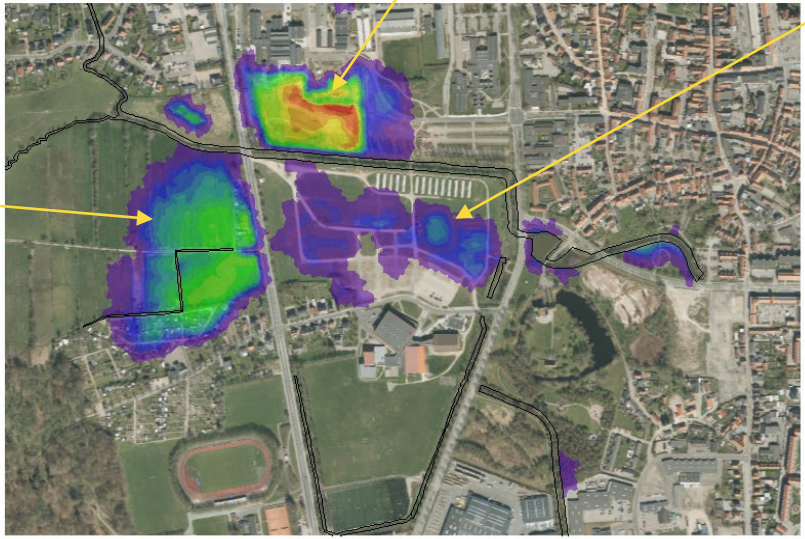
Retention bassins?

Pump-sluice?
Coastal flood barrier?

River run-off - Cloud bursts - Storm surges / SLR

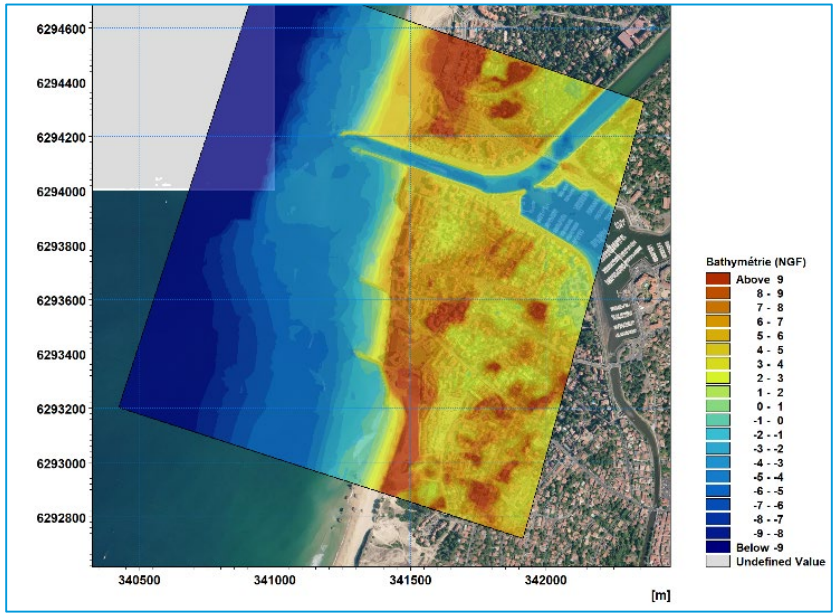
Modeling

Only a fully dynamic 3-way coupled model can reproduce the observations

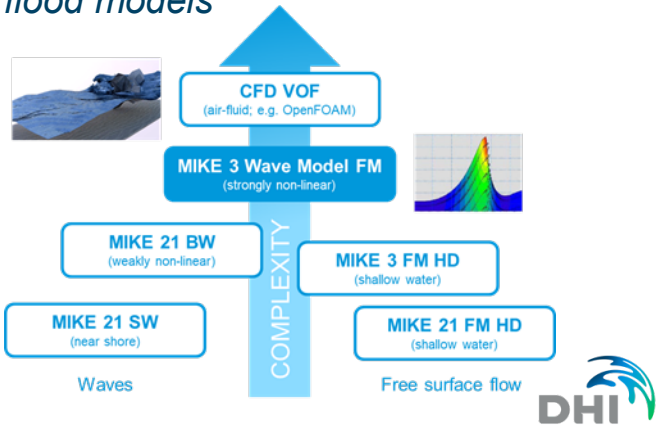


Coastal flooding in Capbreton, France

Capbreton in South-western France is exposed to coastal flooding during storm events (**surge, tide, wave run-up and overtopping**)



Including run-up and overtopping requires a new generation of coastal flood models



Coastal flooding in Capbreton, France

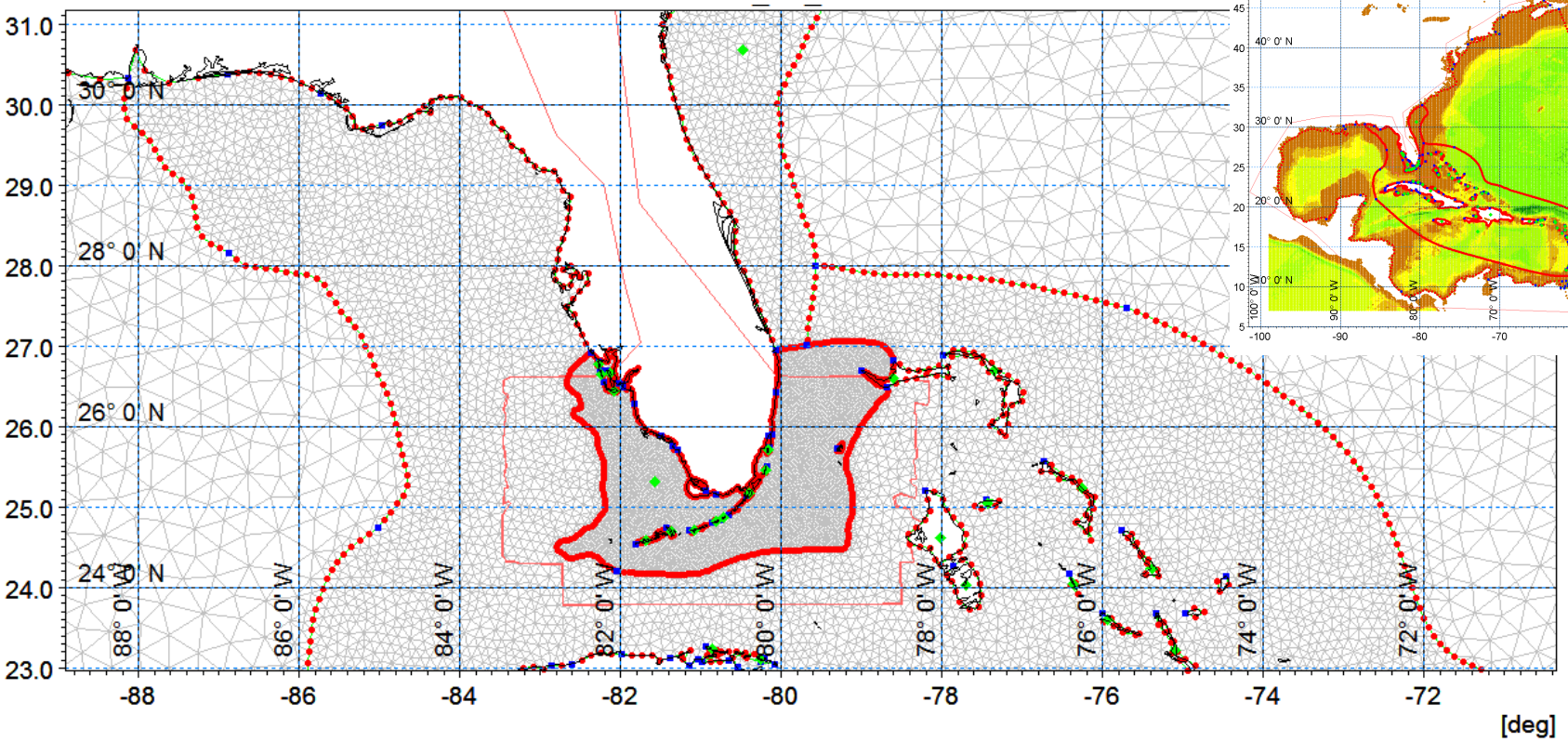
The simulated event corresponds to the peak of the main recent and widely documented storm on this coast, storm Christine, which occurred over 2nd to 4th March 2014.

Time series of waves, tide and surge from regional models.

Input as boundary to MIKE3 Wave FM – terrestrial flooding including run-up and over-topping.

Screenshot of a video taken during the storm on the southern quay of the entrance channel (Source: YouTube, Mars 2014, retrieved from http://www.youtube.com/watch?v=6YuNtXfUHMM)

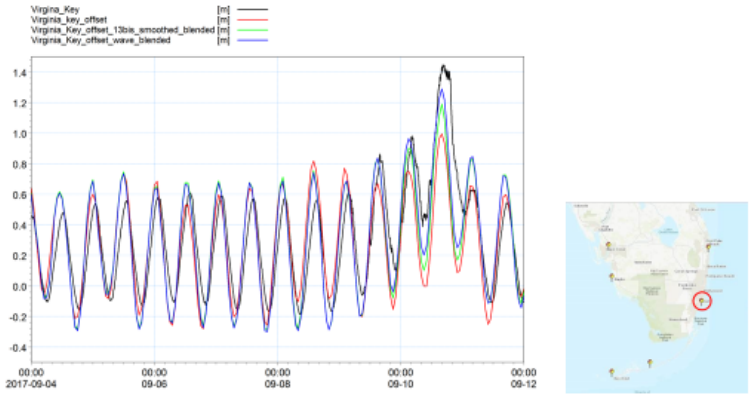
Detailed Integrated Hydrology and Coastal Flood Model Example: Broward FL

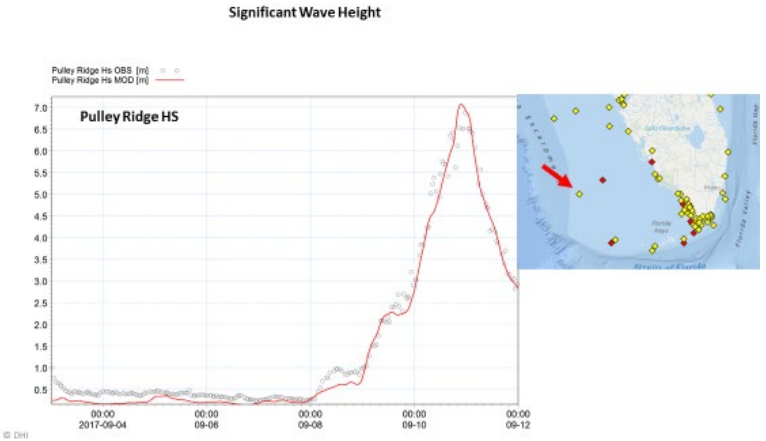


Atlantic / Caribbean / Gulf WL Forecast/Hindcast Model

Detailed Integrated Hydrology and Coastal Flood Model Example: Broward FL

- Use regional and local data - to improve costal model performance within domain (Data assimilation).
- High resolution at area of interest suitable for providing boundary input to terrestrial flood models





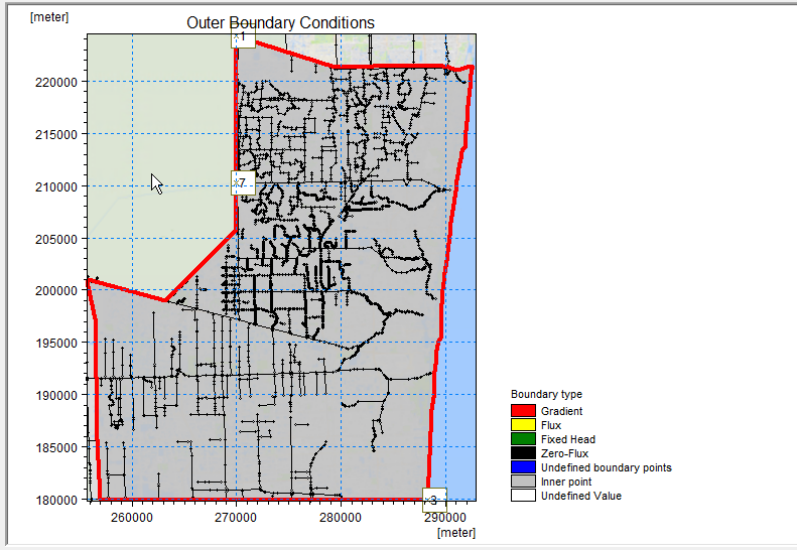
Detailed Integrated Hydrology Flood Model Example: Broward FL

- Detailed drainage system (1D model)
- Overland (2D model)
- Groundwater (3D model)
- Terrestrial boundaries from regional models
- Rain on Grid
- Tide/Surge Coastal Boundary from regional model

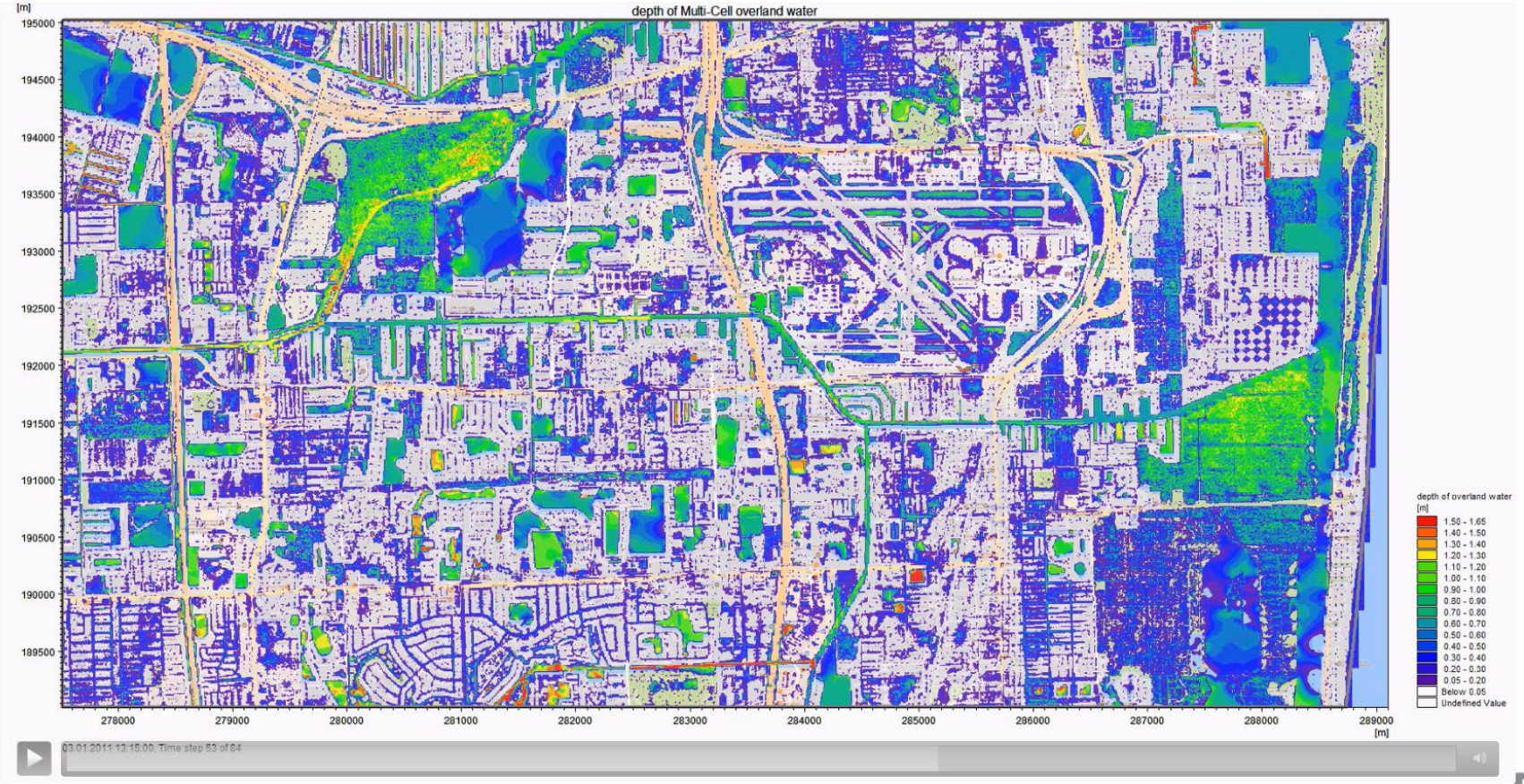
Outer Boundary Conditions

Boundary segments specified clockwise:

	Segment name	Type		From X coordinate	From Y coordinate	To X coordinate	To Y coordinate
1	North Bounda	Zero-Flux		269974.66	224332.66	292521.13	221328.39
2	Coast - L3-5	Zero-Flux		292521.13	221328.39	288242.25	179868.91
3	South Bound	Zero-Flux		288242.25	179868.91	255738.18	178448.03
4	WCA3B	Fixed Head		255738.18	178448.03	248613.61	186301.97



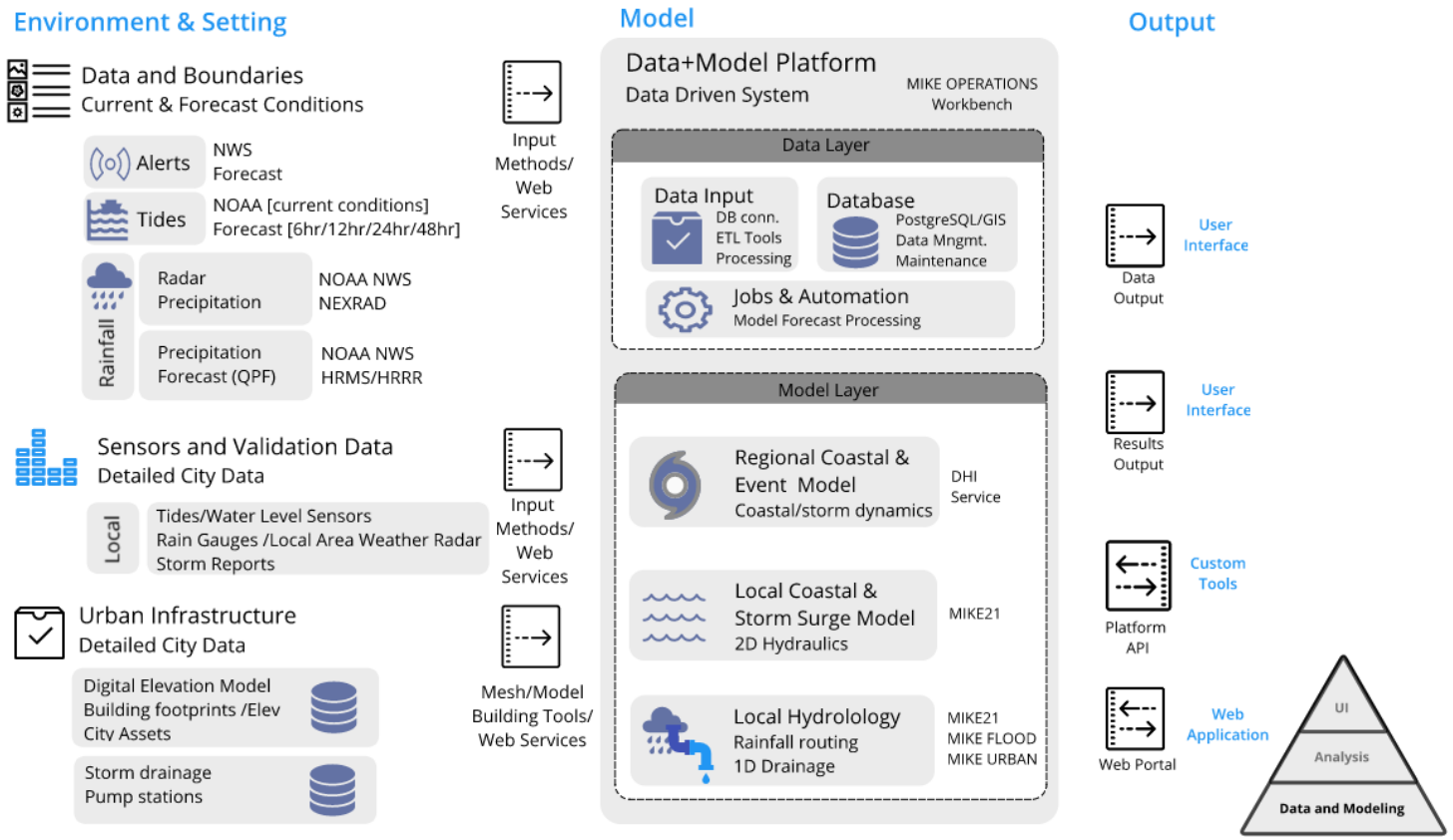
Detailed Integrated Hydrology Flood Model Example: Broward FL



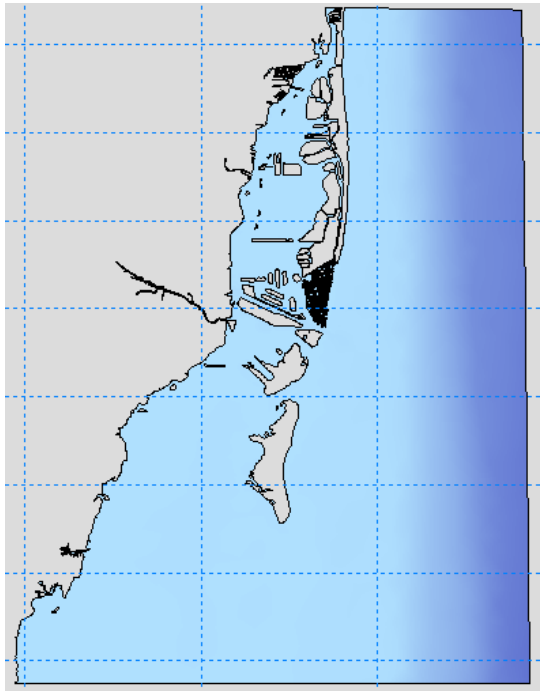
Practical Example of Stakeholder Benefit from Integrated Modeling

Pilot ‘address level’ flood forecasting in high risk area
Miami beach FL
Operational Forecast of Chao Phraya, Thailand

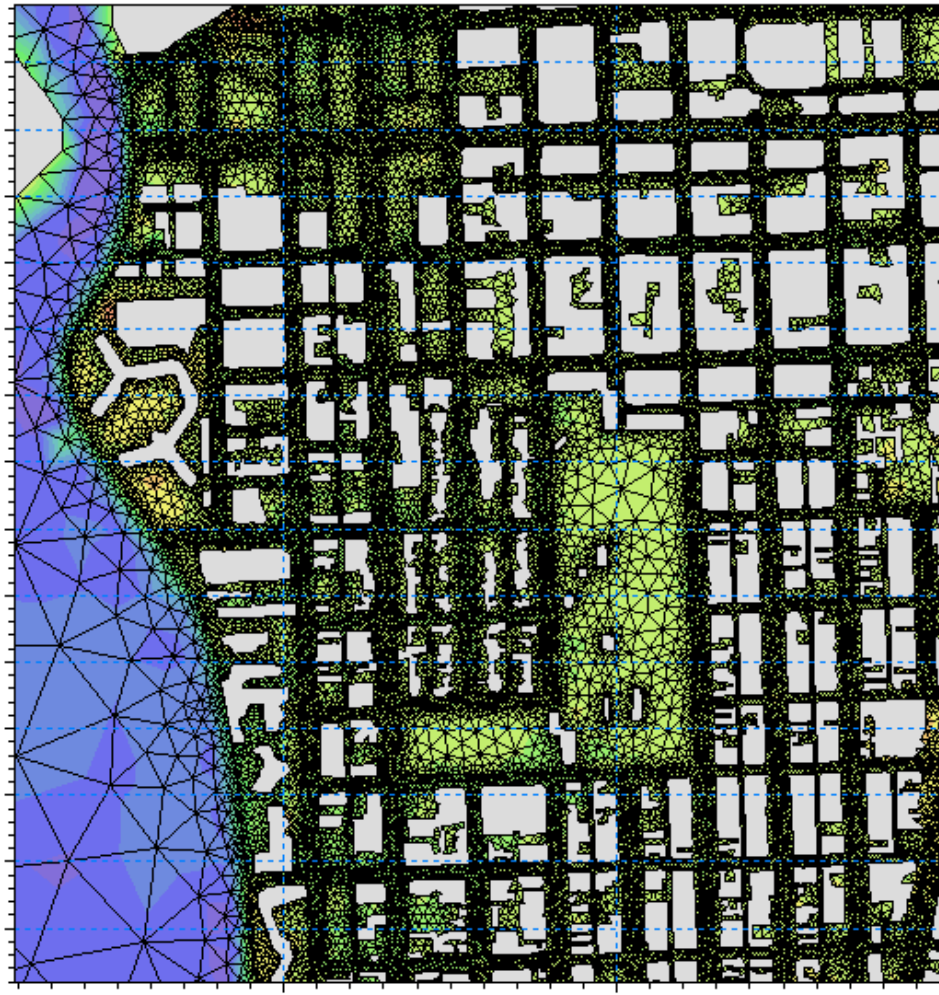
Miami-Beach Pilot Flood Forecast: Data and Modeling Flow



Miami-Beach Pilot Flood Forecast: Meshing

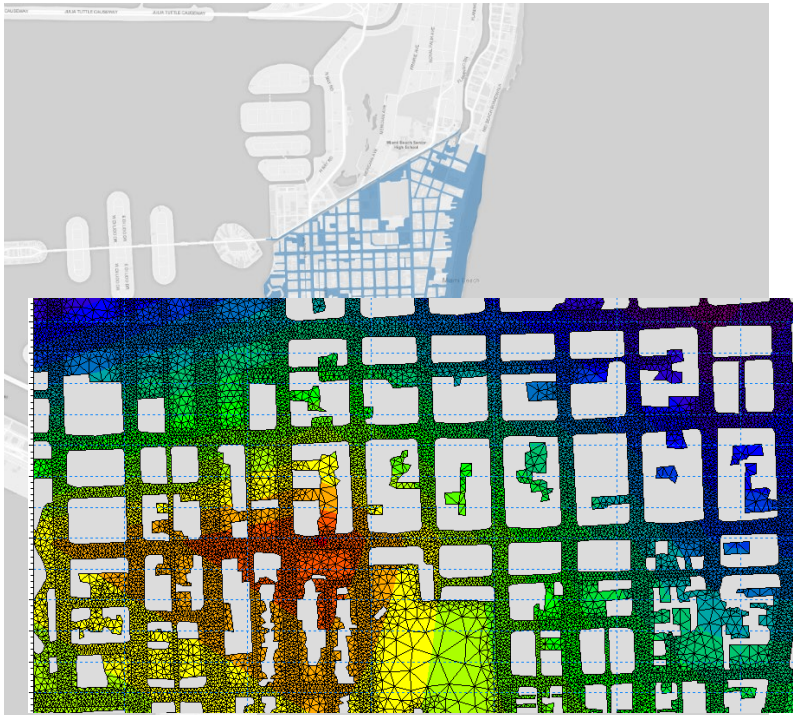


Tide – Surge - Rain

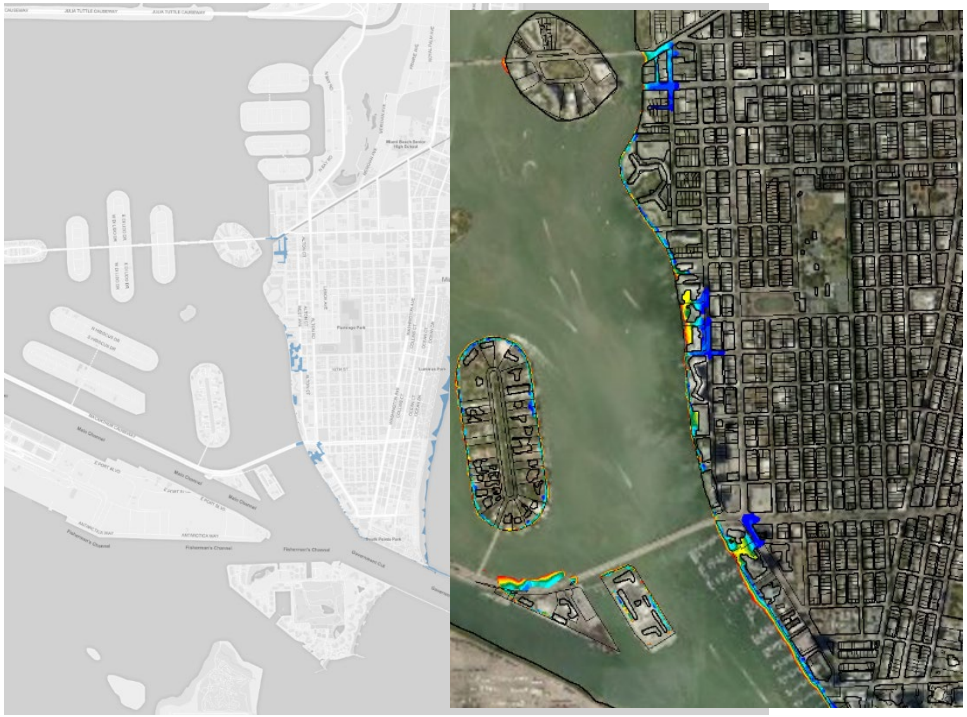


Model Results

- Local Coastal and Urban flood model
- Fine resolution (<5m) flexible mesh, LiDAR elev, detail building footprints



Combined Tide/Surge/Rainfall Flood Event



Tidal / Surge Flood Event

High Resolution Flood Warning and Communications to Stakeholders

Tapping the "+" icon reveals a number of actions. A user can "Share" the page via FaceBook or Email, they can add another "Place" or "Report" an incident.

Tapping the "Report Incident" reveals the types of events they can add.

Tapping "Flooded Areas" allows a user to select a "Minor", "Moderate", or "Major" flood event. They can also add a photo and/or comment to the report.

Once they have selected a flood type, they can send the report to the map.

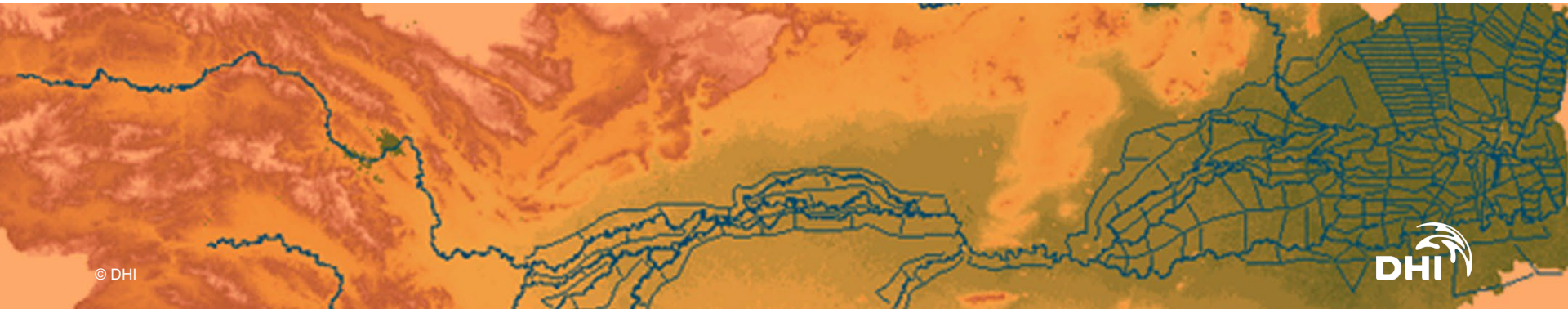
The map now shows the reports that have been collected. A user can tap on the report to get details.

Chao Phraya, Thailand

Flood Warning and Operation System

The Chao Phraya River Basin. 60,000mi^2. **One** Decision Support System to protect against devastating flooding.

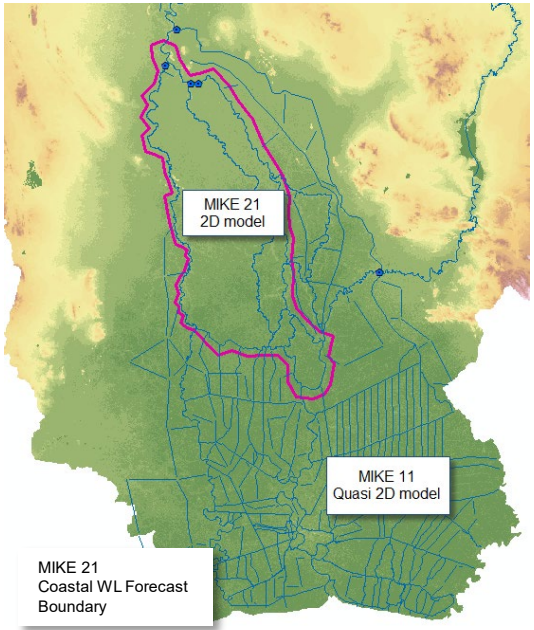
> HAII highly appreciates DHI for their excellent job, especially on the close collaboration and hands on experience that made us become good partners."
>
> *Dr. Piyamarn Sisomphon, Project Leader, Hydro and Agro Informatics Institute*

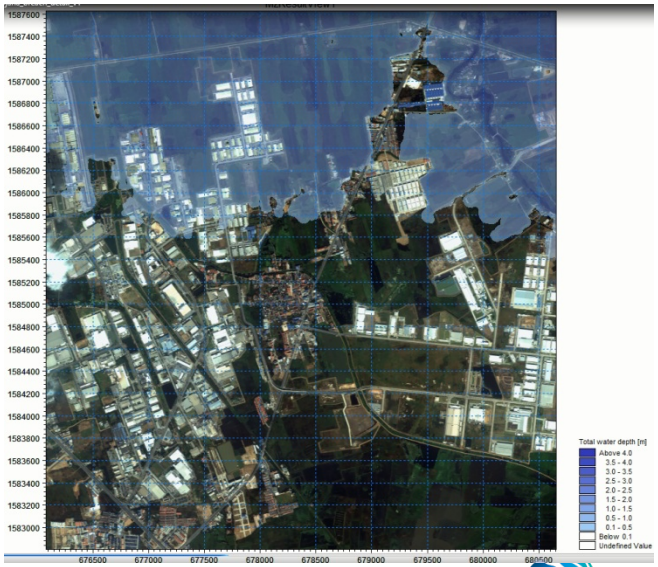


Computational efficiency

Chao Phraya, Thailand

Coupled Marine, 1D and 2D models enables large areas of 2D and complex 1D models to be run in forecast mode required for optimisation of operations and detailed flood forecasting





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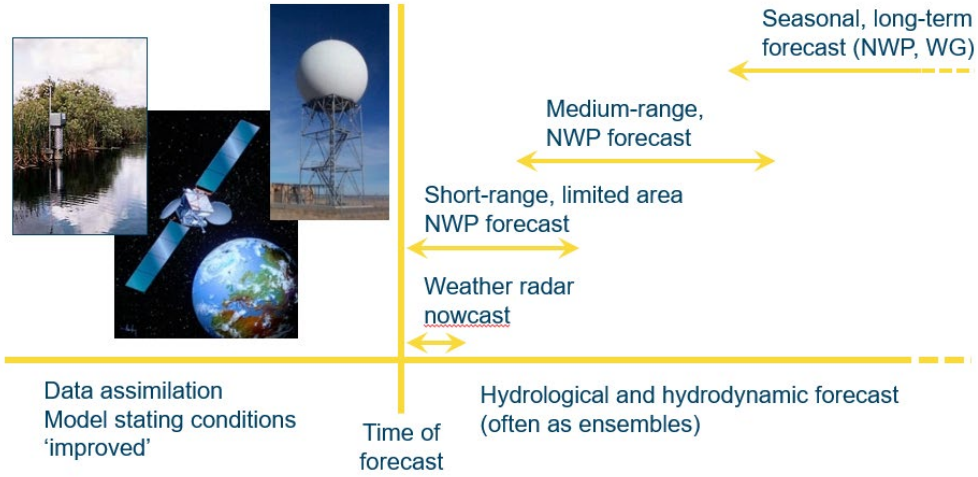
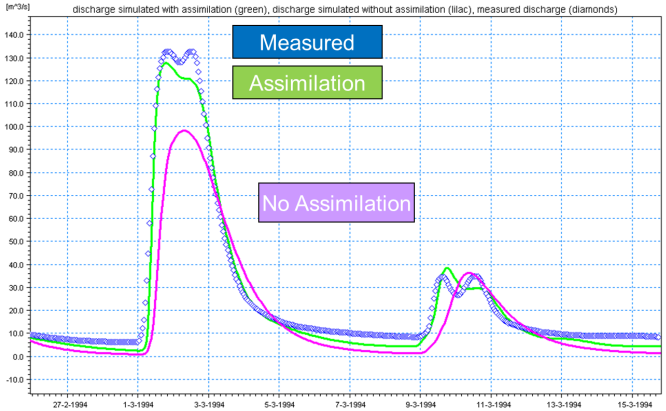
System Structure

Chao Phraya, Thailand



Extensive use of data assimilation for Improved Forecast Accuracy



Benefits

Chao Phraya, Thailand

Integrated Model allows improved decision making across multiple stakeholders

Better use of existing dams and planning of flood detention structures

Better operation of flood control measures during event and improved emergency response

Better use water allocation for irrigation

Better hydropower generation