International Centre for Advanced Studies on River-Sea Systems

DANUBIUS-RI Modelling Node Webinar

2020 International Delft Software Days

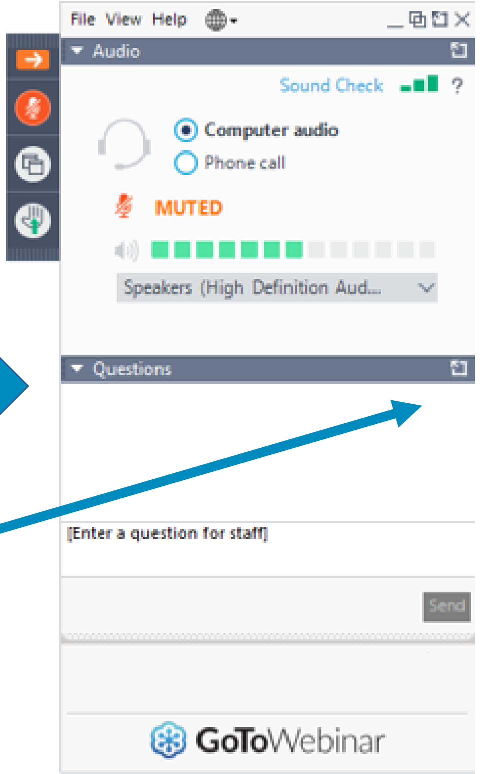
December 1st 2020

Welcome!

Debora Bellafiore (ISMAR-CNR), Georg Umgiesser (ISMAR-CNR), Francesca De Pascalis (ISMAR-CNR), Joost Icke (Deltares) and Björn Backeberg (Deltares)

Code of conduct

- GoToWebinar
- When **listening**…
- When **talking**… …**presenting**…
- To ask a **question**…
- To **participate** in **panel discussion**



Undock pane from Control Panel

- **Recordings**…

Recordings will be available on https://softwaredays.deltares.nl/2020/index.php/agenda/webinars

DANUBIUS-RI The International Center for Advanced Studies on River –Delta – Sea Systems is a pan-European distributed research infrastructure supporting interdisciplinary research on large river-sea systems

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Challenges to be addressed

- **ensuring sufficient flows of water and sediment;**
- **maintaining structural integrity and continuity;**
- **preserve biodiversity;**
- **facilitating processes of natural self-organisation over time;**
- **promoting resilience to extreme events.**

Our Vision

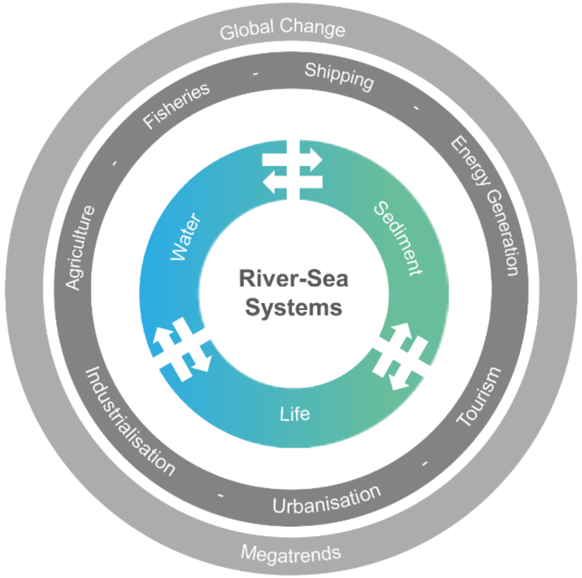
to achieve **healthy River-Sea Systems** and to advance their **sustainable use,** in order to live within the planet's ecological limits by 2050.

Our Mission

- to provide **state-of-the art research infrastructure** from river source to sea;
- to facilitate **excellent interdisciplinary science**;
- to offer **integrated knowledge** to manage and protect River-Sea Systems.

Our Goals

- **to overcome the current fragmentation of science, knowledge, data & management** in rivers and seas by integrating spatial, temporal, disciplinary and sectorial thinking;
- **to provide scientific solutions to environmental and societal risks** from climate change;
- **to resolve problems** arising from human impacts on River-Sea Systems by using an **interdisciplinary perspective**, from source to sea.



RESEARCH AREAS

Global Change and Megatrends
Water and Sediment
Biodiversity and Ecosystems
Multiple Impacts on River- Sea Systems

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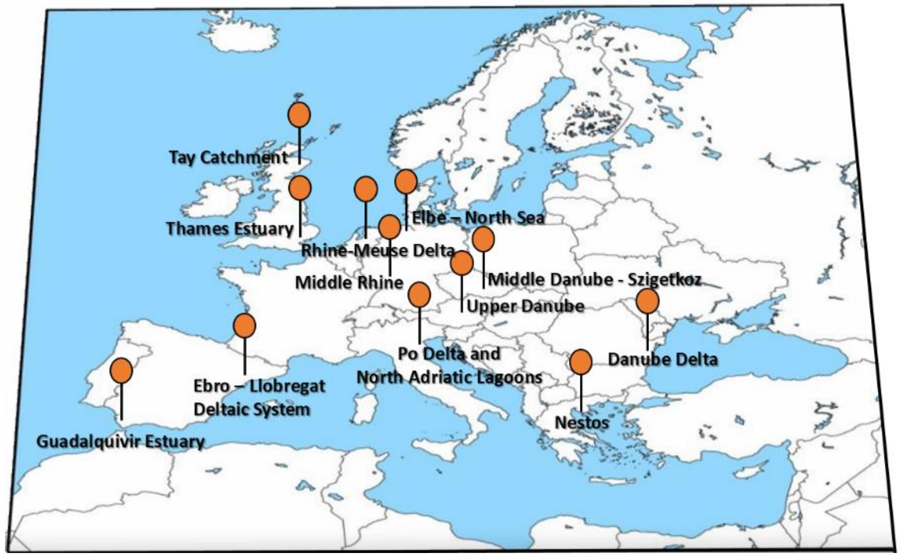
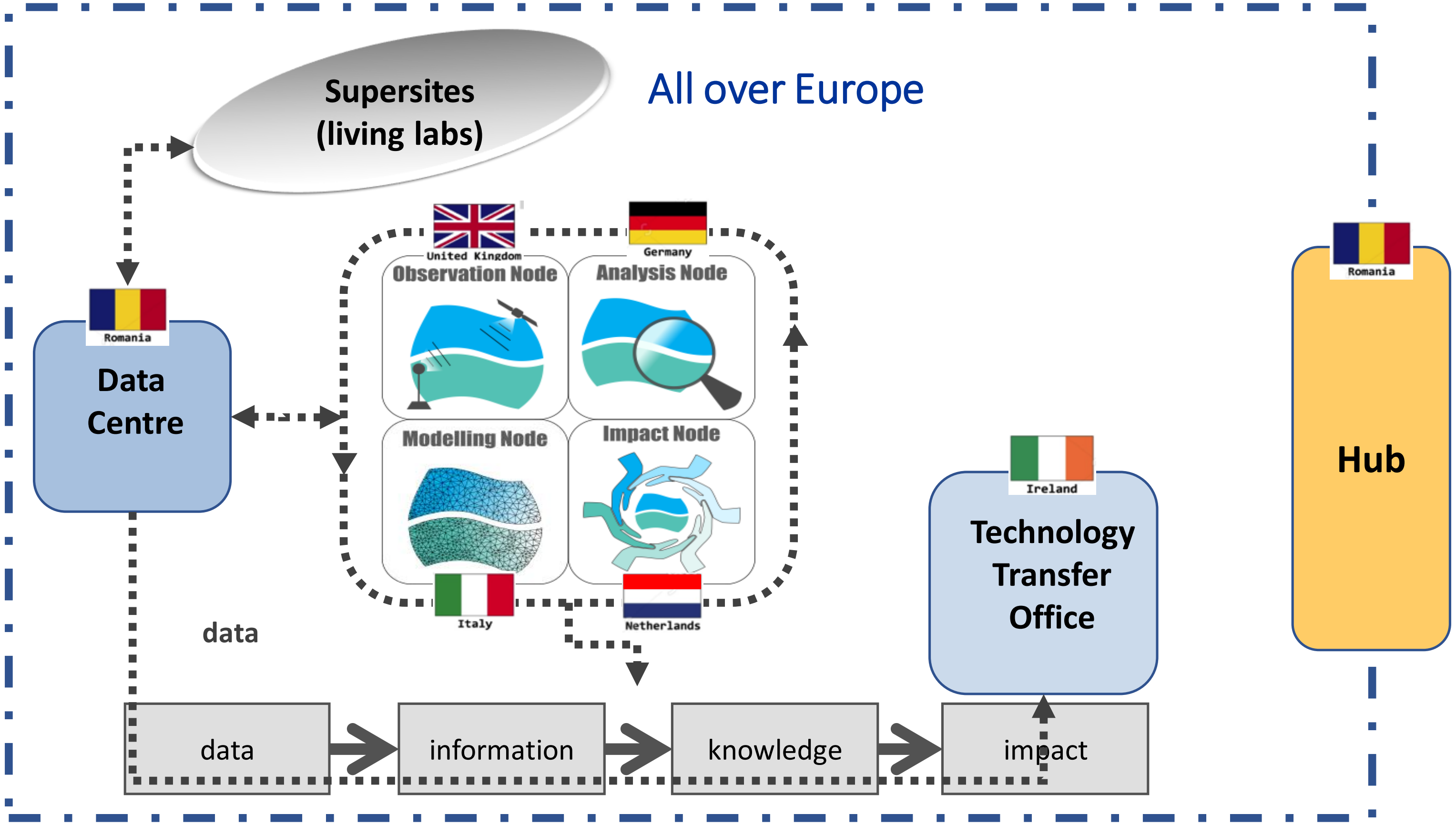
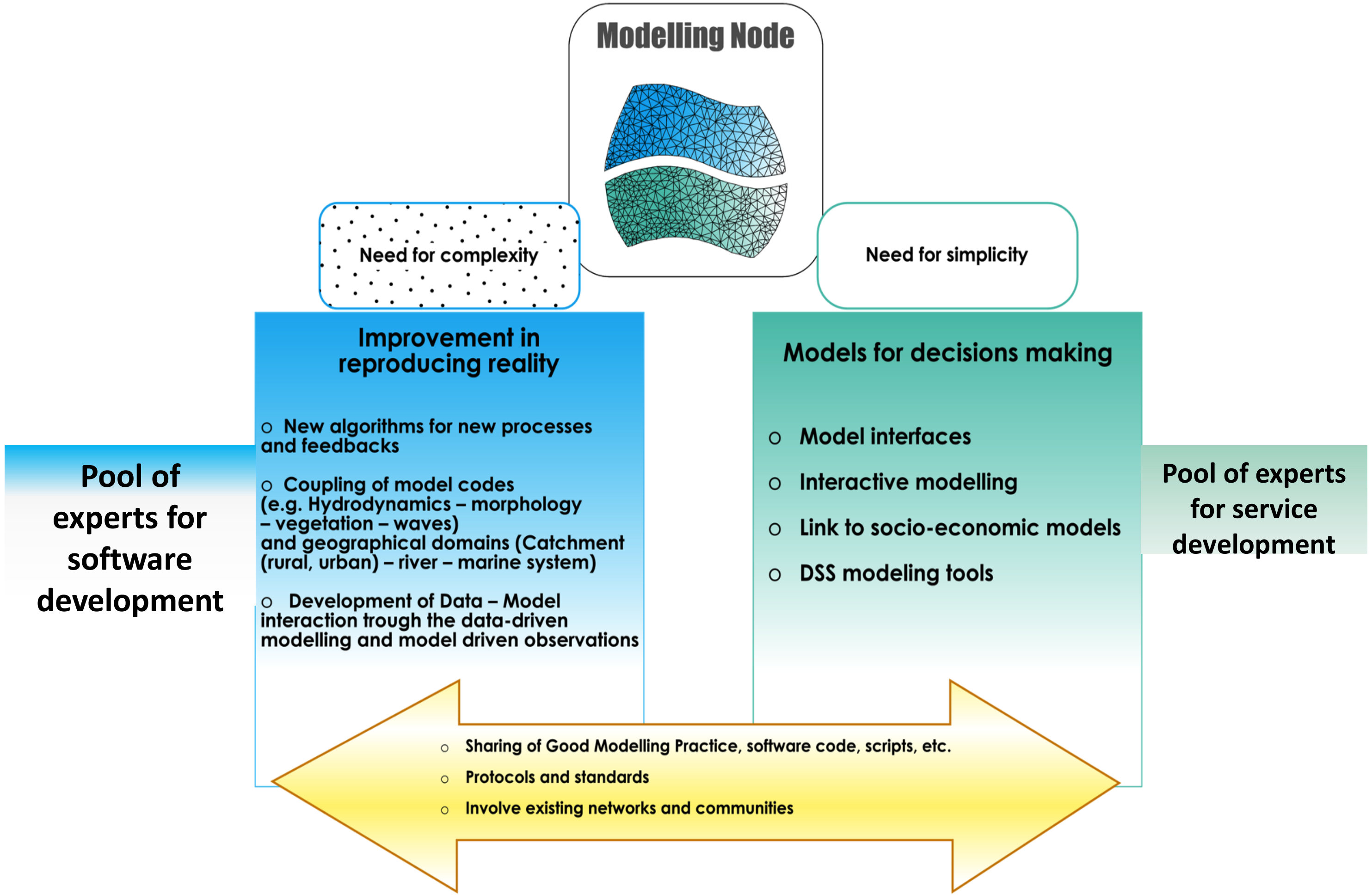
Situation of November 2019





The DANUBIUS-RI Modelling Node



Working groups established to build on community needs and develop the Modeling Node potential

WG1 Spatially integrated models in RDS systems

WG2 Interchange formats, standardization of input/output

WG3 Post processing

WG4 Water quality and pollution modeling

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10:00 - 10:05	**Welcome** Debora Bellafiore (ISMAR-CNR)
10:05 - 10:55	**Lightning Talks**
10:05 - 10:10	Coupling numerical models of two Supersites: Middle Rhine and Rhine-Meuse Delta (WG1) Thomas Brudy (BAW)
10:10 - 10:15	Challenges in cross-scale modelling of Elbe Estuary and German Bight Joanna Staneva (HZG)
10:15 - 10:20	Applications, challenges and bottlenecks in modelling the Supersite Delta Po and North Adriatic Lagoons (WG1) Debora Bellafiore (ISMAR-CNR)
10:20 - 10:25	Coupled hydraulic/fish habitat modeling of lower Nestos river (WG1) Georgios Sylaios (DUT)
10:25 - 10:30	Overview of Delft3D modeling of sediment dynamics and morphodynamics of the Scheldt estuary Jebbe van der Werf (Deltares)
10:30 - 10:35	Morphodynamic modelling in early warning systems (WG2) Agustin Sánchez-Archilla (UPC)
10:35 - 10:40	Towards a unified UGRID-NetCDF file format for flow simulations on unstructured grids (WG2) Aissa Sehili (BAW)
10:40 - 10:45	Post-processing of modeling data: tidal, harmonic and long-term analysis and aggregation (WG3) Julia Benndorf (BAW)
10:45 - 10:50	Recent advances in water quality and pollution modelling: SHYFEM-BFM and mercury modelling (WG4) Donata Canu (OGS)
10:50 - 10:55	Modeling Water Quality in German Waterways - Integration and Workflows Jens Wyrwa (BAFG)
10:55 - 11:05	**Break**
11:05 - 11:55	**Open discussion** Moderator: Björn Backeberg (Deltares)
11:55 - 12:00	**Wrap up / Conclusion**

Wish list for outcome

- Increase the Modelling Node Community, new involvement in WGs
- User needs identified and refined list of priorities
- Sharing of best practices and discussion on Modelling «PROBLEM SOLVING»
- Hypotheses on next opportunities for the modeling community in addressing RSS (projects, test cases, collaborations)
- Identification of “hot topics” in the modelling community

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Lightning Talks

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Coupling numerical models of two Supersites: Middle Rhine and Rhine-Meuse Delta

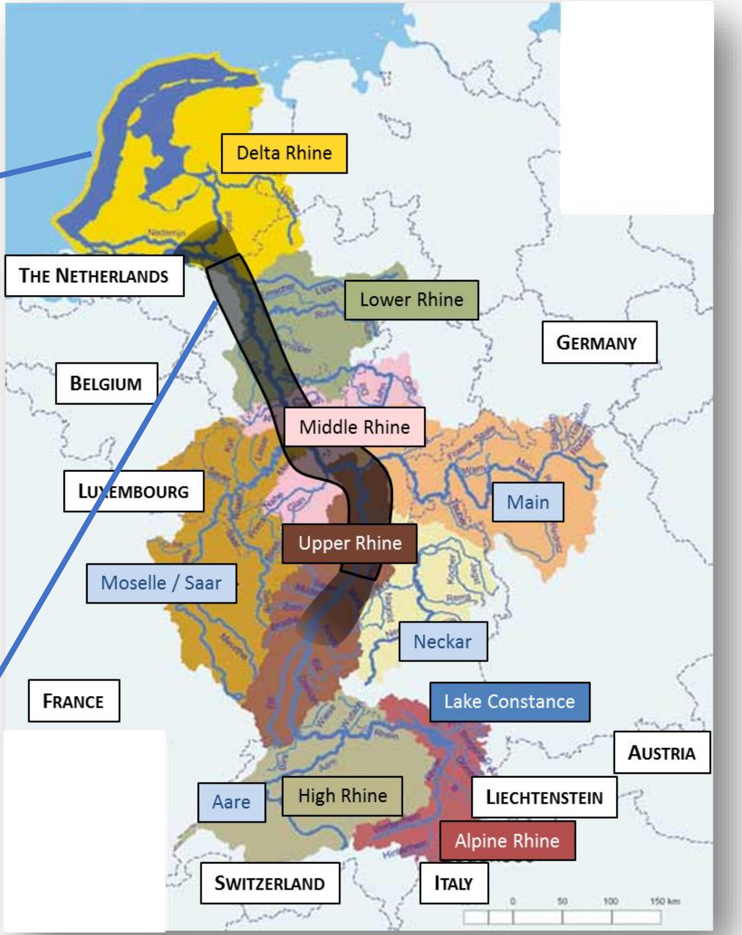
Thomas Brudy

BAW
Federal Waterways Engineering and Research Institute

Supersite Rhine-Meuse Delta:

- Delta region downstream German border / medium-sized river Meuse / North Sea
- Hosted by RWS

https://de.wikipedia.org/wiki/Rhein-Maas-Delta



Supersite Middle Rhine:

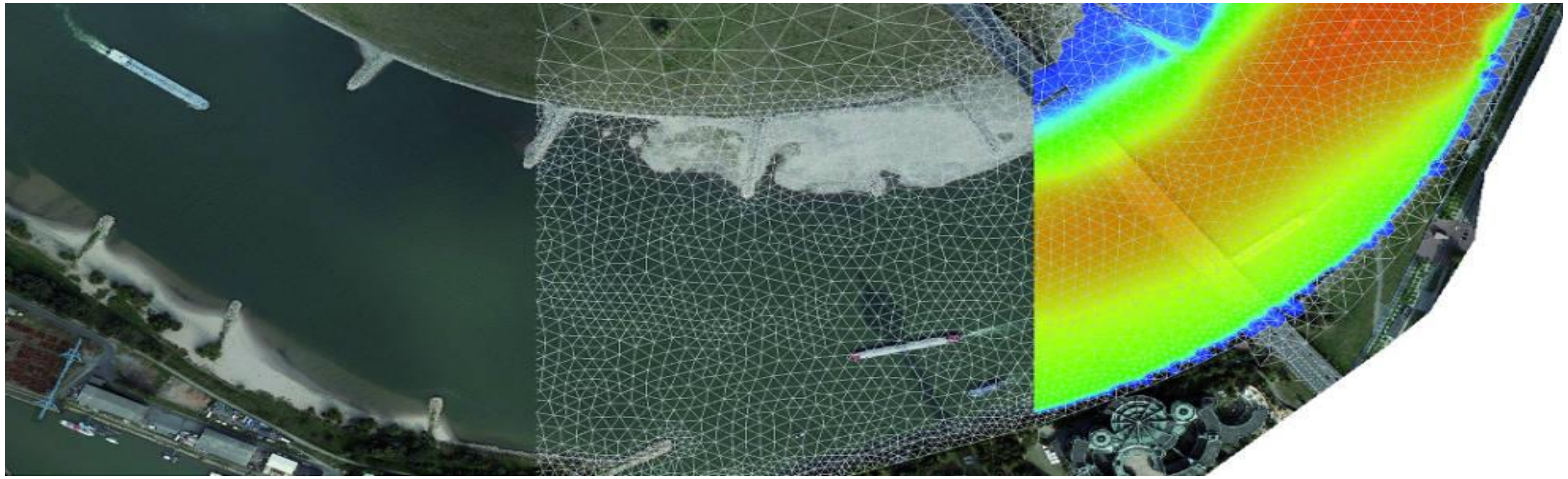
- Free-flowing stretch of River Rhine from Iffezheim to the Dutch border (~ 500 km)
- Hosted by BAW

Two supersites / One River-Sea-System

- Common challenges, scientific issues:
  - Sediment budget, management
  - Sustainable navigation and waterways
  - Climate change
  - …

Coupling of the numerical models of two supersites

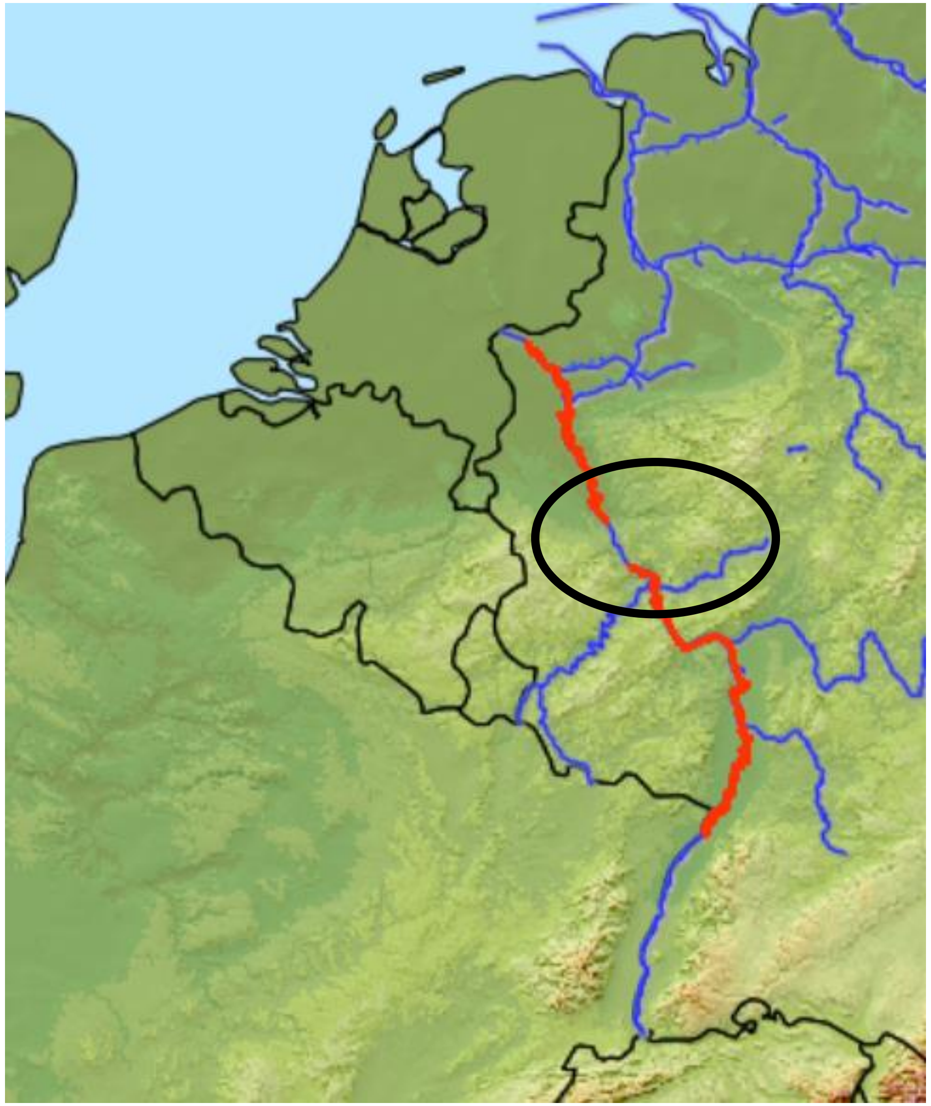
- Matching the strategic objectives of DANUBIUS-RI:
  - **Integrated understanding** on the functioning of the River-Sea Systems
  - **Transboundary, interdisciplinary research** on the River-Sea continuum
- Objectives in detail:
  - **Medium-term**: external coupling of the hydrodynamic models
  - **Long-term**: continuous transboundary models, morphodynamic models



Progress and results:

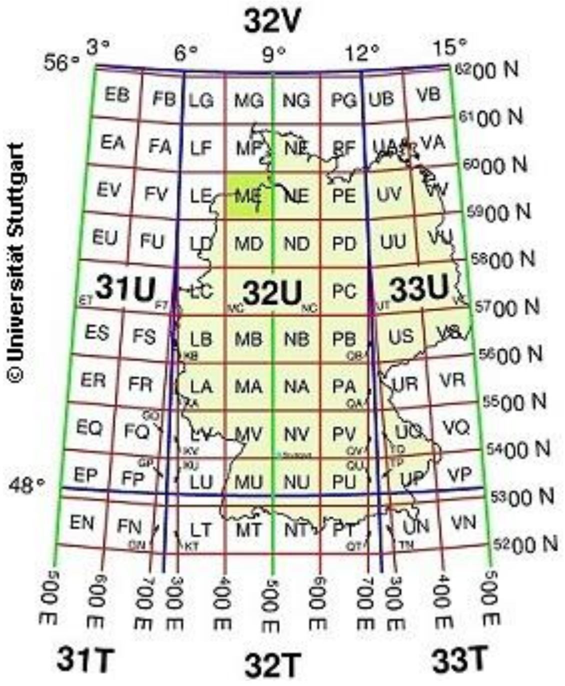
- Dutch/German-working group:
  - Established by the shipping authorities
  - Focus on numerical models in terms of sediment management and navigation
- Completing the chain of hydrodynamic 2D-models based on FE code TELEMAC
- Development of a new high performance code for shallow water flow based on “Dumu^x”

DuMu^X



Challenges and bottlenecks:

- Huge modelling areas => High Performance Computing
- Interfaces between the different model types
- Harmonization of modelling data:
  - Coordinate reference system
  - Height reference systems



https://www.killetsoft.de

Proposed future work:

- Morphodynamic 1D-model covering Lower Rhine / Waal
- Extension of the hydrodynamic 2D-model to the Netherlands Panerdensch Kanaal / Waal
- Further development new code "Dumu^x":
  - Performance (fully implicit)
  - Morphodynamic model
- Close collaboration between GER-NL / supersite coordinators


Sediment nourishment at Lower Rhine

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Challenges in cross-scale modelling of Elbe Estuary and German Bight

Joanna Staneva, Johannes Pein, Benjamin Jacob, Emil Stanev , Corinna Schrum (HZG)

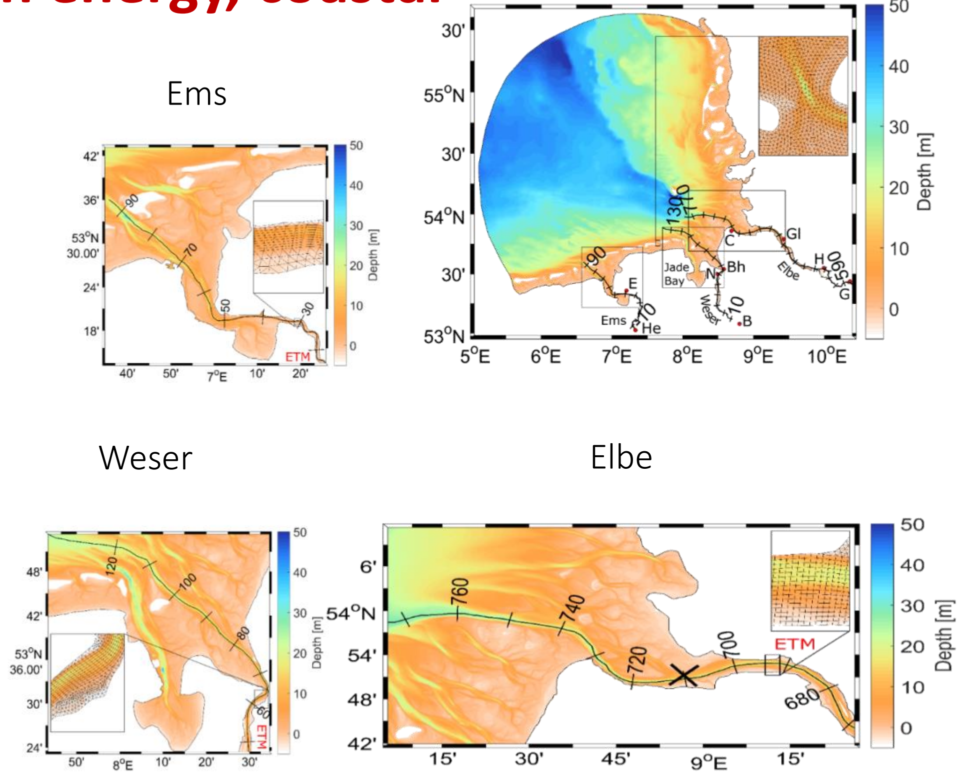
joanna.staneva@hzg.de

Helmholtz-Zentrum Geesthacht

Centre for Materials and Coastal Research

Introduction and background of activity being presented

Is coastal ocean modelling nowadays mature enough to address practical issues from coastal engineering, search and rescue, BGC, green energy, coastal management, response to climate change?



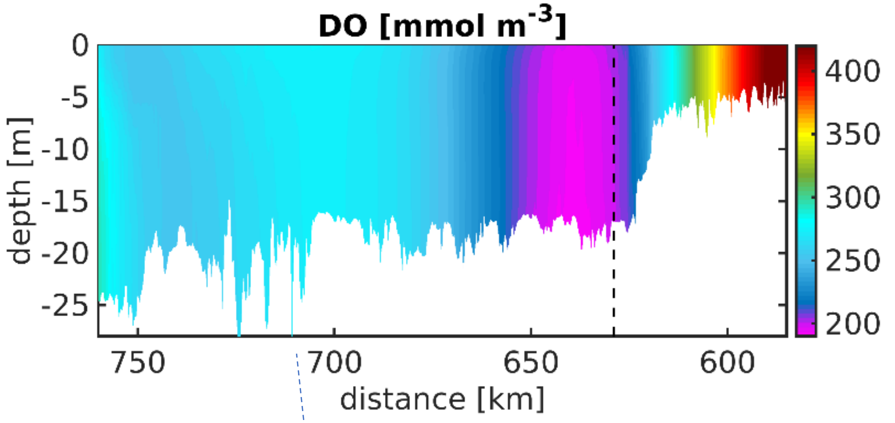
- Novel approaches are currently needed to understanding the general context of climate change and the coastal hazards
- Increased interest in reducing prediction errors at coastal scales.
- Extreme weather events in the marine realm.
- Bridging novel EO data and high resolution coastal models.
- Impact on climate studies and coastal predictions
- Wider social impact

Objective and novelty of activity

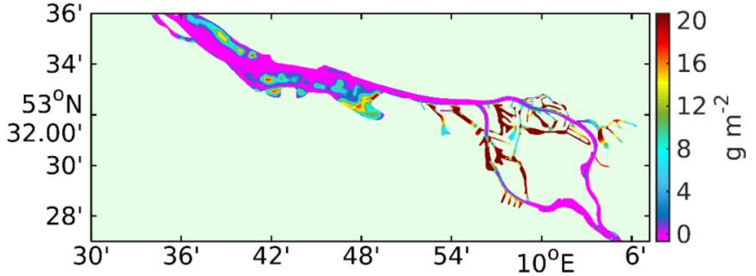
- Implemented a coupled system for the three estuaries of te German Bight using unstructured grids to address the efficient downscaling of coastal processes and the incorporation of freshwater land discharges.
- A generic methodology is p for consistent interfacing (nesting, downscaling and transformed variables) between large scale, structured and coastal models.
- Linkage with hydrology - experiments
- Prepared a set of criteria to extend CMEMS products towards the active coastal fringe, addressing the requirements for boundary conditions, driving terms and derived fields.
- Interfaces towards operationally
- This quest for improved predictions is a repeated requirement by coastal stakeholders, in dire need of more reliable data for currents, waves, surges, and water quality.

Progress and results:
Water quality example

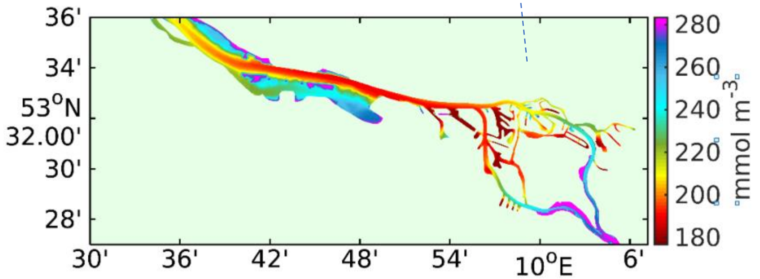
- Numerical model delivers a realistic picture of the dominant estuarine processes, e.g. eutrophication
- Model state variables can be used to derive downstream products, e.g. risk maps for water quality parameters like oxygen concentration (risk of hypoxia)



Organic sediment



Near-bottom dissolved oxygen conc.

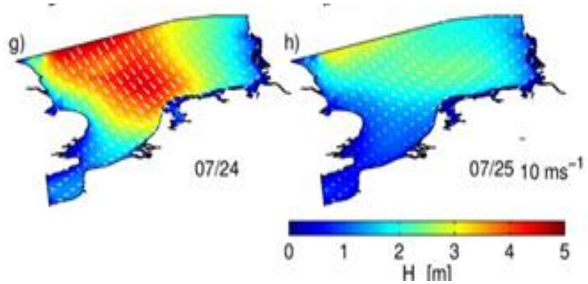


Challenges and bottlenecks faced

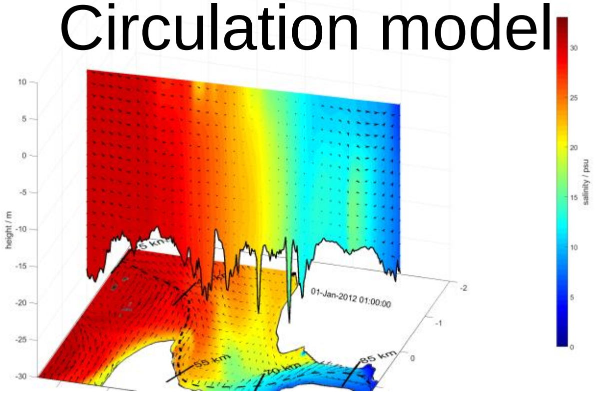
Diversity of model components
Interaction between different models is important
Coastal and estuaries models (incl. BGC) are of not much interest if not well linked to
a) Larger-scale models
b) Atmosphere-wave models
c) Hydrology

Model diversity (Different design/coding)

Wave Model



Circulation model



BGC: Near-Coastal models/applications

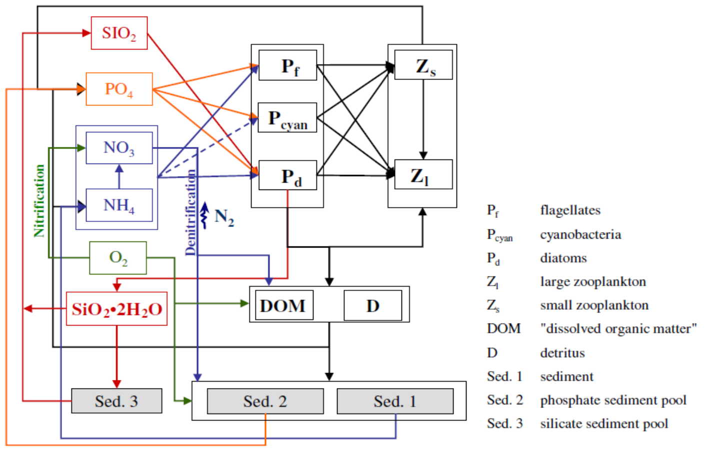


Fig. 2. Schematic diagram of biochemical interactions in ECOSMO II.

- Synergy between newly available data and coastal models
- Solve practical problems
- Operational design
- Demonstration/ End-users/Society demands

Proposed future work:

Elbe esruary water quality : GCOAST (SCHISM- WWM-ECOSMO-SED)

Further integrated with sediment dynamics and morphodynamics

Pollution modelling – land-ocean continuum - atmosphere and ocean

Synergy of newly available observations and Ugrid estuary model – OSSE

Climate scenario (natural variability and human induced changes)

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Applications, challenges and bottlenecks in modelling the Supersite Delta Po and North Adriatic Lagoons (WG1)

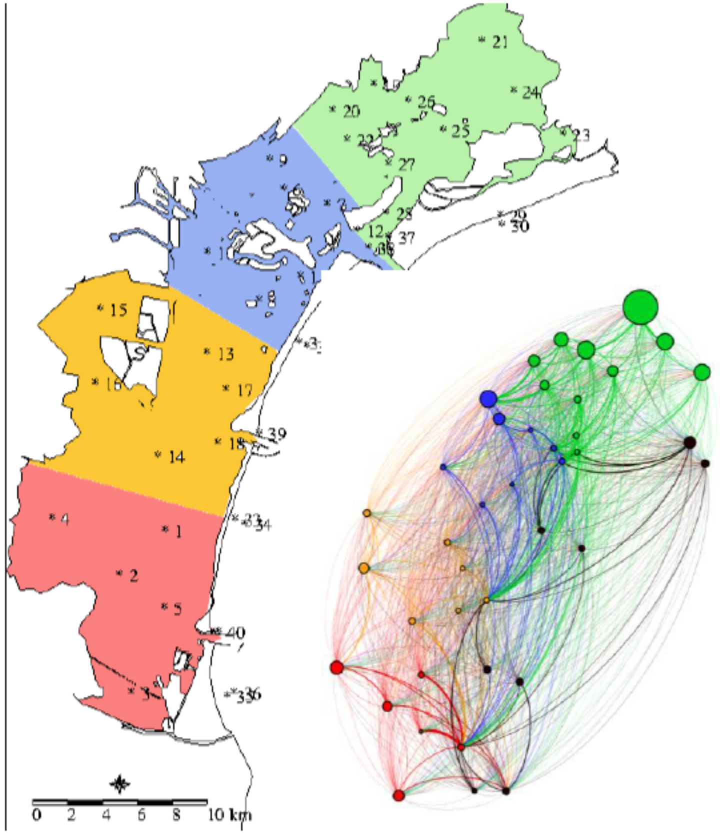
Debora Bellafiore, Georg Umgiesser, Francesca De Pascalis, Christian Ferrarin, Marco Bajo, Michol Ghezzo, William Mc Kiver

CNR ISMAR
ISTITUTO DI SCIENZE MARINE

Introduction and background of activity

Applications of SHYFEM model in the North Adriatic area concerning:
Transitional environment – main basin circulation
Storm surge modelling
Sediment transport
Lagrangian modelling for Ecology (e.g. Connectivity), search and rescue, marine litter

SHYFEM
3D Finite element hydrodynamic model, staggered for the spatial integration.
3D shallow water hydrodynamic model, coupled with a wind wave model and with both an Eulerian and a Lagrangian module, for simulating active tracers transport and diffusion.
External modules:
Sediment Transport SEDTRANS
Ecological module EUTRO-WASP
Biogeochemical module BFM
Wave module WWMII
Turbulence closure module GOTM



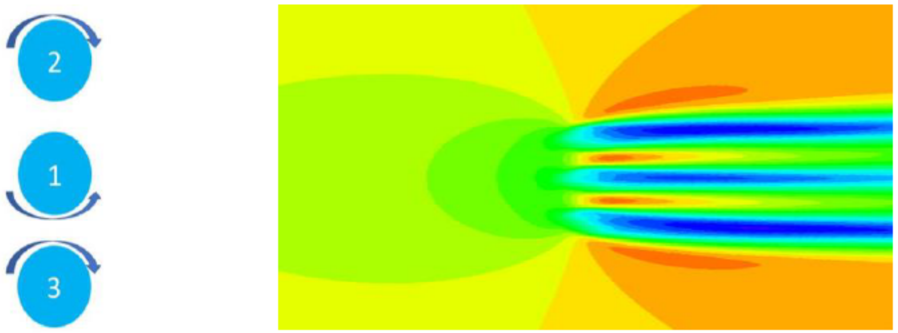
Objective and novelty of activity

including how the activity contributes to the Working Group1: spatially integrated models in RDS systems

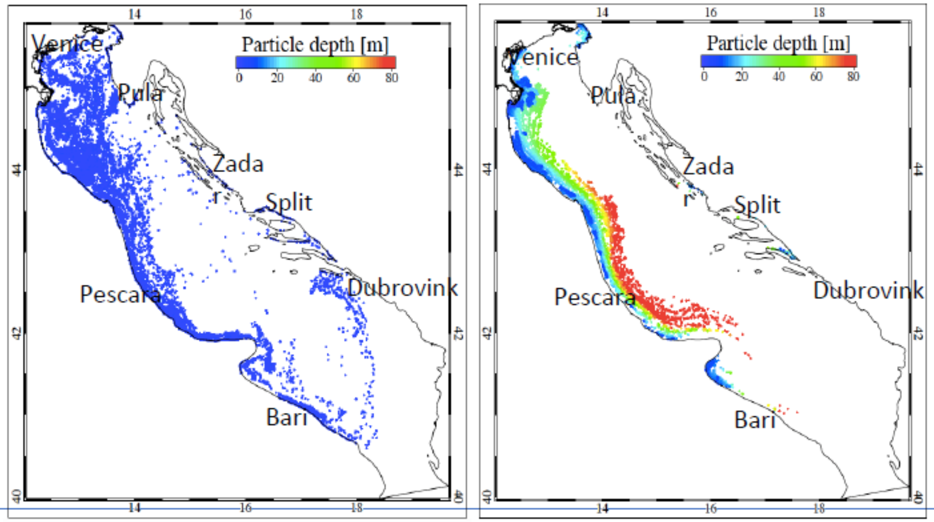
Coupling various sub-modules to allow the spatially integrated modelling (river –delta –open ocean)
Full use of SHYFEM potentiality. Addressing scientific topics as coastal mixing and saltwater intrusion, we push SHYFEM to new technical issues as reproducing internal dynamics along the river and interaction effects with the coast.

Explore new applicative sectors:

-**ENERGY PRODUCTION**: **simulating the effect of energy turbines** on the hydrodynamic field (online computation, with interaction of the working turbine with currents);



-**PLASTIC DYNAMICS for ENERGY PRODUCTION (Project MarGnet):** development of alghoritms for **3D lagrangian simulations, including settling and deposition**



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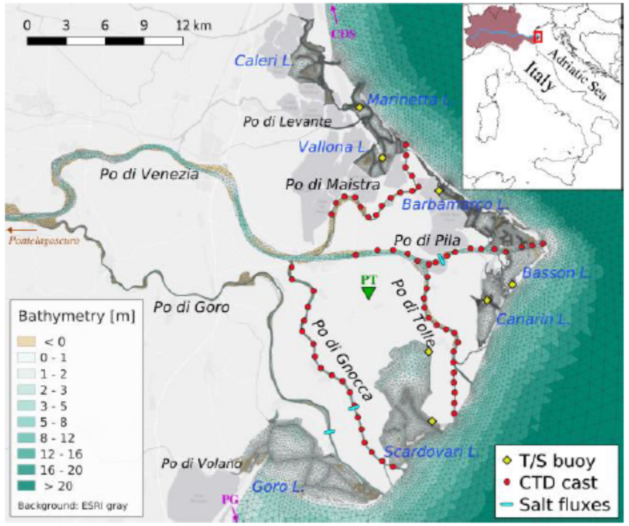
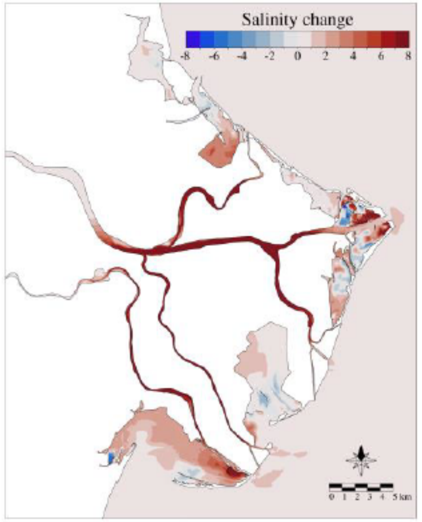
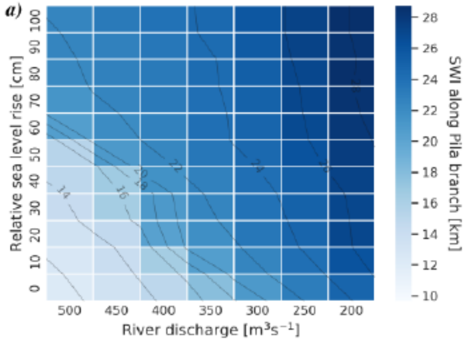
Progress and results

Range of most updated implementations in the area:

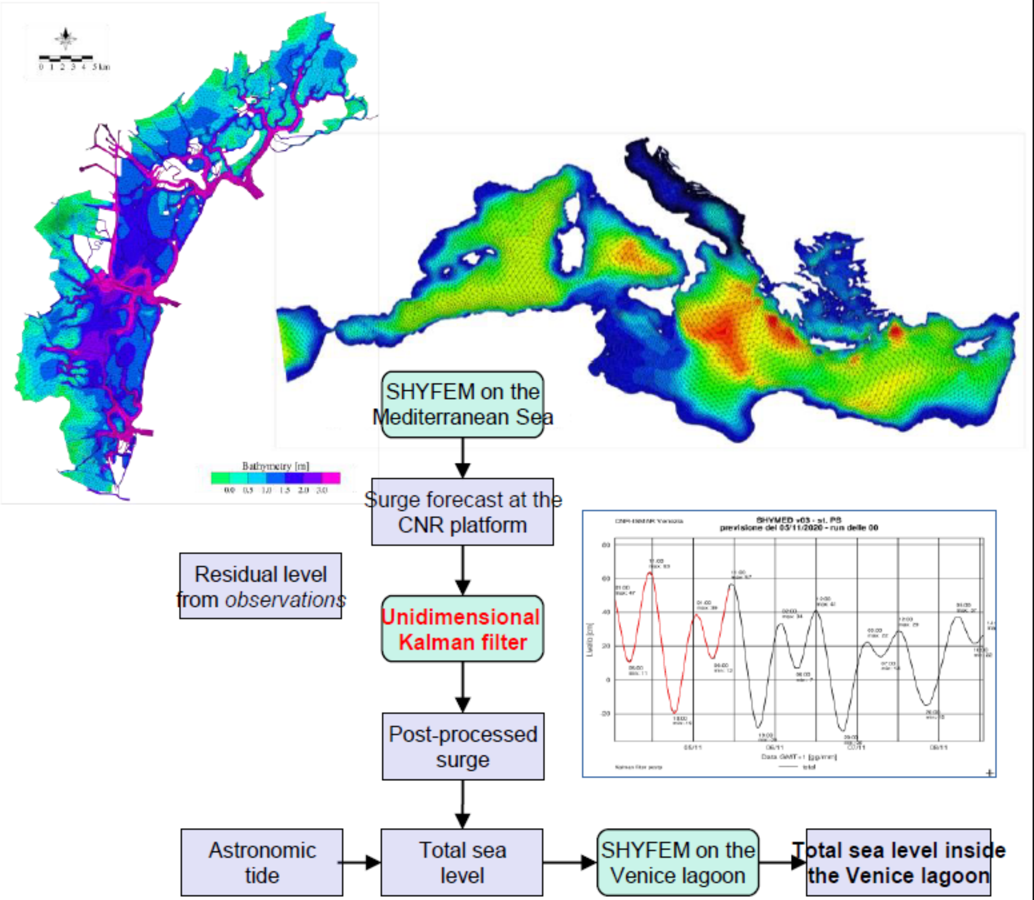
→Saltwater intrusion in the Po Delta in the Climate Change perspective







→ Storm Surge forecast – high tide forecast in North Adriatic and Venice Lagoon and investigation



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Challenges and bottlenecks

→ need to couple coastal models to catchment models

→ need to improve wetting drying in sigma coordinates

→ need to take into consideration effects of waves addressing Compound Flood modelling: learn from flood models and verify how to balance between a fully nested approach (coastal models – flood boussineq models) and just the use of empirical formulations for flooding. Improvement of the coupled current wave model

→ need of updated bathymetric information or coupling to reliable morphodynamic model in highly active systems to avoid highly biased hydro results in RS systems

→ need to improve computational costs

Proposed future work

full coupling to catchment models to sea specifically for the Venice Lagoon and for the Po Delta:
--possible tools SWAT and Deltares tool used in DAnube NUtrients Black Sea Project MONERIS (Modelling of Nutrient Emissions in River Systems) → data on river discharge, nutrients loads, eventual chemicals and plastics loads.
-Take into account distributed sources of water and material, considering **groundwater sources**, integrating inland topography

A proper modelling reproduction of compound floods, evaluating different technical options:
-integrate through nesting flooding bousinnesq models;
-develop the coastal models (SHYFEM) enhancing the capability of the current-wave modelling (perhaps integrating also the empirical formulations usually implemented in flooding areas). **From stand-alone or 1-way coupling to a full integration in SHYFEM**

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Coupled hydraulic/fish habitat modeling in lower Nestos river

G. SYLAIOS, I. BOSKIDIS, N. KOKKOS, A. SAPOUNIDIS & E. KOUTRAKIS

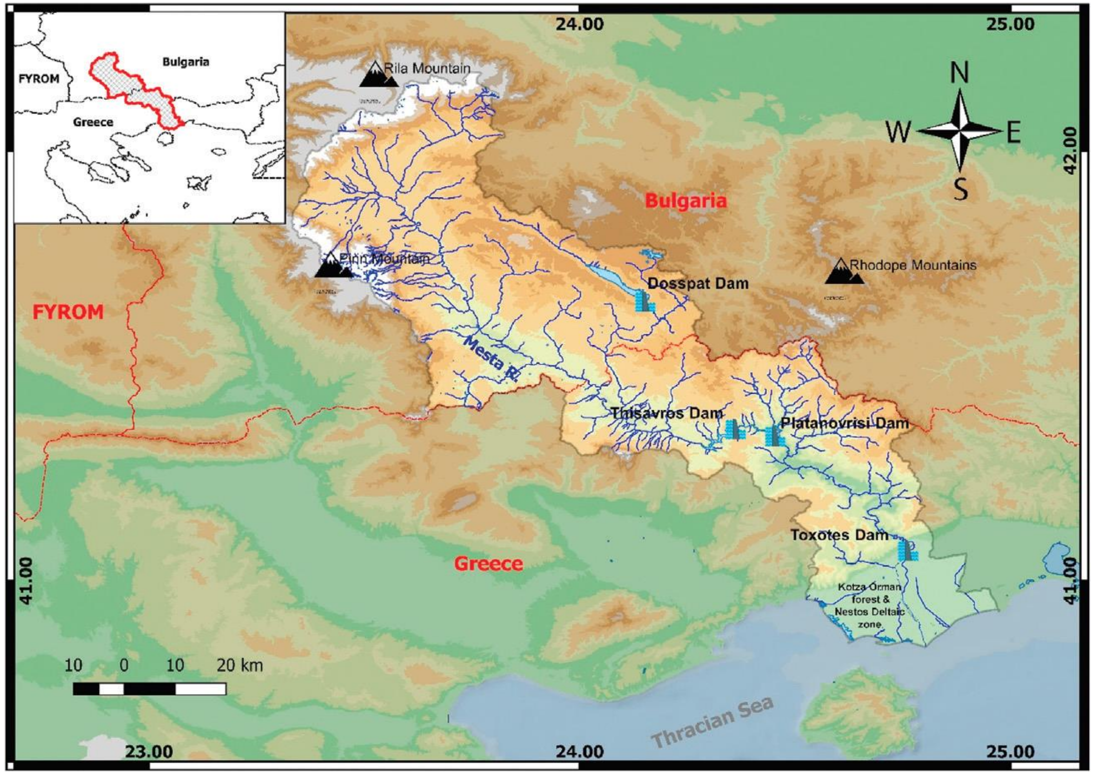
ΔΗΜΟΚΡΙΤΕΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΡΑΚΗΣ
DEMOCRITUS UNIVERSITY OF THRACE

HELLENIC MINISTRY OF RURAL DEVELOPMENT & FOOD
HELLENIC AGRICULTURAL ORGANISATION "DEMETER"

Presently, the management of Heavily Modified Water Bodies (HMWB), like the Dammed River Systems requires the assessment of the **minimum Environmental Flow Requirement (EFR)** and its redefinition under conditions of climate change and water deficiency.

The EFR is defined as the minimum quantity, time availability and quality of river runoff required to ensure the protection of internal and transitional ecosystems, as well as the sustainable presence and development of humans, whose activities depend on these ecosystems (Brisbane Declaration, 2007).

Aim of the present work is the implementation of a coupled hydraulic and fish habitat modeling of Nestos River (Northern Greece) under various low flow conditions, serving for the analysis and the ultimate determination of environmental flow at this sensitive river zone.



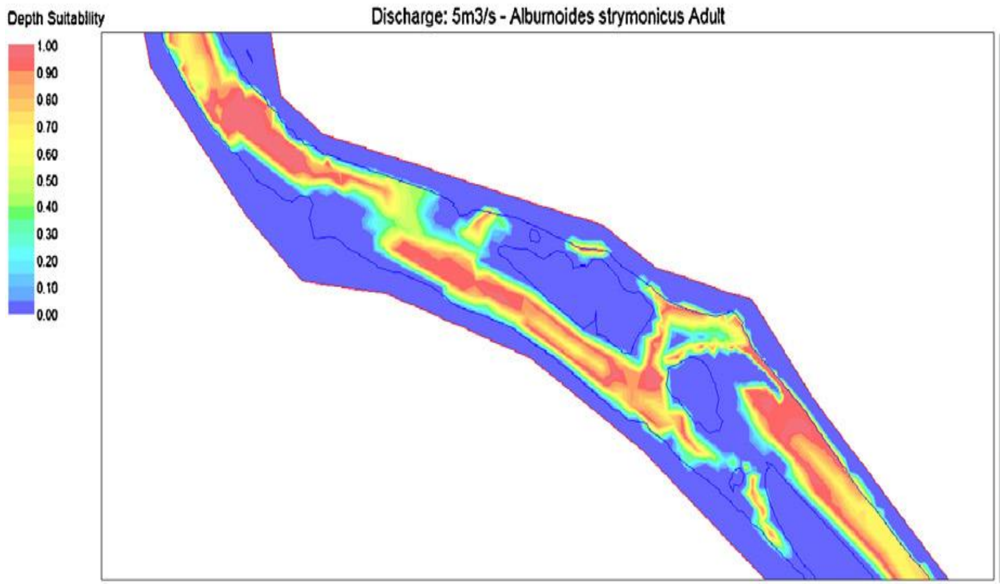
RIVER2D is a two-dimensional, depth averaged hydrodynamic and fish habitat model, widely used in environmental flow assessment studies.

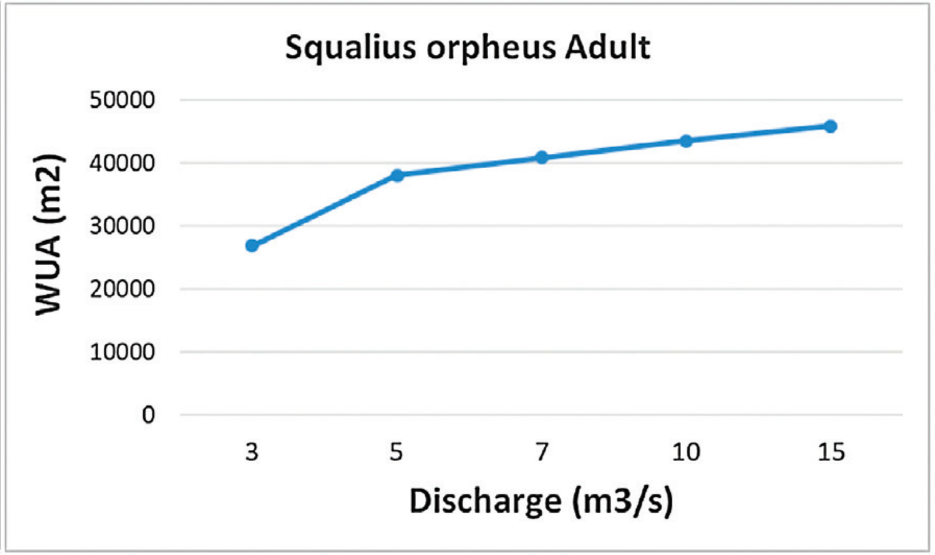
Fish habitat modelling was conducted for four different fish species (*Alburnoides strymonicus, Barbus strumicae, Rhodeus amarus* and *Squalius orpheus*), divided into two age groups (adults and juveniles), forced under five typical low flow conditions.

Novelty: The work illustrates that ecohydraulic modelling of river basins should be considered as an indispensable component in sustainable water resources management, in line to WFD implementation.

RIVER2D model uses the Weighted Usable Area (WUA) methodology calculated as the sum of the Composite Suitability Index (CSI with a range of 0.0–1.0) estimated at each point of the computational grid.

All examined fish species presented an increase of their WUA as the discharge increases. Juveniles are more sensitive to low river flow conditions. Overall, the ecohydraulic model results illustrate that higher river flows improve the quality and quantity of fish habitat in the river, while lower flows may stress it.





Challenges and bottlenecks faced

- Need for better DEM
- Better knowledge of Suitability Indices per parameter
- Upstream boundary conditions should be better defined

Conclusions

- In lower Nestos River the increase of base flow from 7 m^3/s to 10 m^3/s increased the habitat area of all fish species (juveniles by 8.8% and adults by 15.3%).

- *Squalius orpheus* is the most sensitive species among adult age groups in terms of habitat area response to low river flow conditions.

- The application of coupled hydraulic/fish habitat models in HMWB could be a valuable tool in evaluating the impacts of low flow regimes on fish populations and assessing the minimum required environmental flow in rivers.

Proposed future work

- Installation of meteohydraulic station equipped with an underwater camera with motion sensor to assess fish behavior under variable river flow conditions.

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Overview of Delft3D modeling of sediment dynamics and morphodynamics of the Scheldt estuary

Jebbe van der Werf, Bjorn Röbke, Thijs van Kessel, Mick van der Wegen, Marcel Taal and many others

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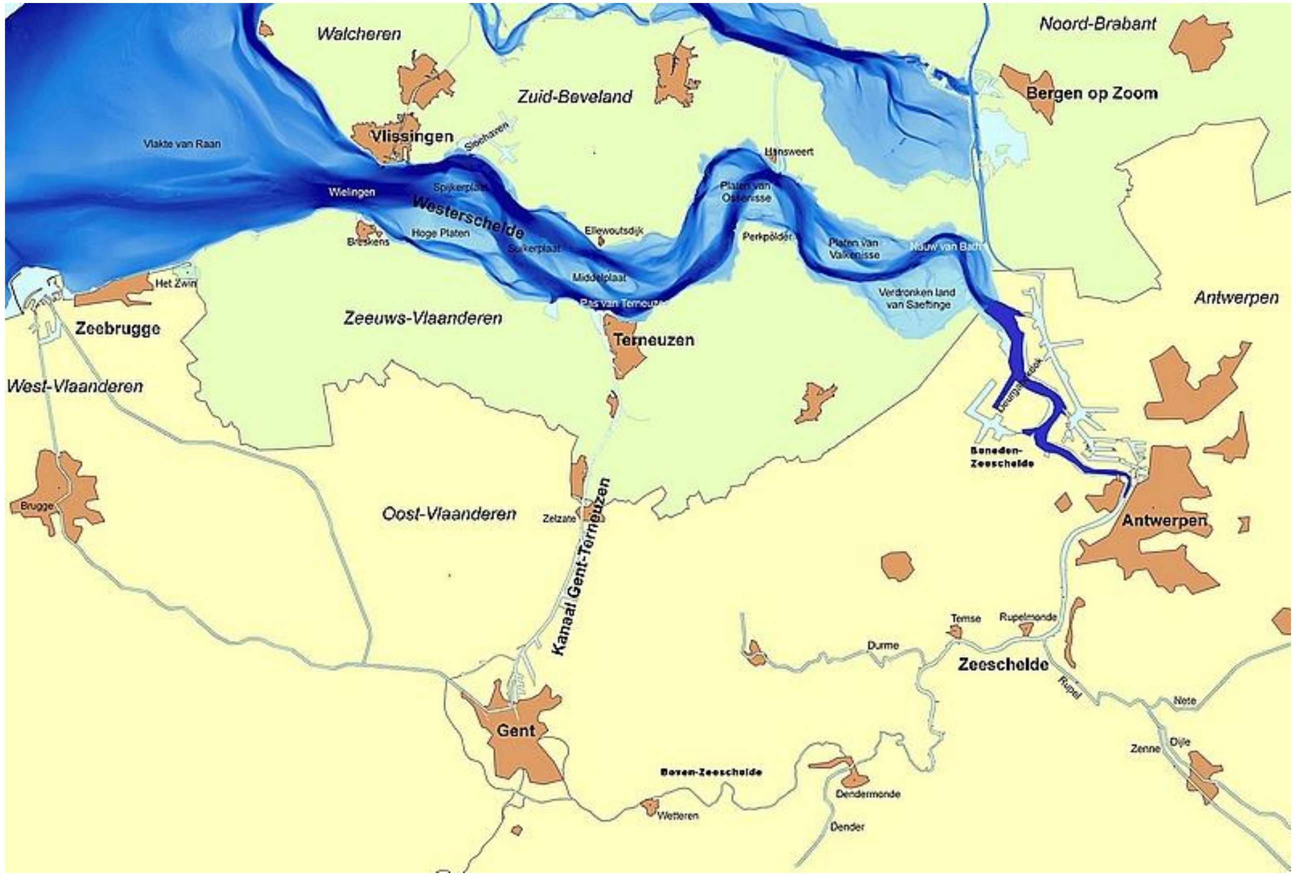
Enabling Delta Life

Scheldt estuary



Mouth ~25 km

\+

Western Scheldt ~60 km

\+

Lower Sea Scheldt ~40 km

\+

Upper Sea Scheldt ~60 km

Well-mixed with average river discharge ~100 m^3/s

Meso- to macrotidal with tidal range >5 m at Antwerp

Numerical models can contribute to policy & management

Potentially conflicting functions: safety, nature & navigation

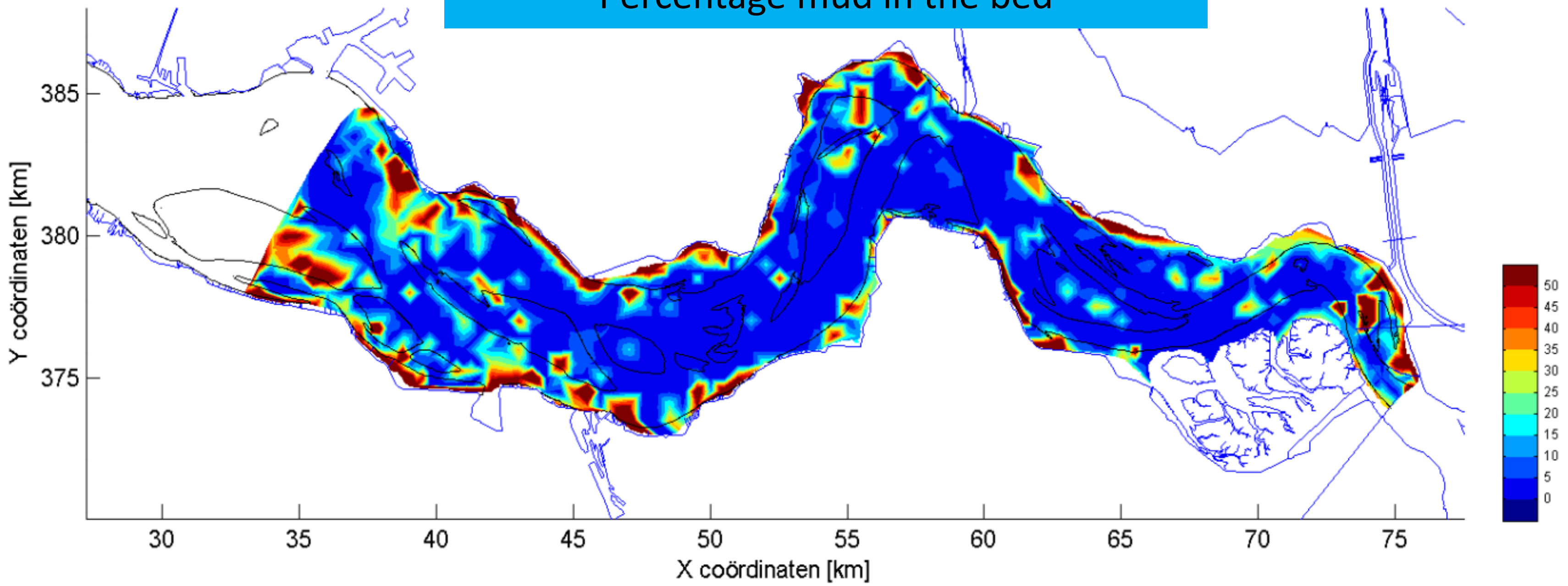
No free entrance between 1587 and 1795!

Entrance to Port of Antwerp (BE) over NL territory

Modeling challenges

1. Complex physics: sand & mud, tides, winds & waves, transition from fresh water to sea water
2. Large domain (100+ km), long time scales (up to decades)
3. High spatial resolution required at beaches and intertidal areas (~10 m)

Percentage mud in the bed



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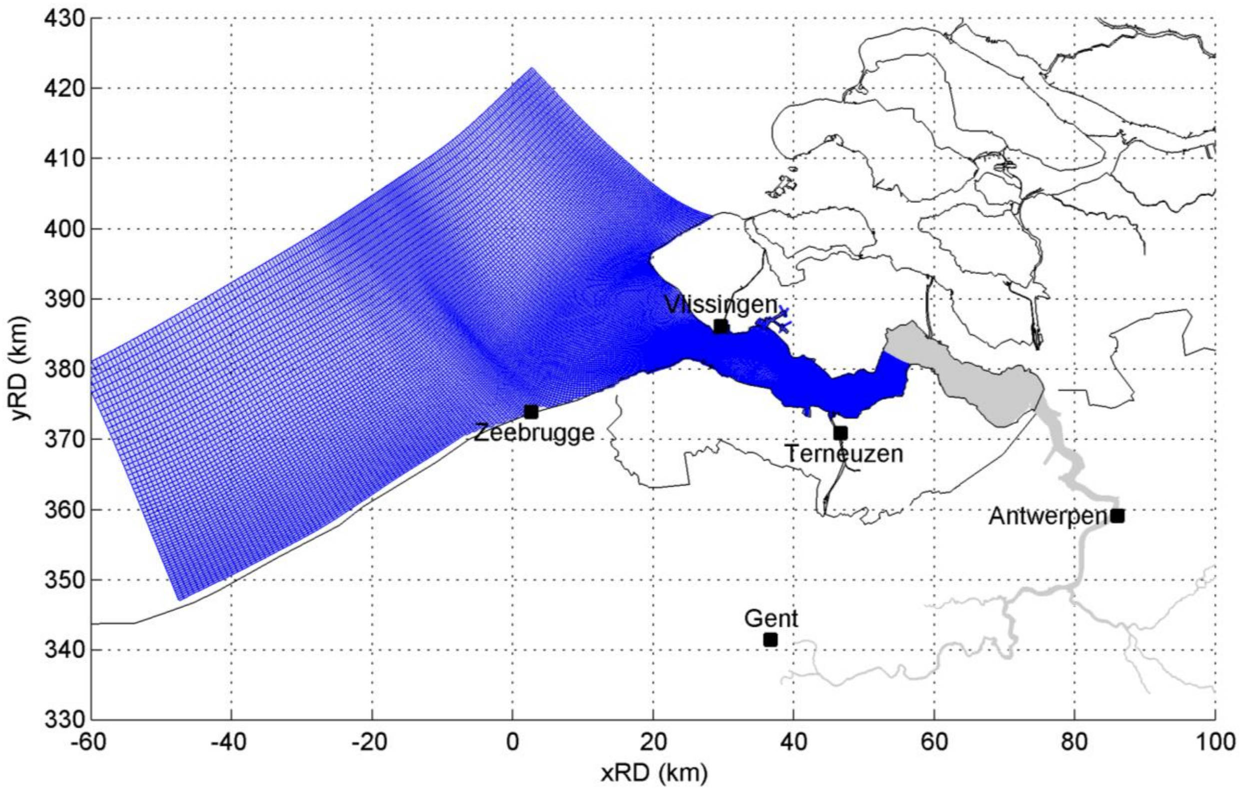
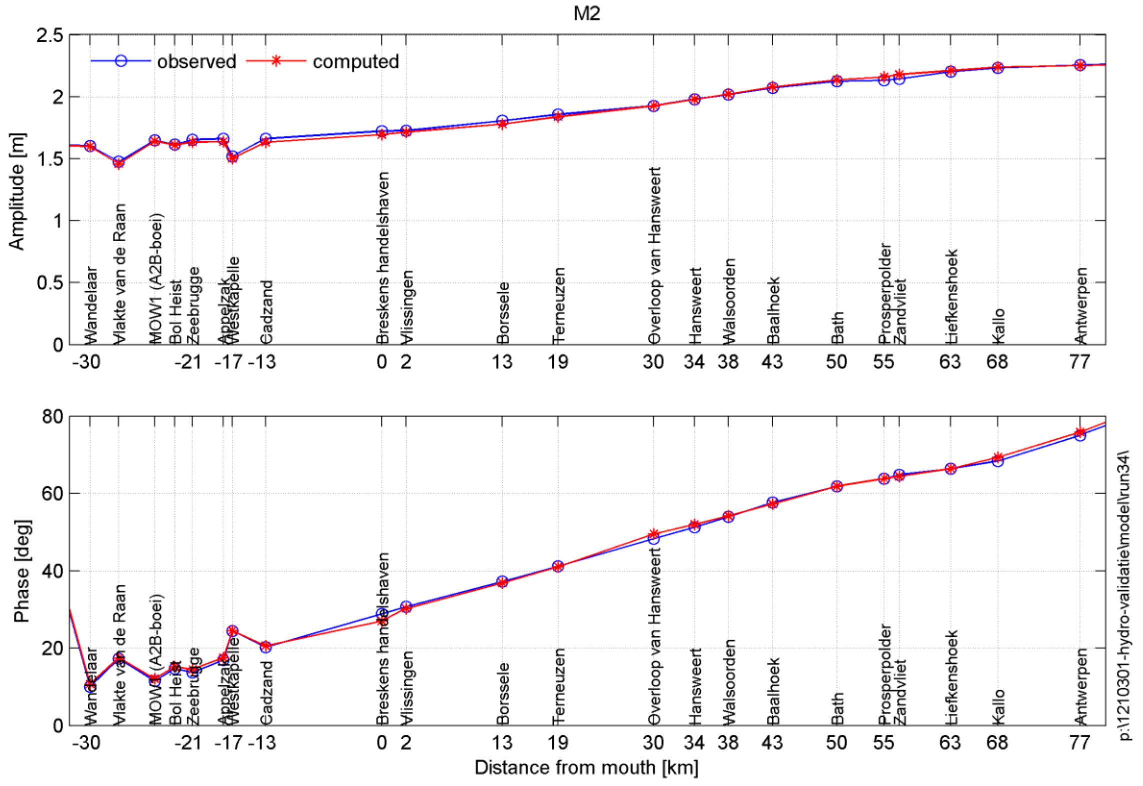
Traditional approach: suite of fit-for-purpose models

Depth-averaged (2DH) Delft3D model for large-scale hydro-morphodynamics

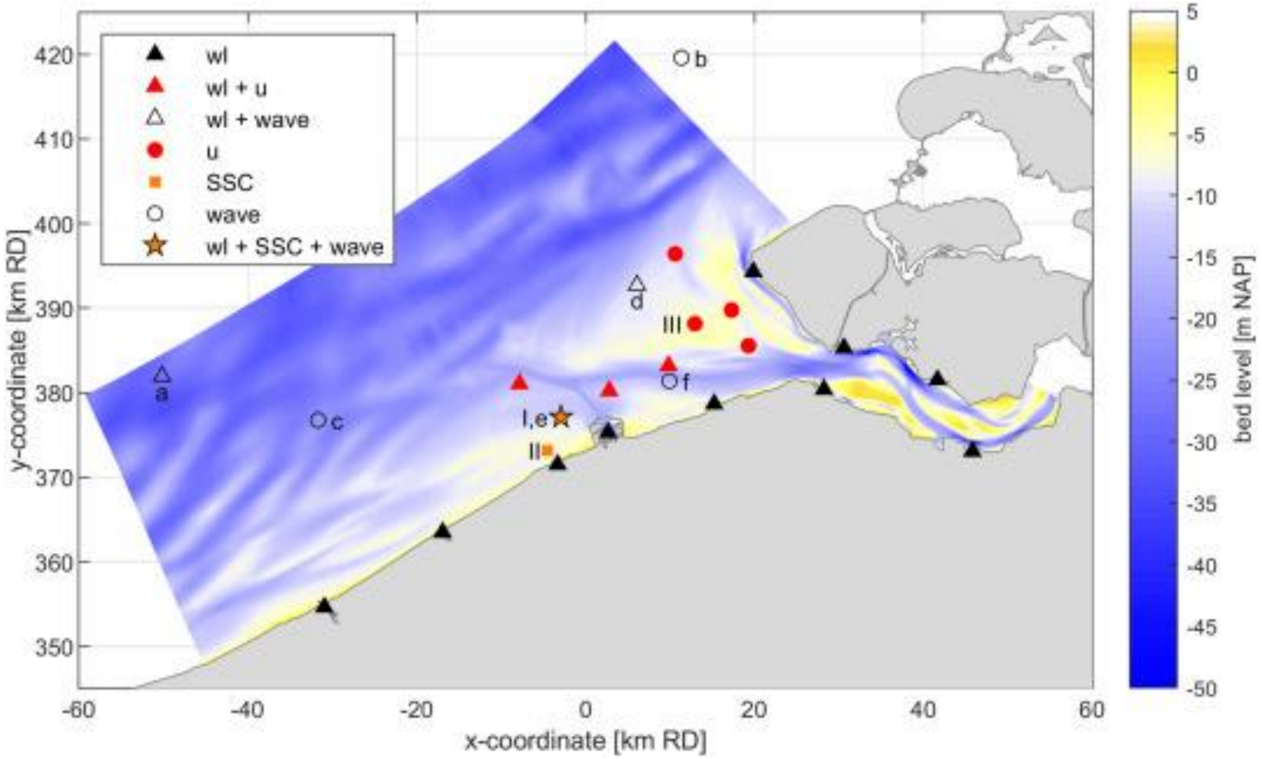


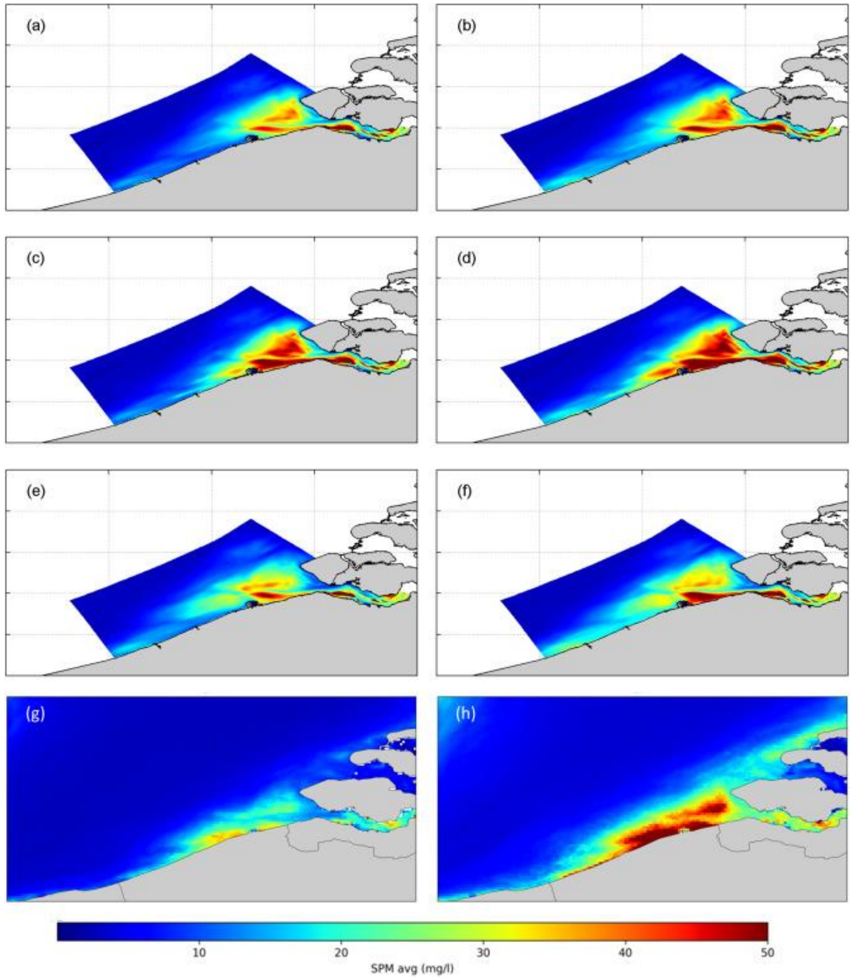


Van der Werf et al., 2020, https://doi.org/10.1016/j.csr.2019.104027

Traditional approach: suite of fit-for-purpose models

Detailed 3D model for short-term sediment dynamics near Port of Zeebrugge

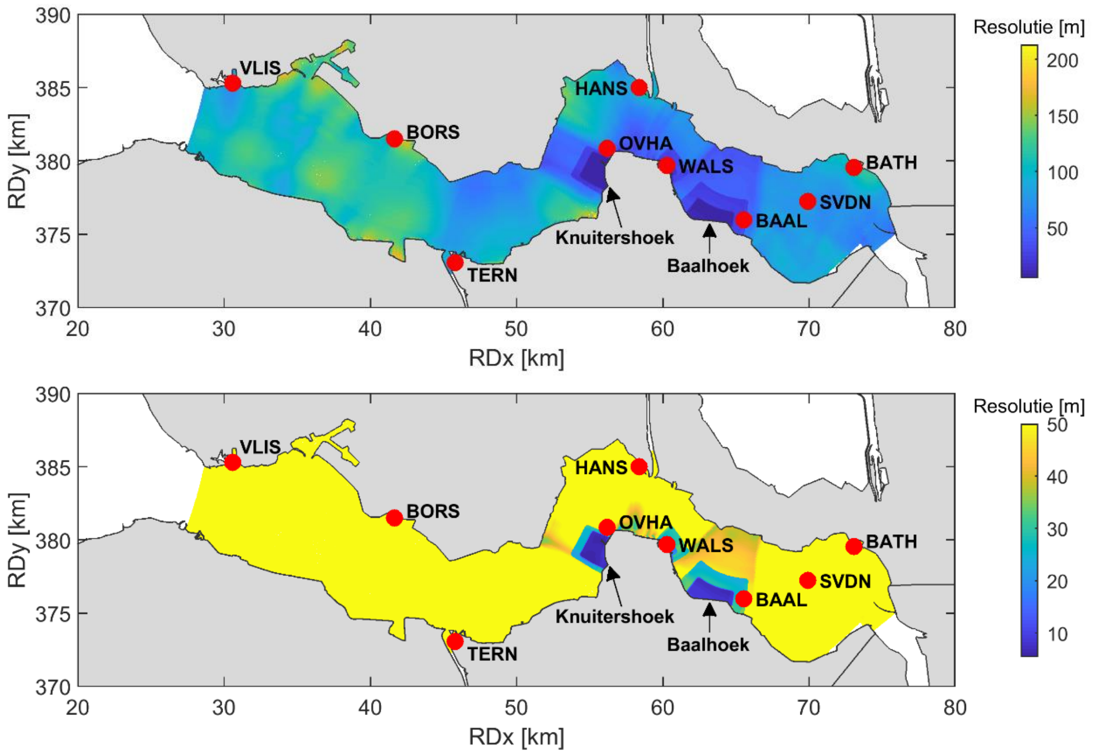




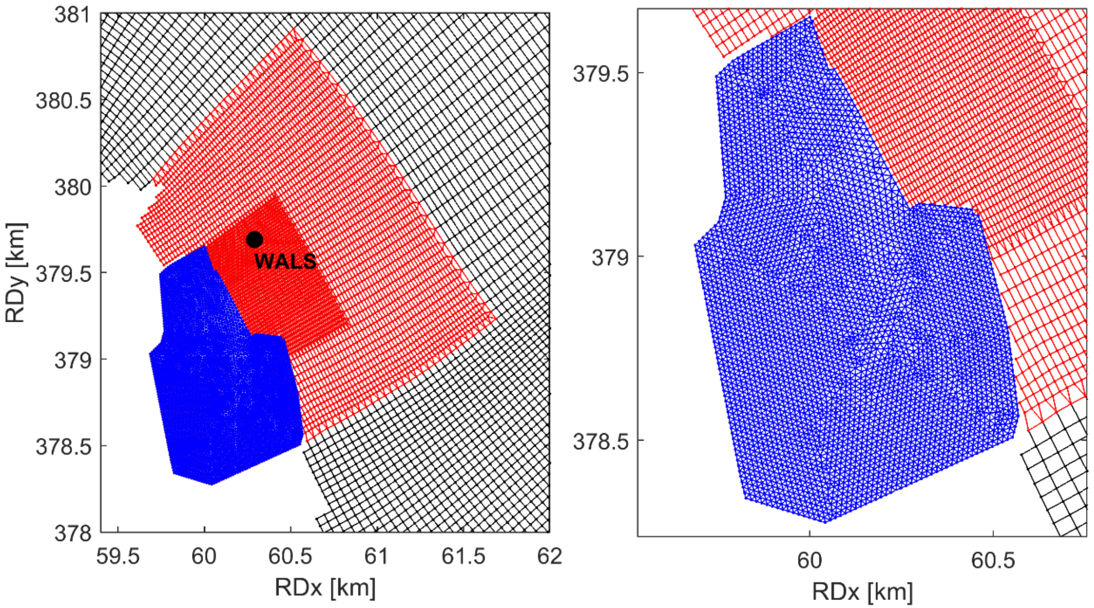
Van Maren et al., 2020, https://doi.org/10.1016/j.margeo.2020.106186

Future modeling: addressing the challenges

1. Flexible Mesh: easy local refining & faster computation
2. Fully coupled, long-term & large-scale sand-mud-morphodynamics



Intertidal area Western Scheldt: in 3 steps from rectangular grid with resolution ~100 m to triangular grid with resolution ~15 m



Laboratori d'Enginyeria Marítima
UPC - BARCELONATECH

CIIRC
Centre Internacional d'Investigació dels Recursos Costaners

Reliable Simulations

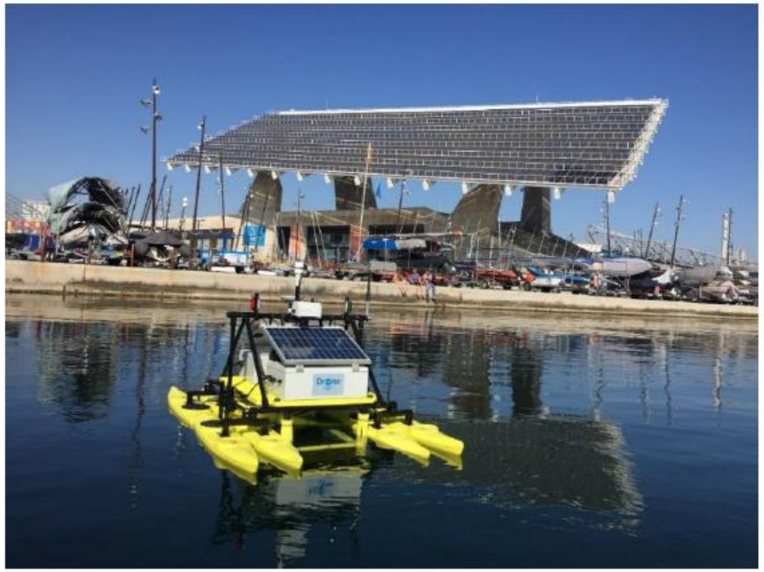
Risk management
Natural solutions

A. Sanchez-Arcilla, V. Gracia, M. Mestres, M. Espino, X. Sanchez

(agustin.arcilla@upc.edu)

- Illustrative Cases (Med coast)
  Pressures, conflicts & solutions
- Limitations of simulations
  Models, boundaries, errors
- Challenges and future work

Objective: Reliable downscaling for present decisions and future planning
Novelty: Bathymetric up-dating and error control considering sand budget (BC)



Model performance under extreme conditions

- Large topo-bathymetric response
- Models outside calibration range
- Non-linear evolution (predictability?)

Med storm Gloria (Jan 2020)

Up to **15 m/s**

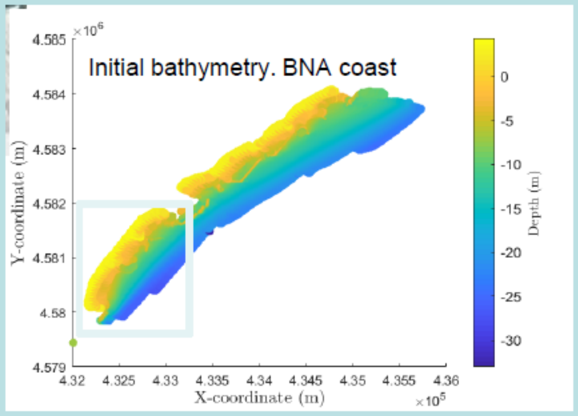
Up to **8m** H_s
& to **12m** H_{max}

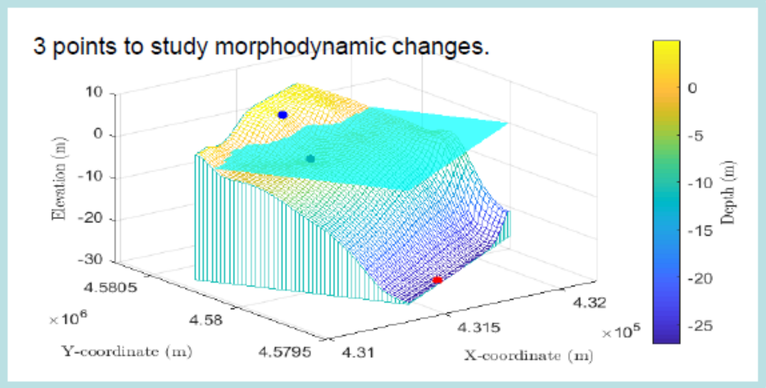
Progress: practical problems

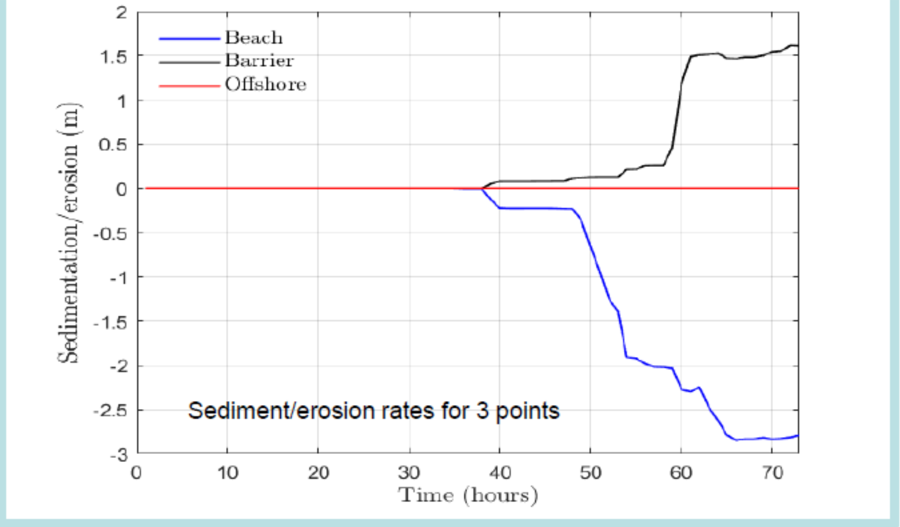
- Topo-bathymetry matching
- Errors from
  - Smoothing
  - Interpolation
  - Gradient response…
- Explicit error
  - Inversely prop. to Δx
  - Directly prop. to Δt

	10x10	50x50	100x100
1 hour	0.2296	$3.8789 * 10^{-5}$	$3.7645 * 10^{-5}$
1 day	1.6671	$1.6868 * 10^{-4}$	0
3 days	5.0685	0.0439	0

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y_i})^2$$

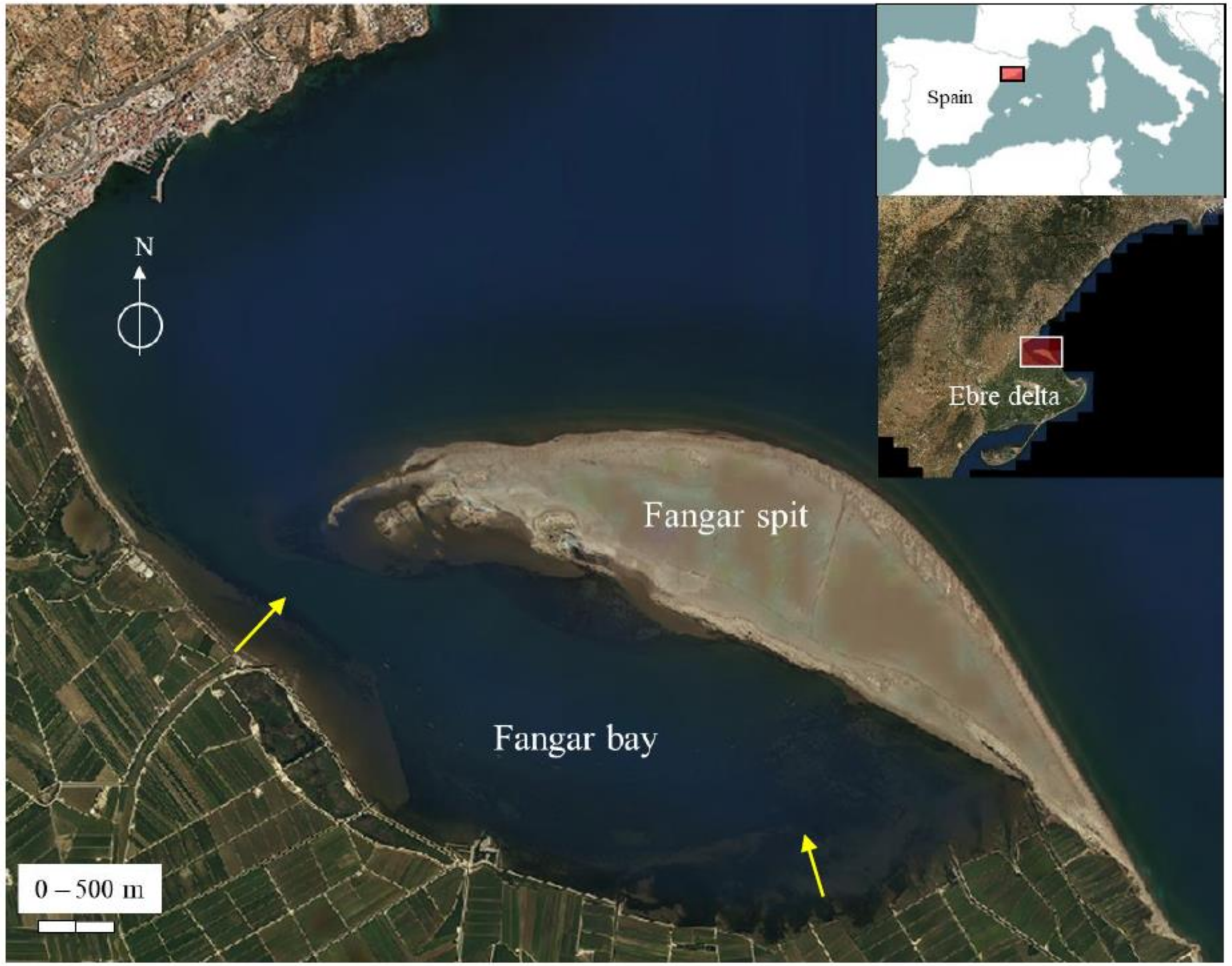






Some Challenges: Quantify sustainability with/out NBS
Bay economic activities: support to proactive management

- Different land discharges based on yearly estimates + observations (partial)
- Minimum estimate for 2 channels (2 x 7.5 m^3/s)
- Maximum estimate for 2 channels (2 x 10 m^3/s)

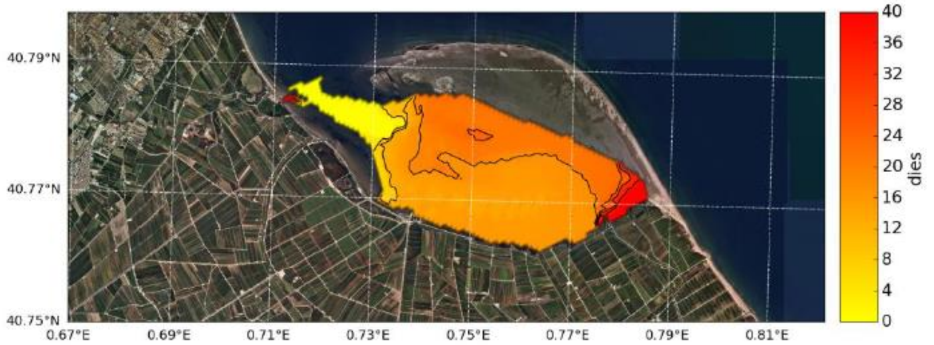


- Coastal lagoon
- 6 km long x 2 km wide

Bay entrance 1km
Bay max depth ≈ 4 m

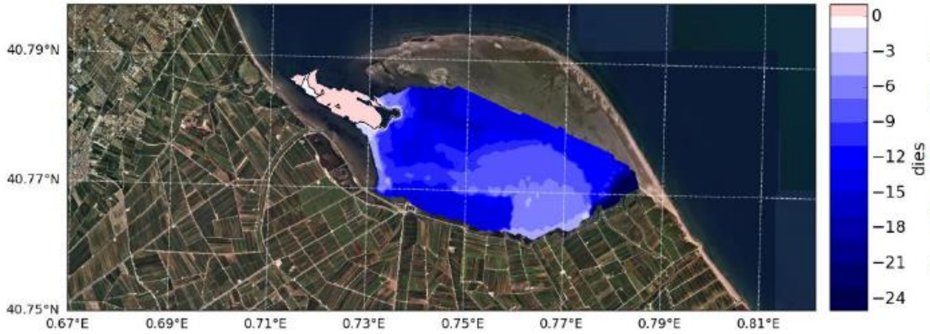
CMEMS driven

Controlled freshwater discharges + favourable winds vs local flushing times (LFT)



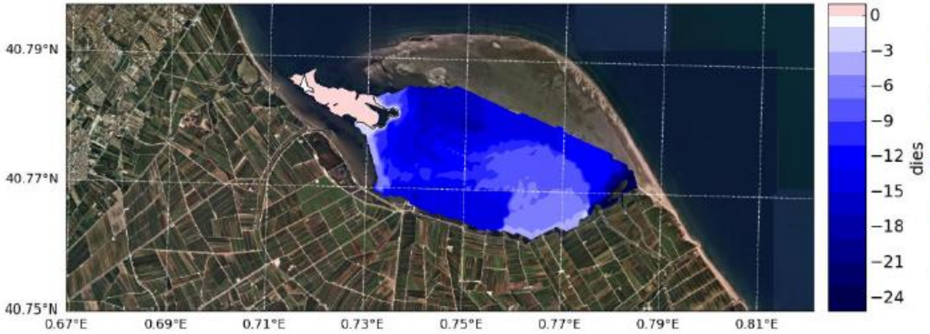
Vertically-averaged LFT for control case (current situation)

- Mean (LFT) = 16.5 days
- **Max (LFT) ≅ 40 days**



LFT variations case Q1 (**Q = 7.5 m³/s**) compared to control case

- Mean (LFT) = 6.25 days
- ***Max (LFT) ≅ 24 days***
- Mean (ΔLFT) ≅ 9 days reduction

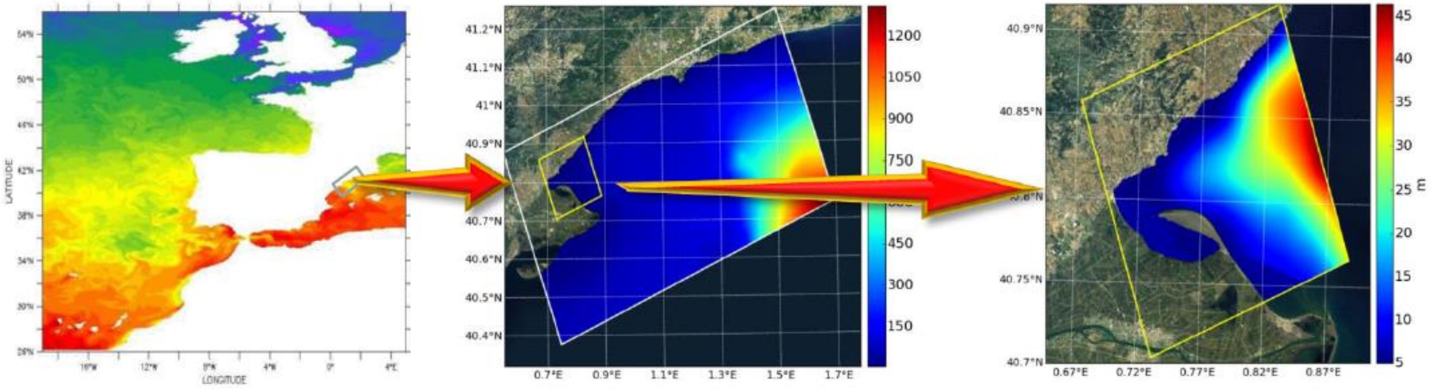


LFT variations case Q2 (**Q = 10 m³/s**) compared to control case

- Mean (LFT) = 5.7 days
- ***Max (LFT) ≅ 24 days***
- Mean (ΔLFT) ≅ 9 days reduction

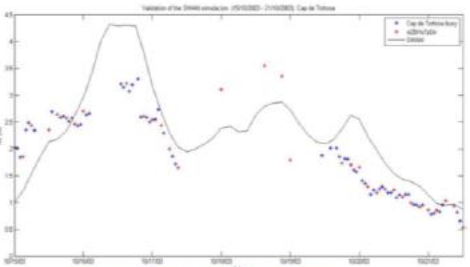
Deltaic bay sustainability: NBS
Limited energy (C footprint) and impact

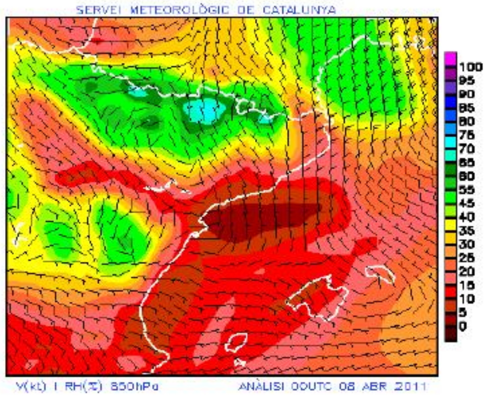
Future Work: Model nesting vs unstructured mesh
Combining satellite with in situ data (near the land-water border)
Limits in models (non-linear coupling) and data (Sentinel 2 topo-bathy)



Operational predictions

CMEMS driven





S2: Accretion ≈ 350m, Erosion ≈ 100m

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December 1st 2020

Towards a unified UGRID-NetCDF file format for flow simulations on unstructured grids

Aissa Sehili, Günther Lang and Julia Benndorf

BAW

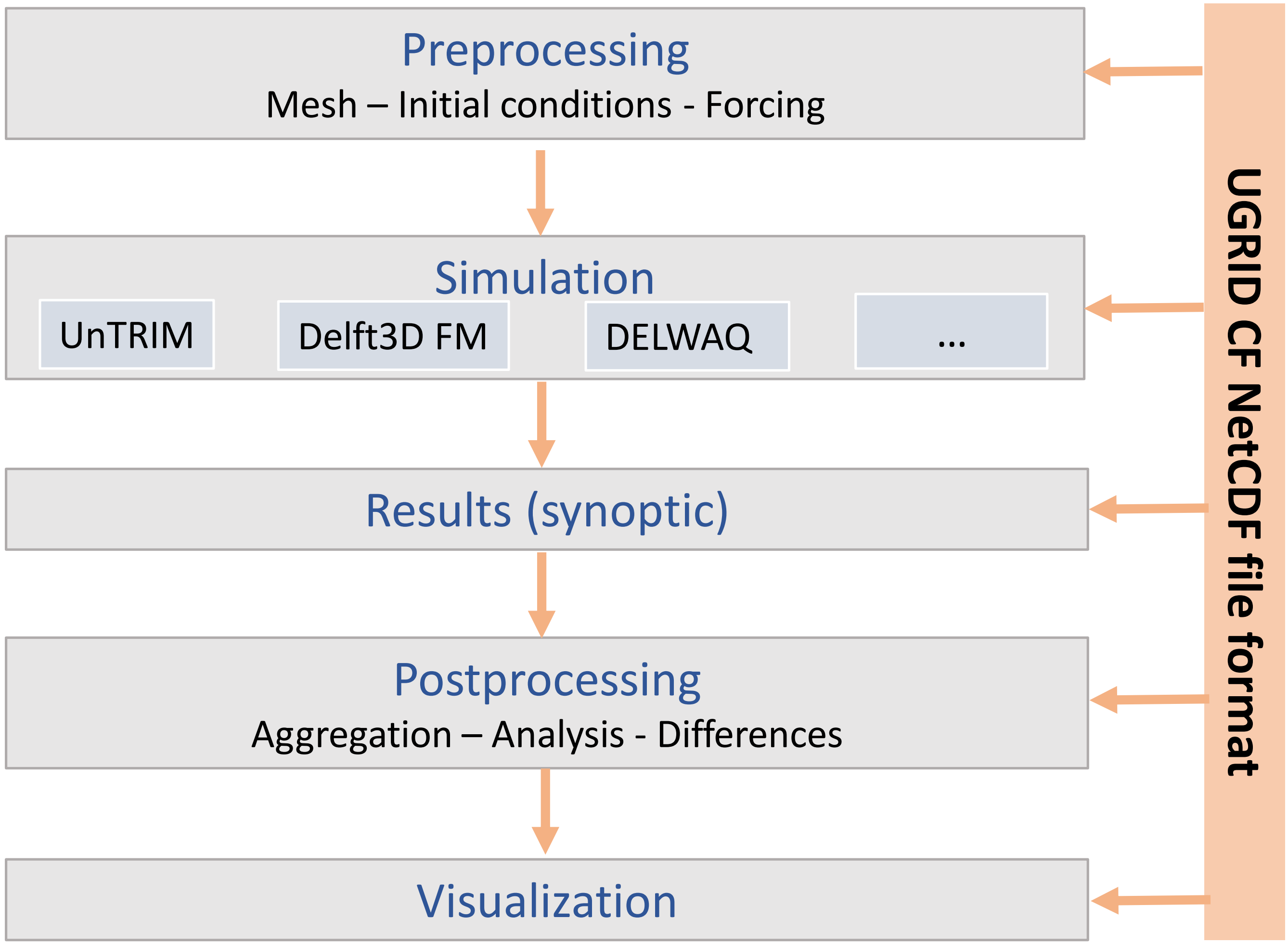
Federal Waterways Engineering and Research Institute

Background

Unstructured grids are widely used in ocean, coastal and estuarine modelling

Data exchange between models is still being a major bottleneck requiring in some cases considerable effort

Interpolation of imported data between edges, nodes and faces is common resulting in non-negligible accuracy loss



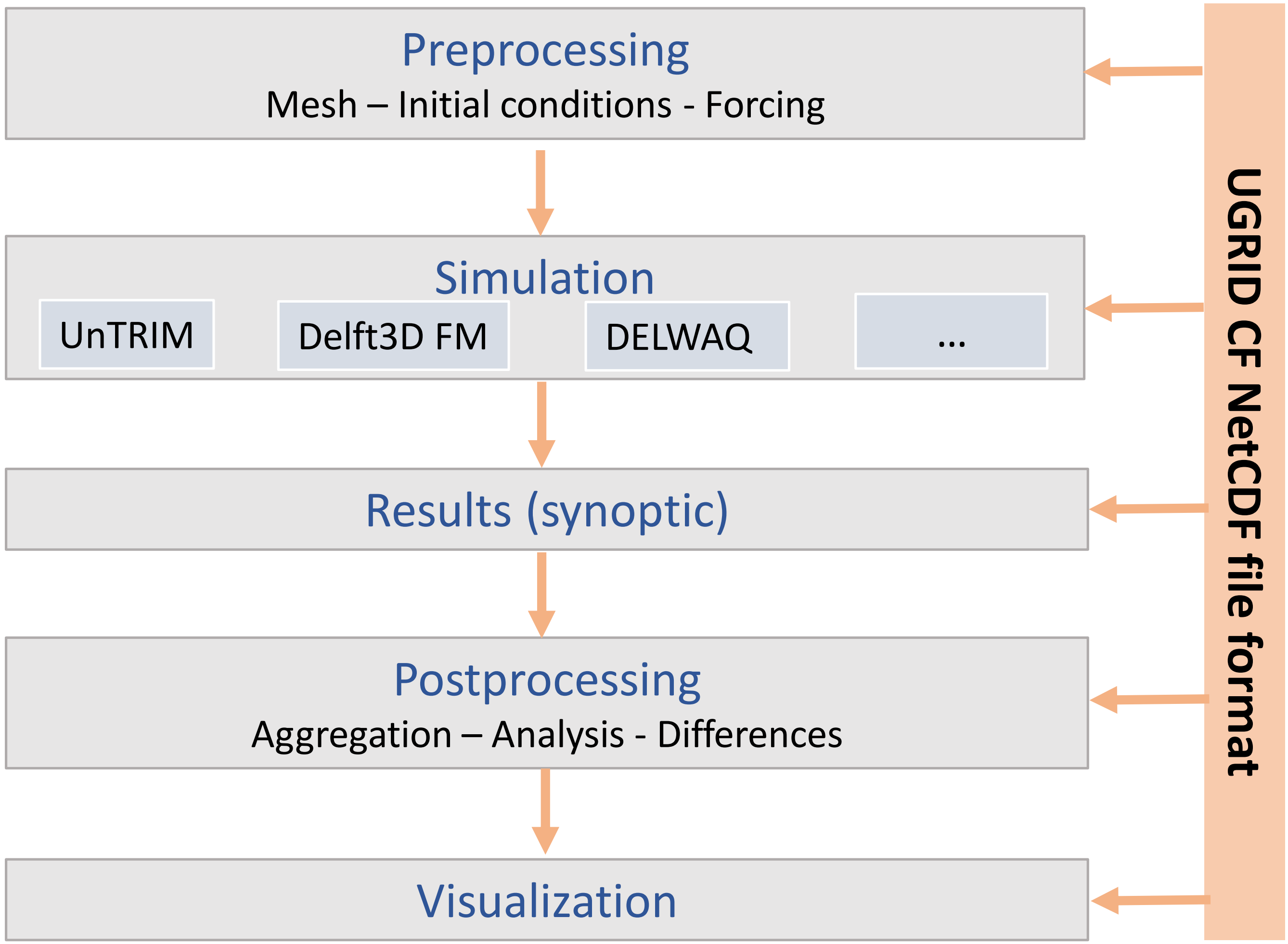
Background

Need for a file format based on cross-platform standards that is safe, robust and flexible allowing data handling at Postprocessing level

NetCDF is a well established and freely available cross-platform API

The CF (Climate and Forecast) conventions metadata provide standards for the description of NetCDF data and is widely used in the ocean and atmospheric modelling community

UGRID can be regarded as an extension to CF ready made for use with unstructured grids like UnTRIM grids



Objective and goal of activity

Why UGRID CF NetCDF?

Safe use of dimensional data thanks CF canonical units
→ attribute “units”

Safe data transformation (e.g. intensive to extensive variables)
→ attribute “cell_methods”

Filtering based on number of data (easy tidal analysis)
→ attribute “ancillary_variables” + attribute “standard_name = number_of_observations”

Keep track of data processing activities
→ attribute “history”

Visualization of data at their original locations

Progress and results

The German Bight Operational Model.
Operational data communication between DFlow FM (Deltares) and UnTRIM (BAW)

UGRID-NETCDF GRID

⇩

DCSM FM (Deltares) Forcing

⇨

UGRID-NETCDF Output (HIS or MAP)

⇩

UGRID-NETCDF BAW-Postprocessing

UGRID-NETCDF GRID

⇩

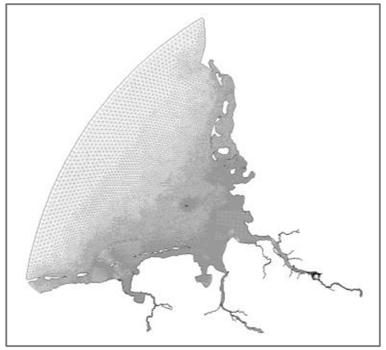
GBOM (BAW) Operational Forecast

⇨

UGRID-NETCDF 2D/3D (loc,sec,area)

⇩

UGRID-NETCDF BAW-Postprocessing



Progress and results

Tidal Characteristic Numbers of Water Level

float tnw_mean (TimePeriod, nFace) ;

:cell_methods = "TimePeriod: **mean** nFace: mean" ;

:ancillary_variables = “**tnw_number of events**" ;

int **tnw_number of events**(TimePeriod,nFace) ;

:units = “1" ;

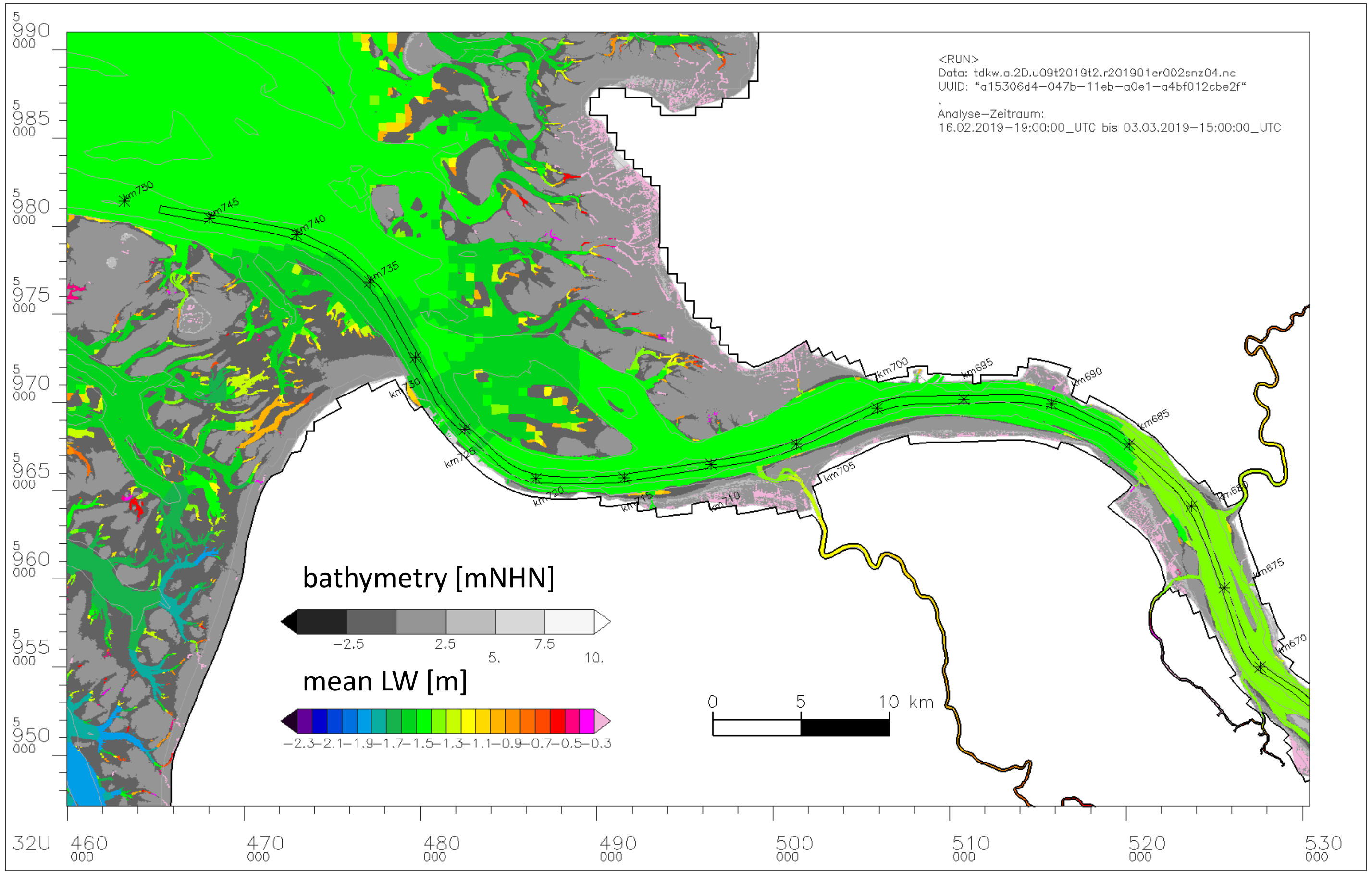
:standard_name = **number_of_observations**" ;

Remark: “number of observations” (NOO) can be used to modify visualization of results. E. g. results are shown

- *only for locations where all events were detected, or*
- *for locations where at a certain NOO. were detected,*
- *… and so on.*

https://wiki.baw.de/en/index.php/NCANALYSE

Mean tidal low water at Elbe Estuary for the period 16.02-03.03.2019 (28 tides)



Challenges and bottlenecks faced

Main challenges

Implementation of UGRID methods in low level libraries in a generic way
Problems and compatibility issues from pre-requisite libraries (e.g. HDF5, PETSC,…)

Ongoing

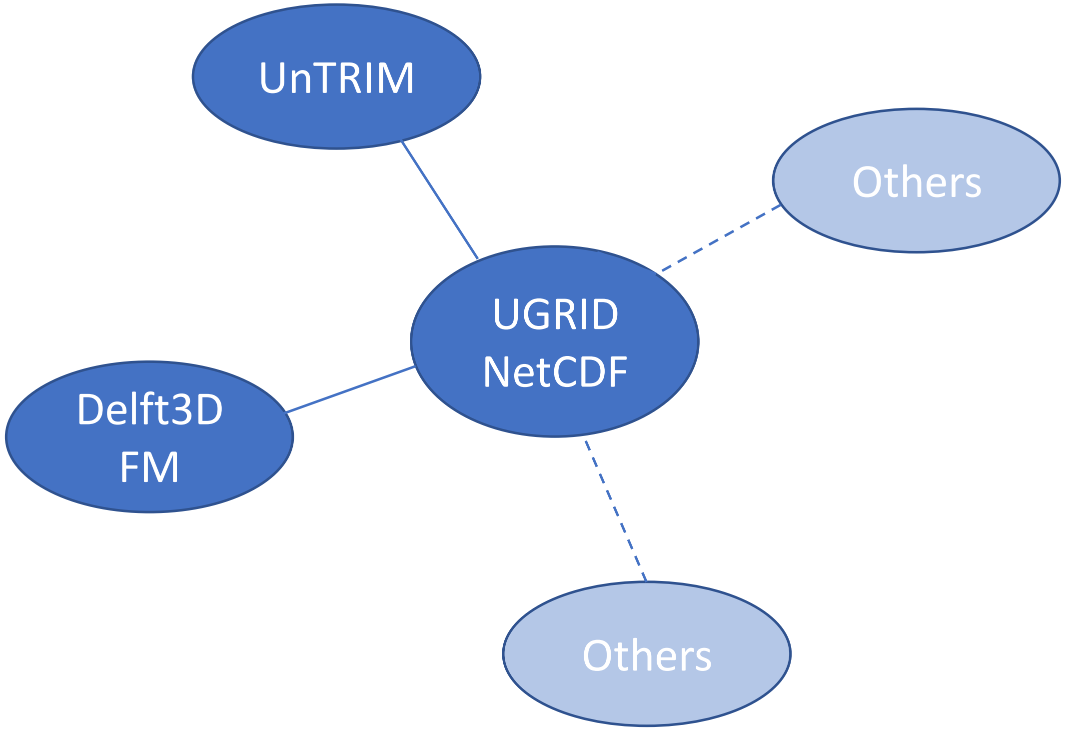
Joint project between Deltares and BAW to enhance DFlow FM outputs to the UGRID CF NetCDF standard used at BAW
DFlow FM NetCDF results should be processed without modification by BAW NC-Postprocessors

Striving to

Make UGRID extensions full part of the CF NetCDF conventions
Backward compatibility: Use of UnTRIM results as is in DFlow FM Simulations/Postprocessing

Proposed future work

Open for further collaboration with the aim of establishing UGRID CF NetCDF as a widely used standard for data exchange and processing of unstructured model results



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Post-processing of modelling data: tidal, harmonic and long-term analysis and aggregation

Julia Benndorf, Günther Lang, Aissa Sehili

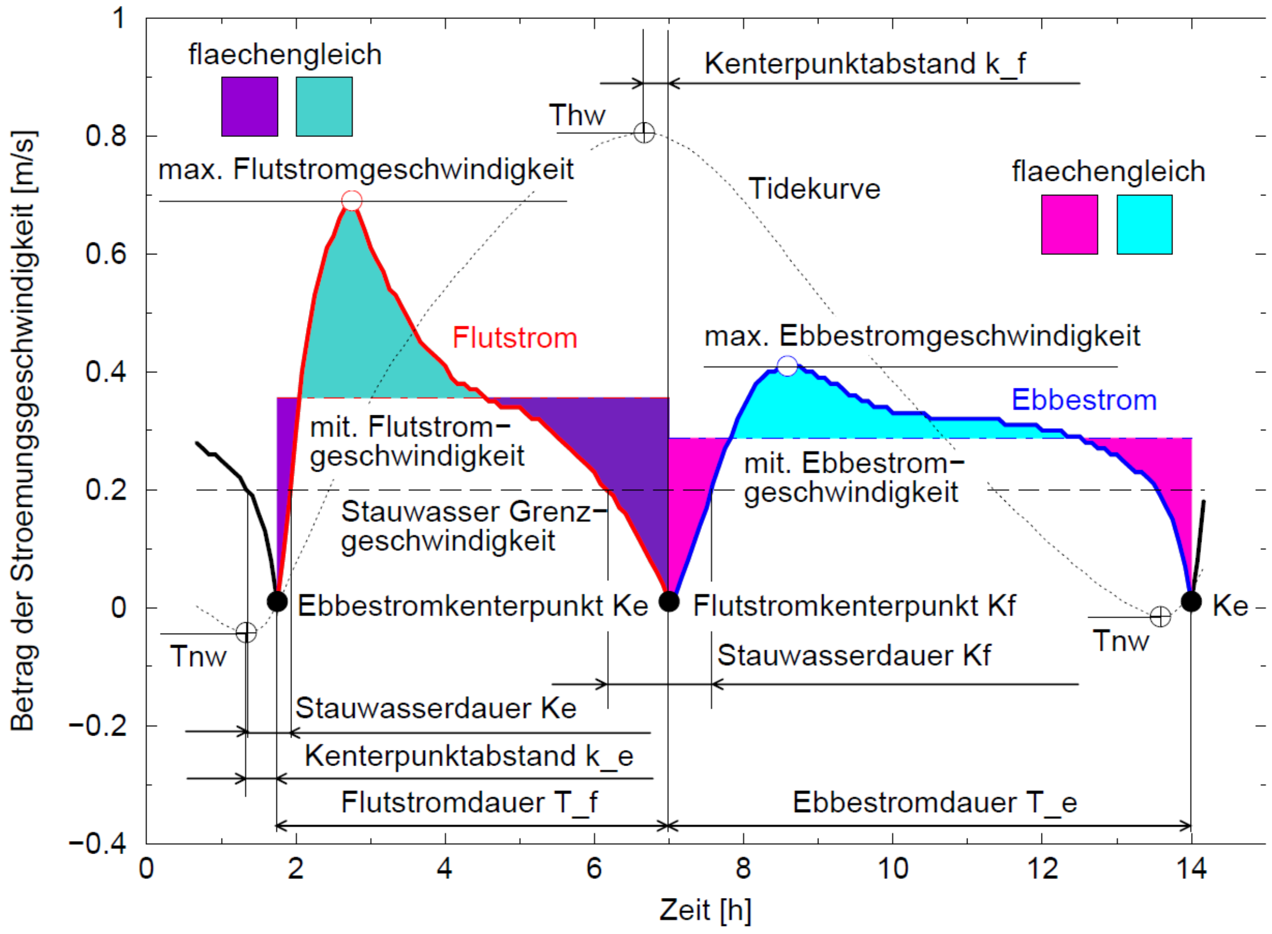
BAW
Federal Waterways Engineering
and Research Institute

Introduction and Objective

"For a **better understanding of natural processes** just watching them is normally by far not sufficient. It may be a much better approach to take, in a first step, some precise and objective measurements. Afterwards, with some characteristics of the processes in mind, different analyses may yield characteristic numbers for each of them."
(from https://wiki.baw.de/en/index.php/Elementary_Aspects_of_Data_Analyses)

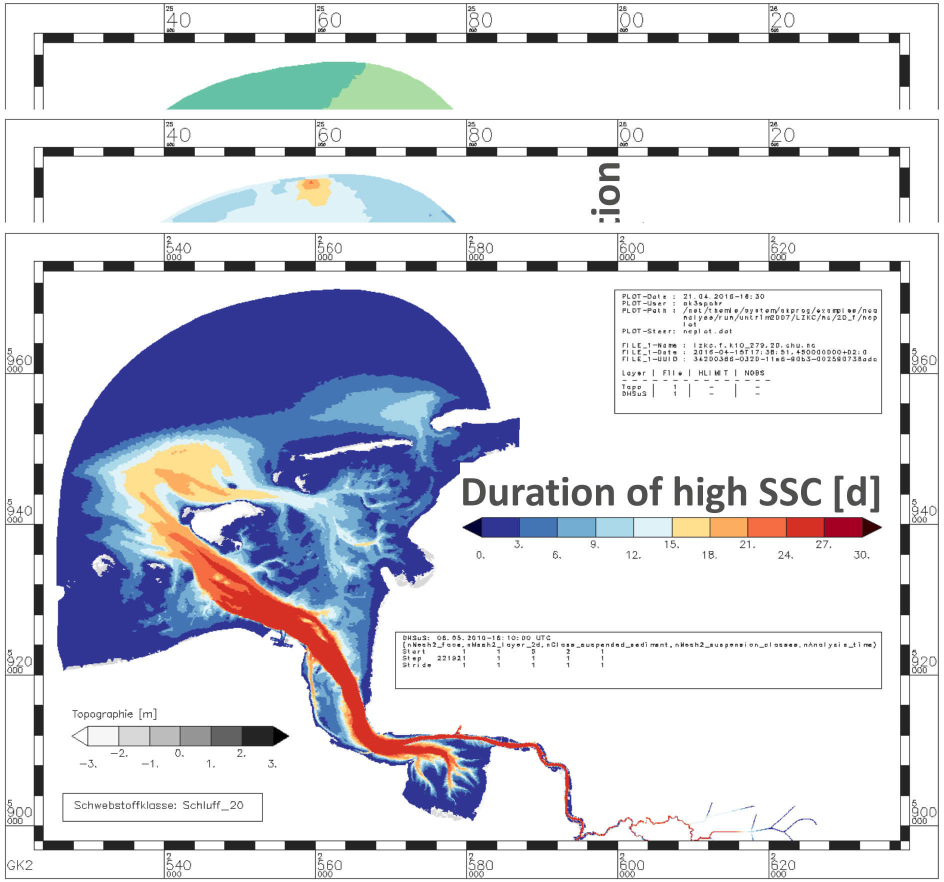
Reliable methods necessary in order to

- Analyse and aggregate large amounts of data from modelling (e.g. event-driven for tides)
- Compare data from different models or systems
- Describe changes in time and space



Progress and Results

UnTrim → (chunking) → analysis



Parameter	Tidal Analysis	Long-term Analysis	Harmonic Analysis	Tidal Transport Analysis	Long-term Transport Analysis
Water level	★	★	★		
Current velocity	★	★	★	★	★
Salt	★	★		★	★
Temperature	★	★		★	★
Suspended Sediment	★	★		★	★
Tracer	★	★		★	★
Oxygen		★			
Bedload	★	★			★
Effective bed shear stress	★	★			
Morphodynamics		★			
Energy					★

https://wiki.baw.de/en/index.php/Analysis_of_Calculated_Results

Progress and Results

UnTrim → (chunking) → aggregation → analysis

- Spacial aggregation for the analysis of mean/max/pecentiles within specific regions and transport between them
- Here: water-volume flux into and out of the Dollart area

(Note that there is a water level difference between begin and end time of aggregation, therefore the net water flux is not zero!)

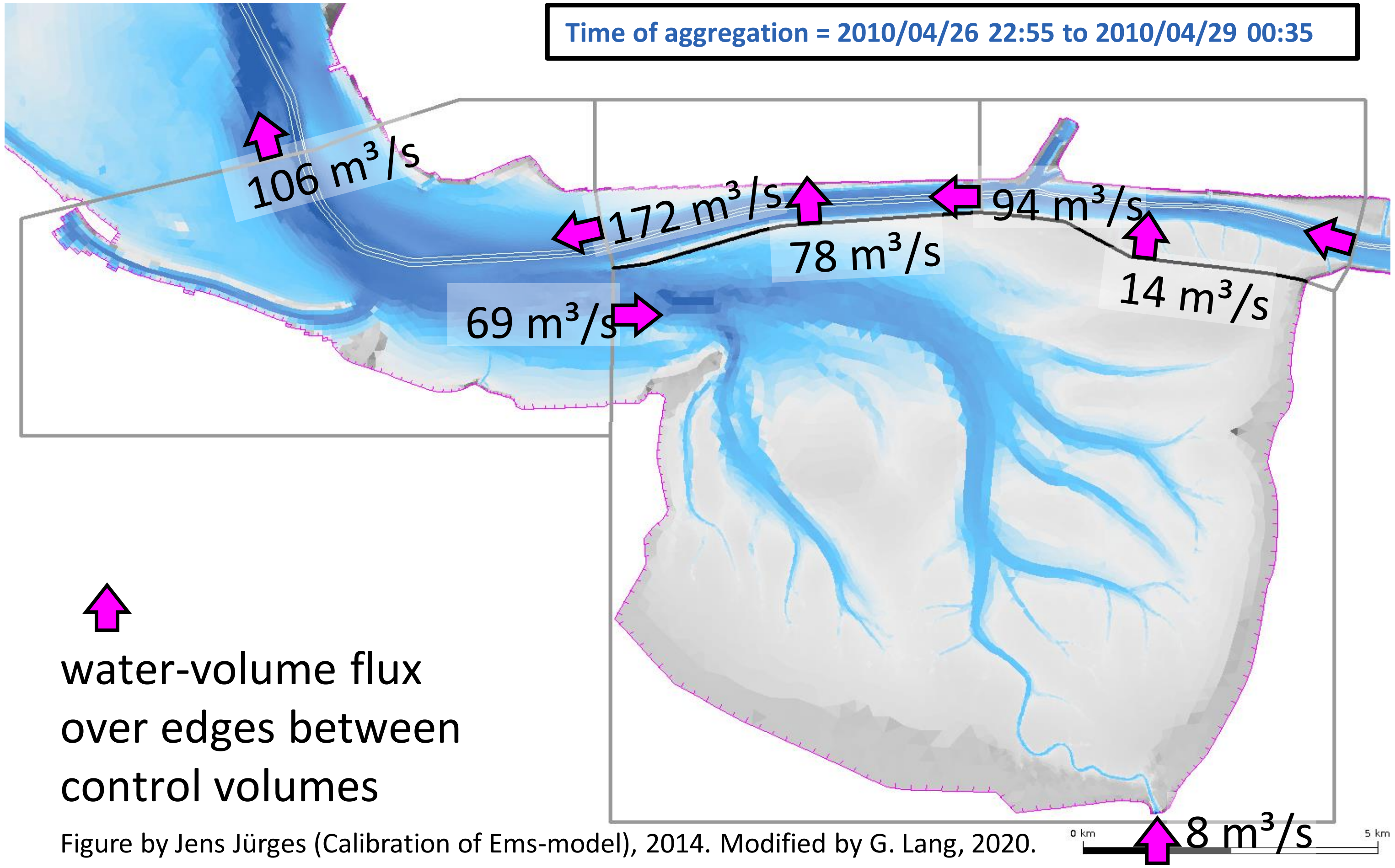


Figure by Jens Jürges (Calibration of Ems-model), 2014. Modified by G. Lang, 2020.

Challenges and bottlenecks faced

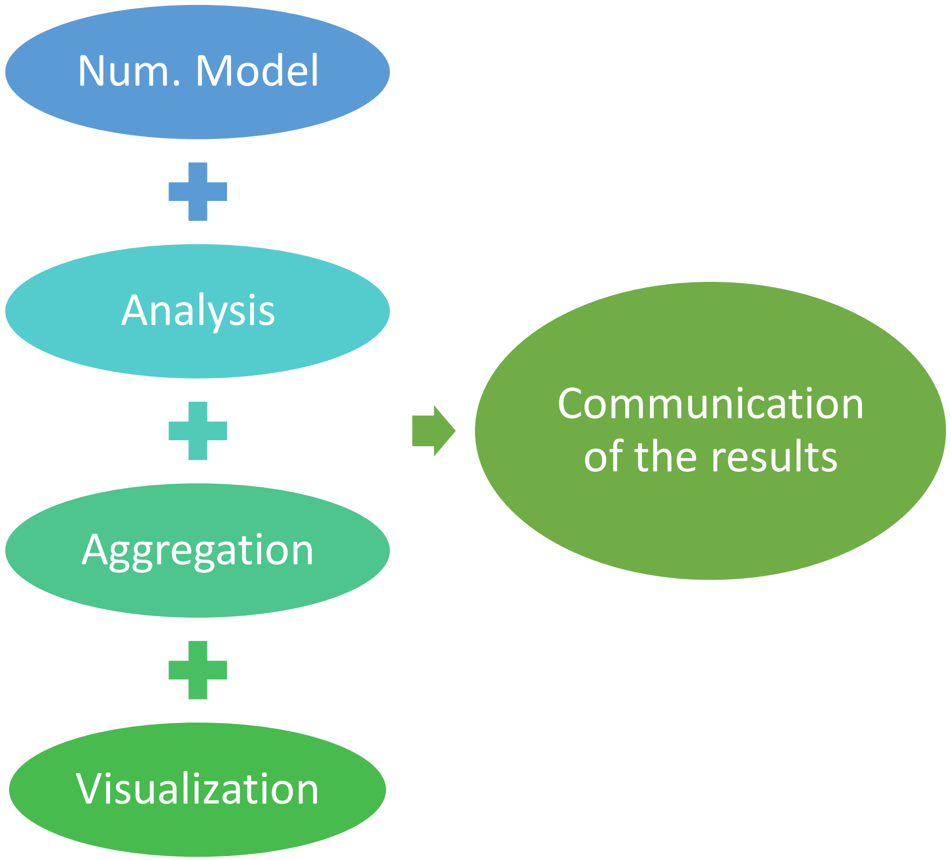
„During automatic calculation of various characteristic numbers several parameters must be properly chosen. Inadequate choice of parameters may result in either wrong results or failure of data analyses programs […]. In any case automatically calculated results shall be checked with respect to plausibility and consistence with underlying physical principles. “
(from https://wiki.baw.de/en/index.php/Parameters_for_Data_Analyses)

- Choice of adequate analysis time and reference points
- Communication of results
- Different post-processing methods lead to different results
- Quality control

Proposed future work

- Developments of standards for post-processing
- Validation and quality control of post-processing methods

- Open for discussion
- Participants in workpackage wanted!



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Modelling mercury dynamic in lagoons Coupling SHYFEM with MERC

Donata Melaku Canu, Ginevra Rosati

National Institute of Oceanography and Applied Geophysics -OGS

Introduction and background of activity being presented

- Mercury hot-spots in the Mediterranean and Black Sea
- Bioaccumulation and toxicity
- Cost of monitoring and measure
- Which is the relative contribute of the different processes characterising the Hg cycle at the hot-spot level? management support

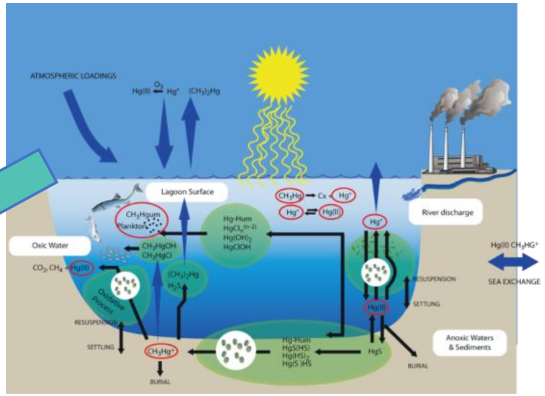
Objective and novelty of activity

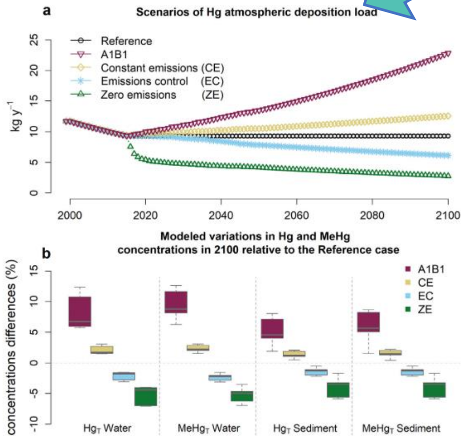
Objective:

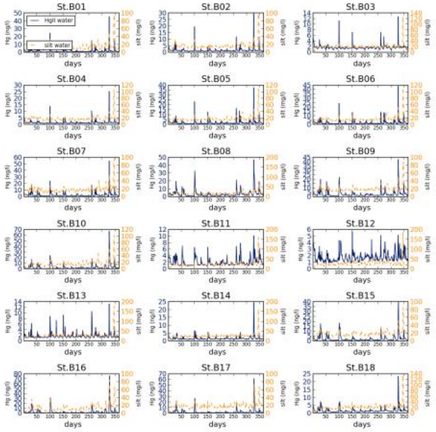
- Mercury cycle: biogeochemical model structure and implementation;
- Model results: HgII Hg0 and MeHg concentrations in water and sediment, and budgets
- Model scenarios

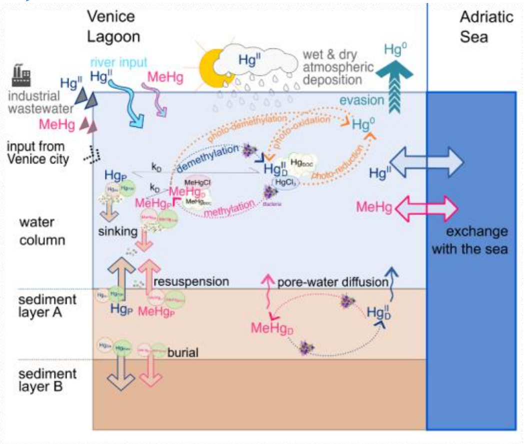
Novelty:

- Linking biogeochemical and transport processes in transitional systems
- Linking abiotic and biotic components
- Providing information on the potential harm for biota and human health (MeHg bioaccumulation through seafood consumption)









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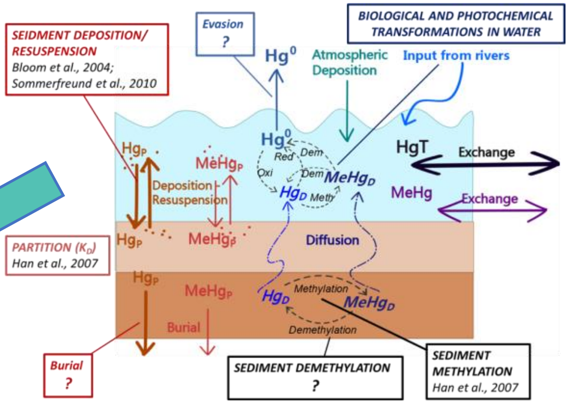
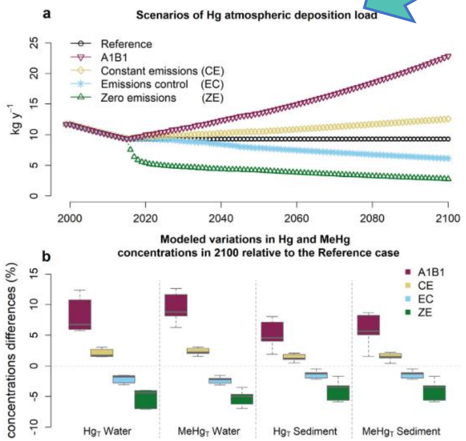
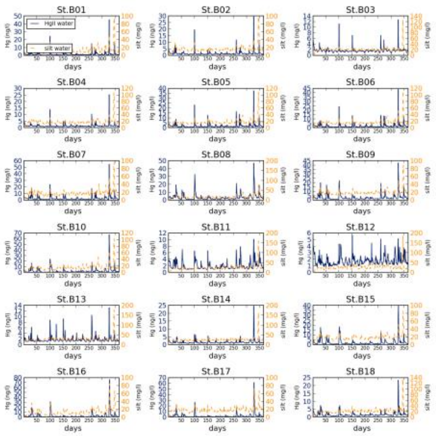
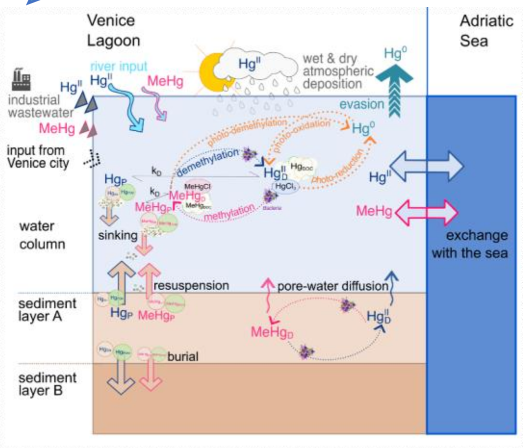






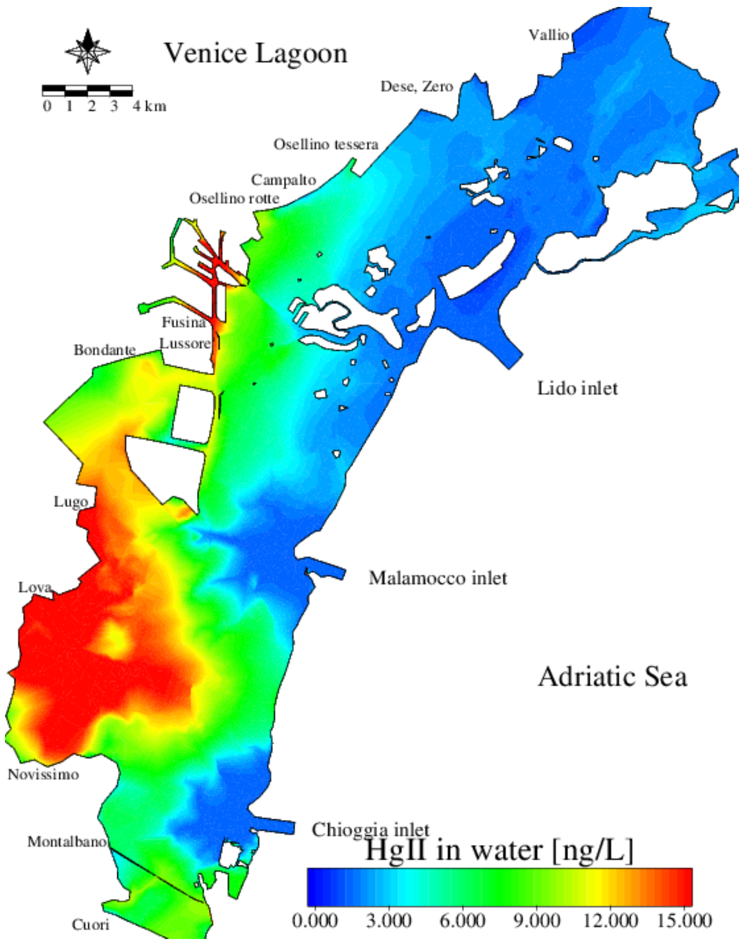


Progress and results

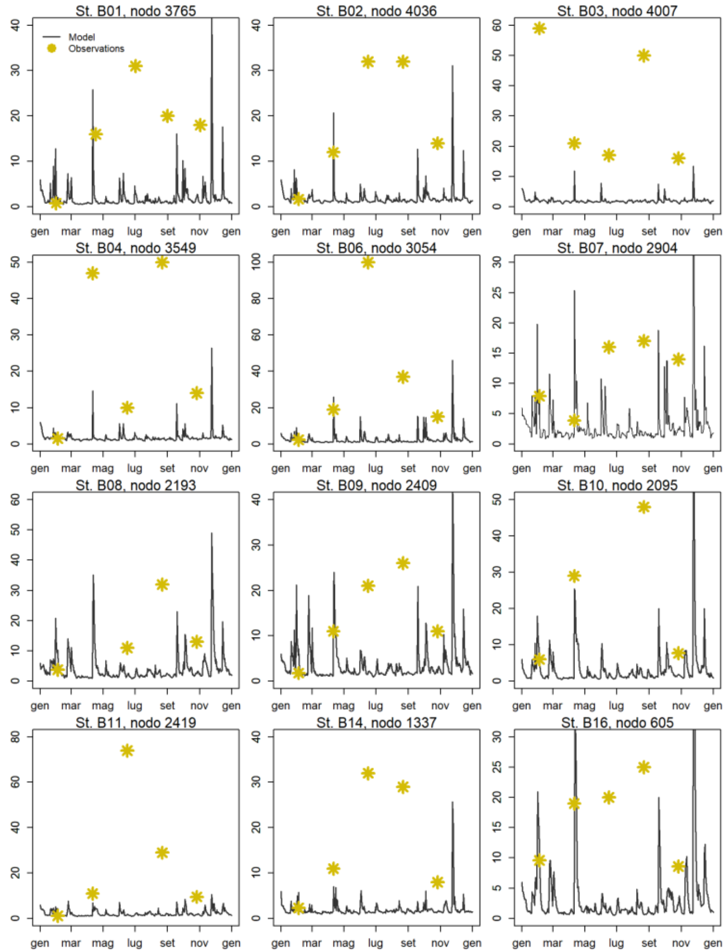
Coupling the Shyfem Model with a Hg module and a simple sediment transport module

** Data: Mela project (2005)*

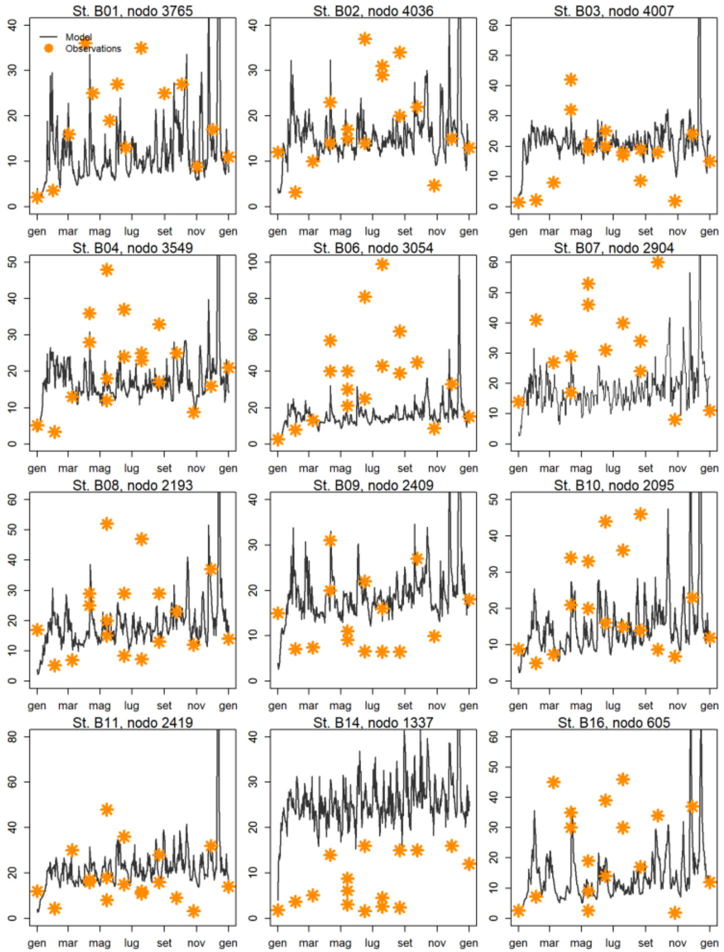
Water HgII concentrations



Water HgT concentrations



Suspended Particulate Matter

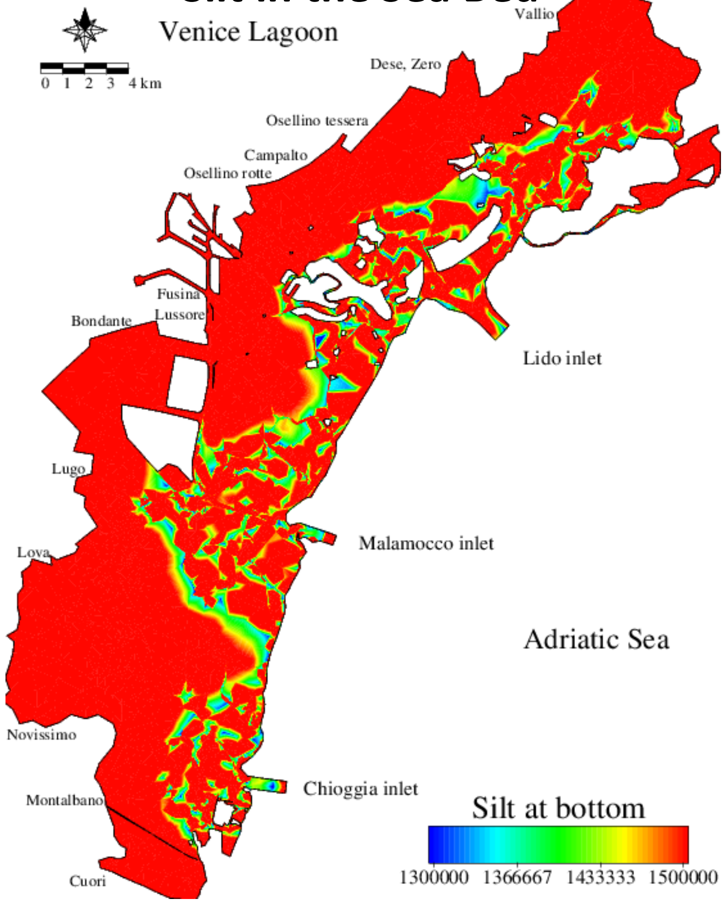


Progress and results

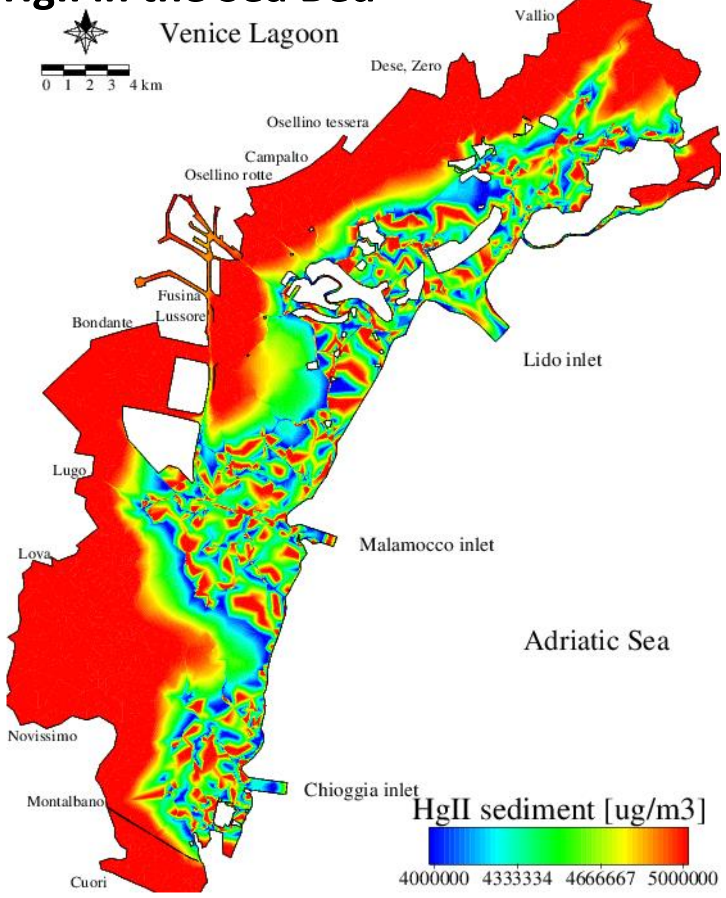
Coupling the Shyfem Model with a Hg module and a simple sediment transport module

December 2005 simulation

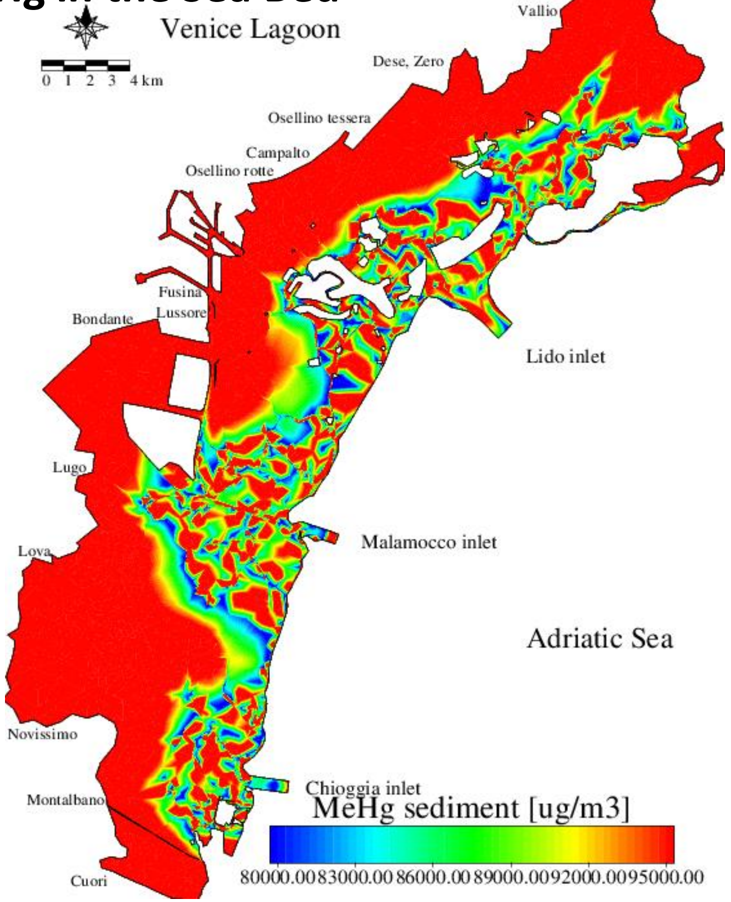
Silt in the Sea Bed



HgII in the Sea Bed

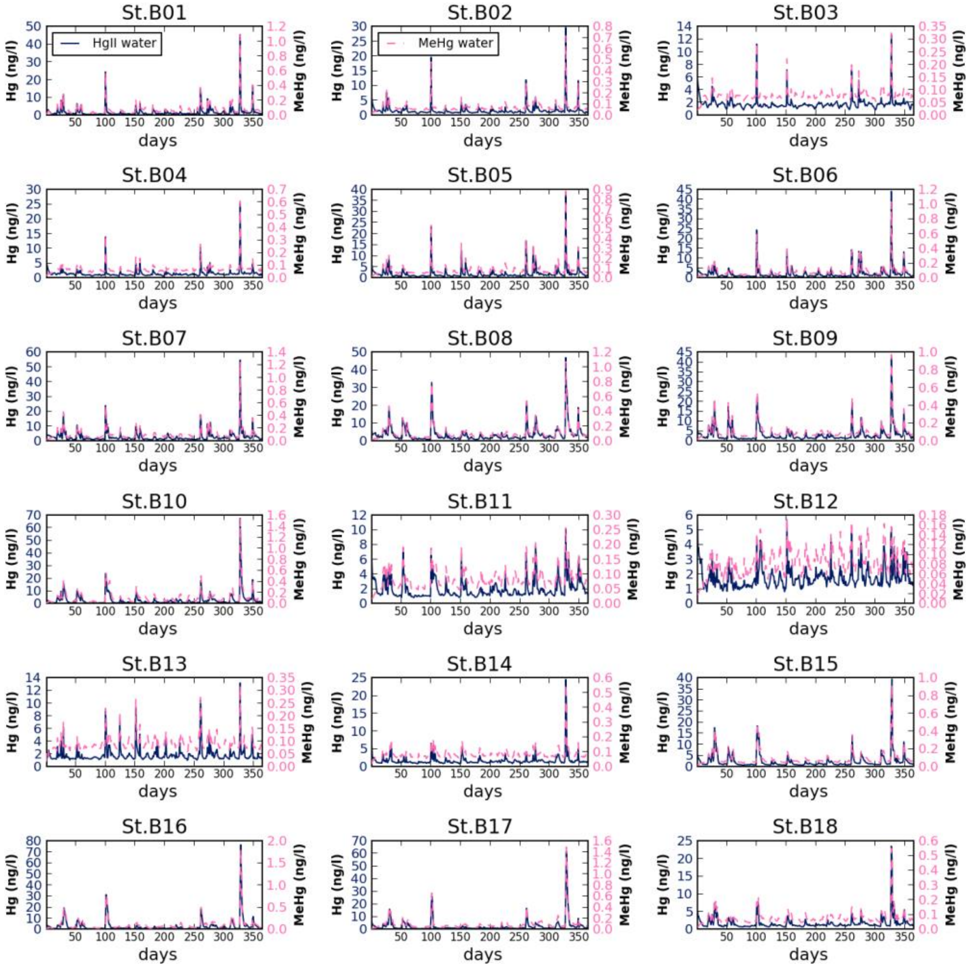


MeHg in the Sea Bed



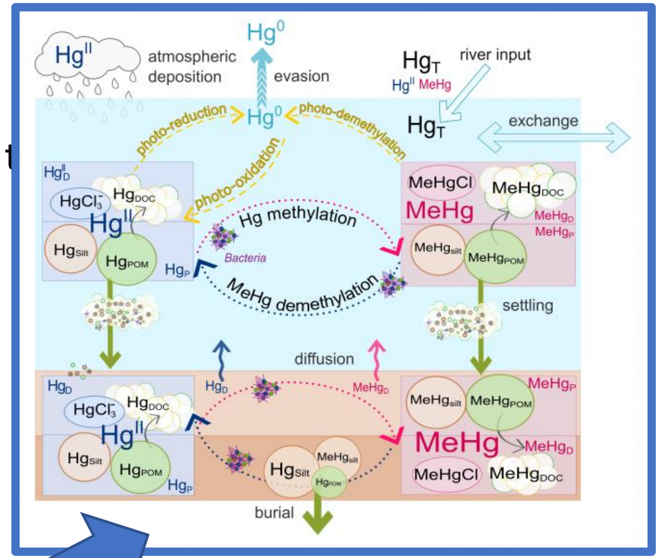
Challenges and bottlenecks faced

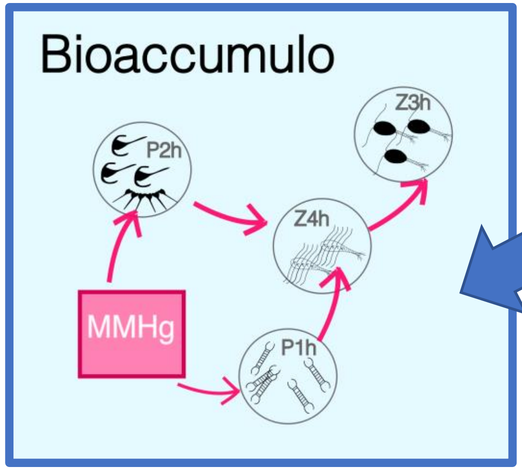
- Implementation, coupling and testing of two new modules (sediment module)
- Limited data availability for Hg species (e.g. MeHg concentrations)
- Uncertainities in the Hg cycle (e.g. transformation rates)
- High computational cost

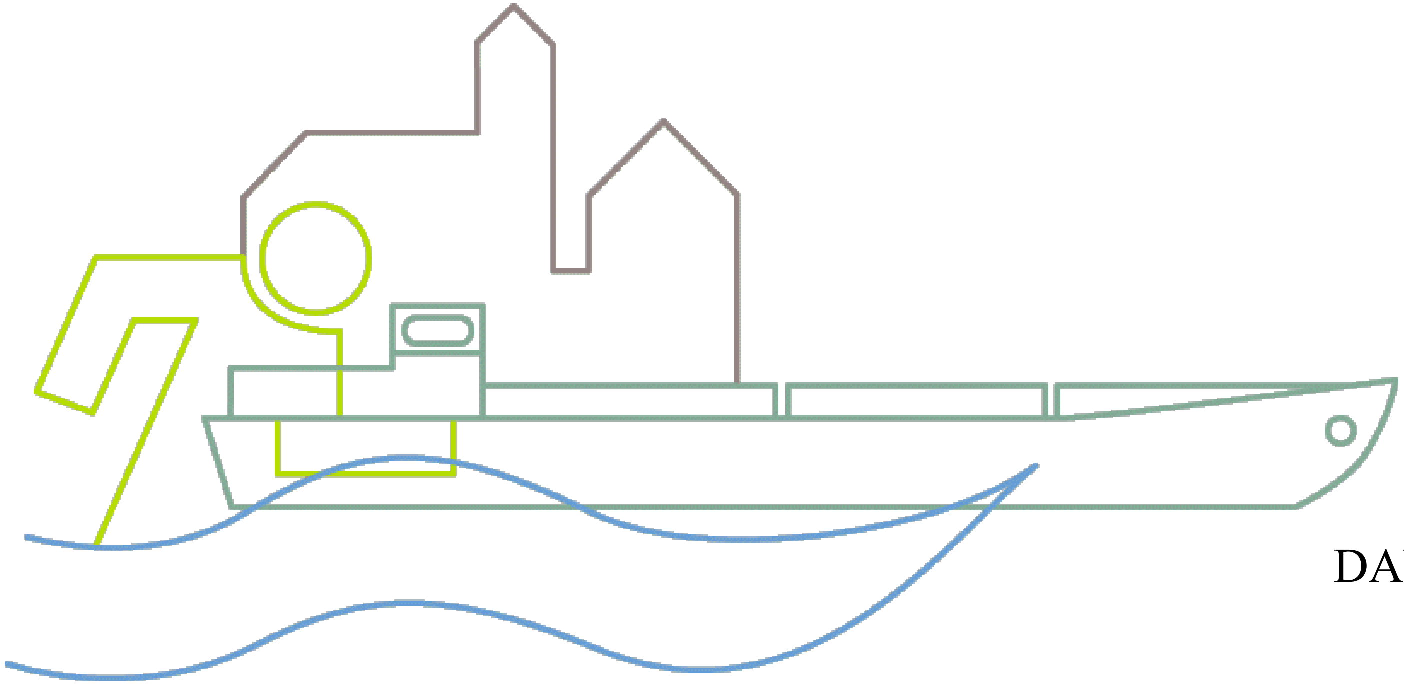


Proposed future work

- Dynamic coupling with biological processes (e.g. bacterial POM remineralization)
- Adding bioaccumulation process for plankton (high variability across ecosystems, major driver t concentrations)
- Dynamic coupling with the atmosphere
- Sediment diagenesis to improve benthic flux (?)







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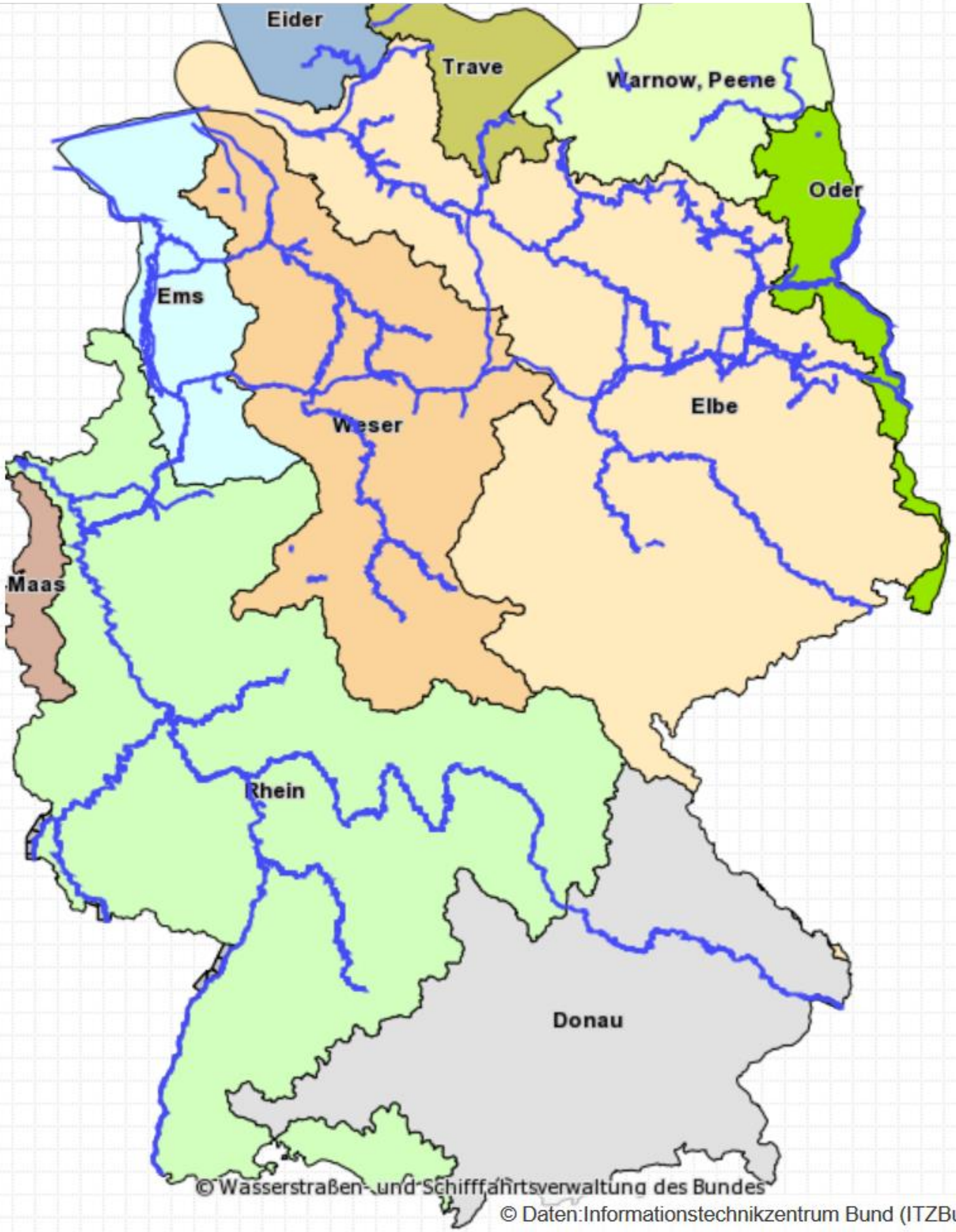
Modelling Water Quality in German Waterways

Jens Wyrwa
German Federal Institute of Hydrology , Koblenz
Department of Microbiol Ecology
Wyrwa@bafg.de

german waterways



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QSim

since 1979 **oxygen deficits** main question

application to nearly all navigable rivers in Germany

deterministic model, main components:

❖ primary production of organic carbon (algae)
❖ mineralisation of organic carbon by bacteria

- second trophic level, algae consumtion
- balances of potentially limiting nutrients (N, P, Si)
- temperature, light, surface aeration

https://www.bafg.de/DE/08_Ref/U2/01_mikrobiologie/QSIM/qsim_node.html

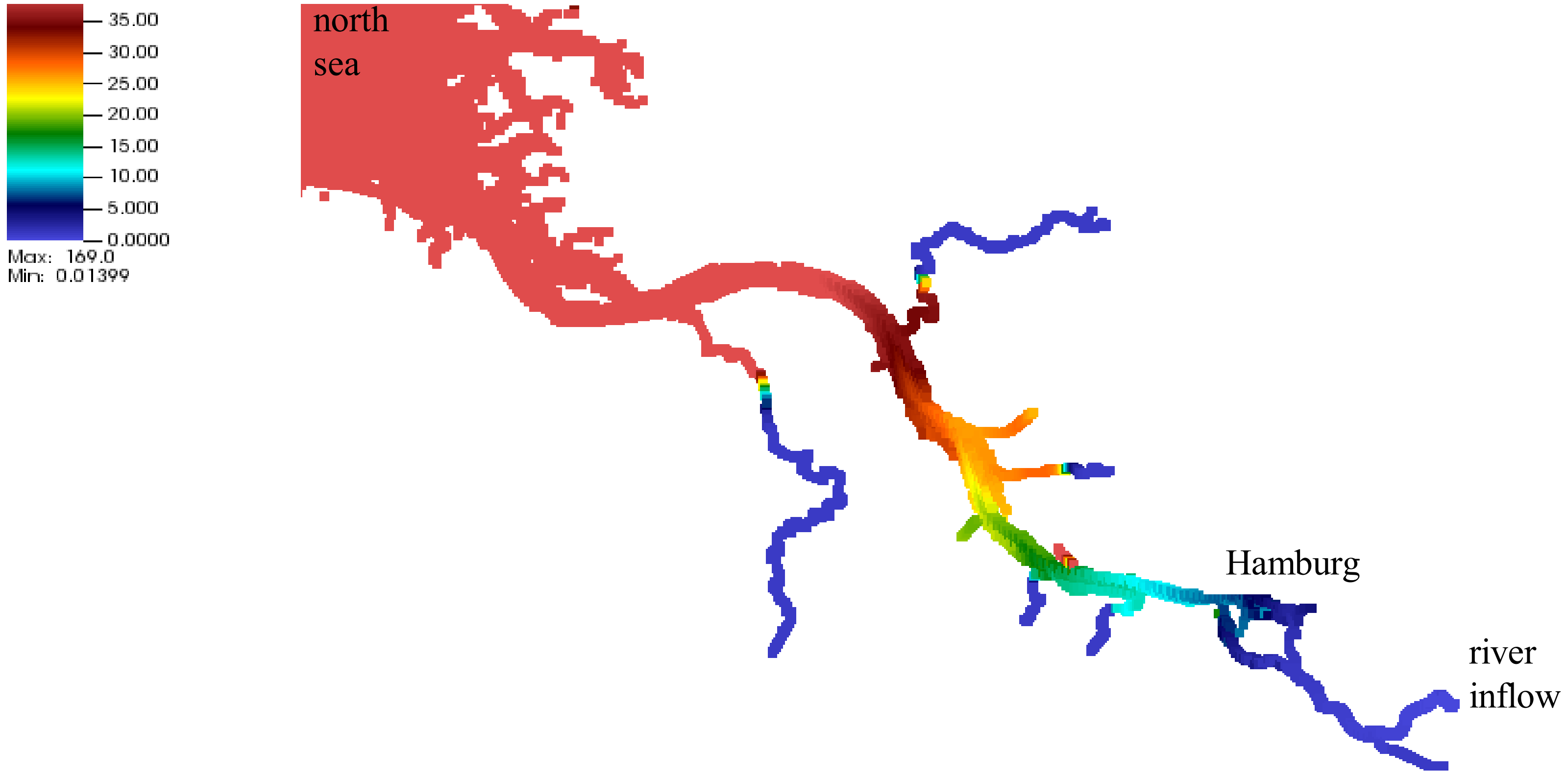
QSim used for:
large german rivers

specific:

- climat conditions
- fresh water
- retentions time
  2 days … 2 months

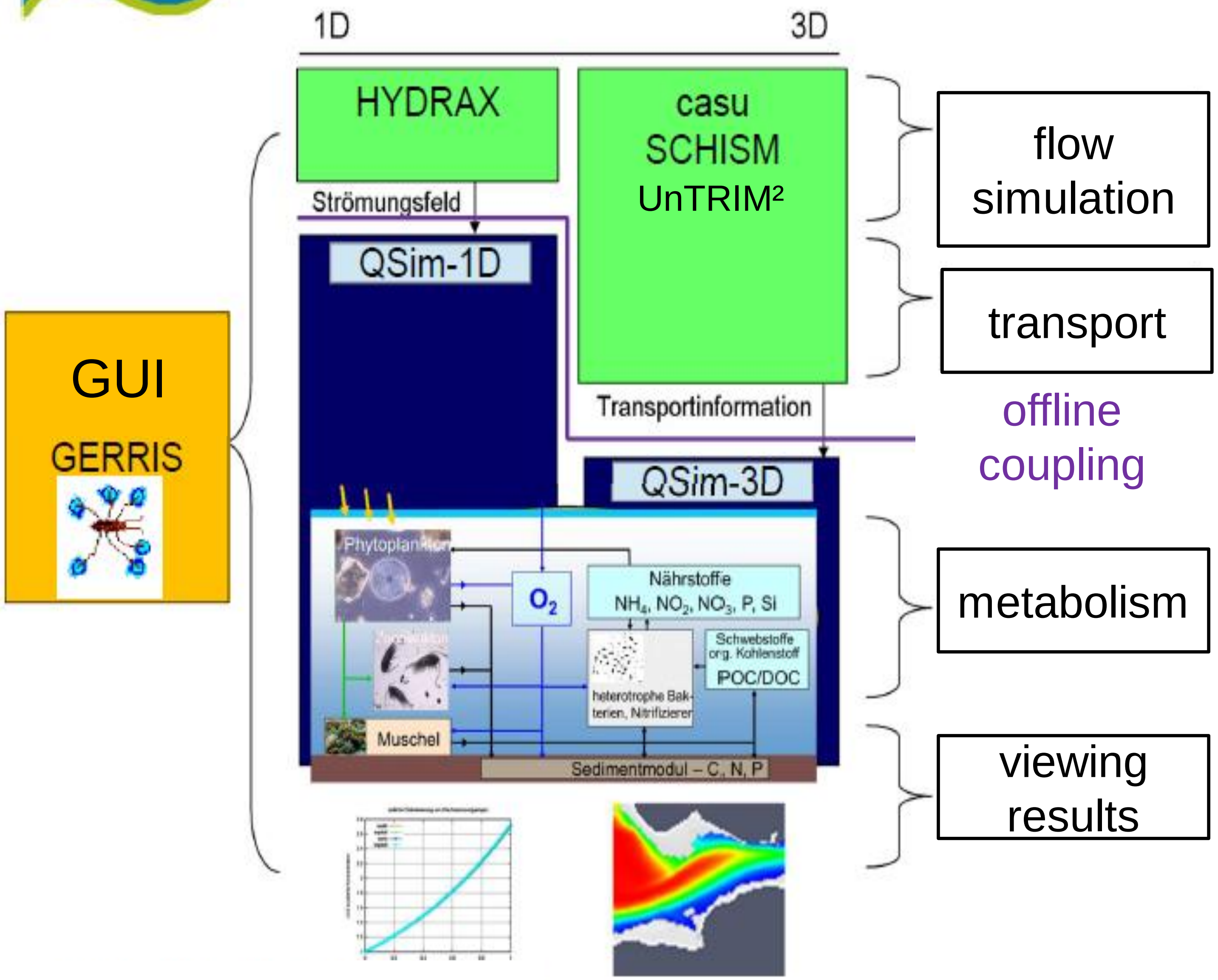
Elbe Estuary , July 7th 2011 12:03, ebb flow

water age (d)



Schöl, A., Hein, B., Wyrwa, J.& V. Kirchesch (2014): Modelling Water Quality in the Elbe and its Estuary – Large Scale and Long Term Applications with Focus on the Oxygen Budget of the Estuary. Die Küste, 81 (2014), 203-232.

QSim software family



offline or **soft-coupling** is faster if:

* multiple quality simulations based on one flow field (one year per night)
* interdisciplinary cooperation

Graphical User Interface **GUI** needed for:

- efficient model use
- safe model build up
- reproducible research
- quick viewing of results

Challenges

- Water quality simulation needs large model areas and integrated models
- Water quality modelling needs interdisciplinary expertise
- format standardisation would be a great help (WG2)
- tools for efficient and safe application are more essential in water quality modelling (extend WG3?)
- biological simultion algorithms are more site specific than physical ones (WG4)

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Break

We will be back for the open discussion at 11h45 CET

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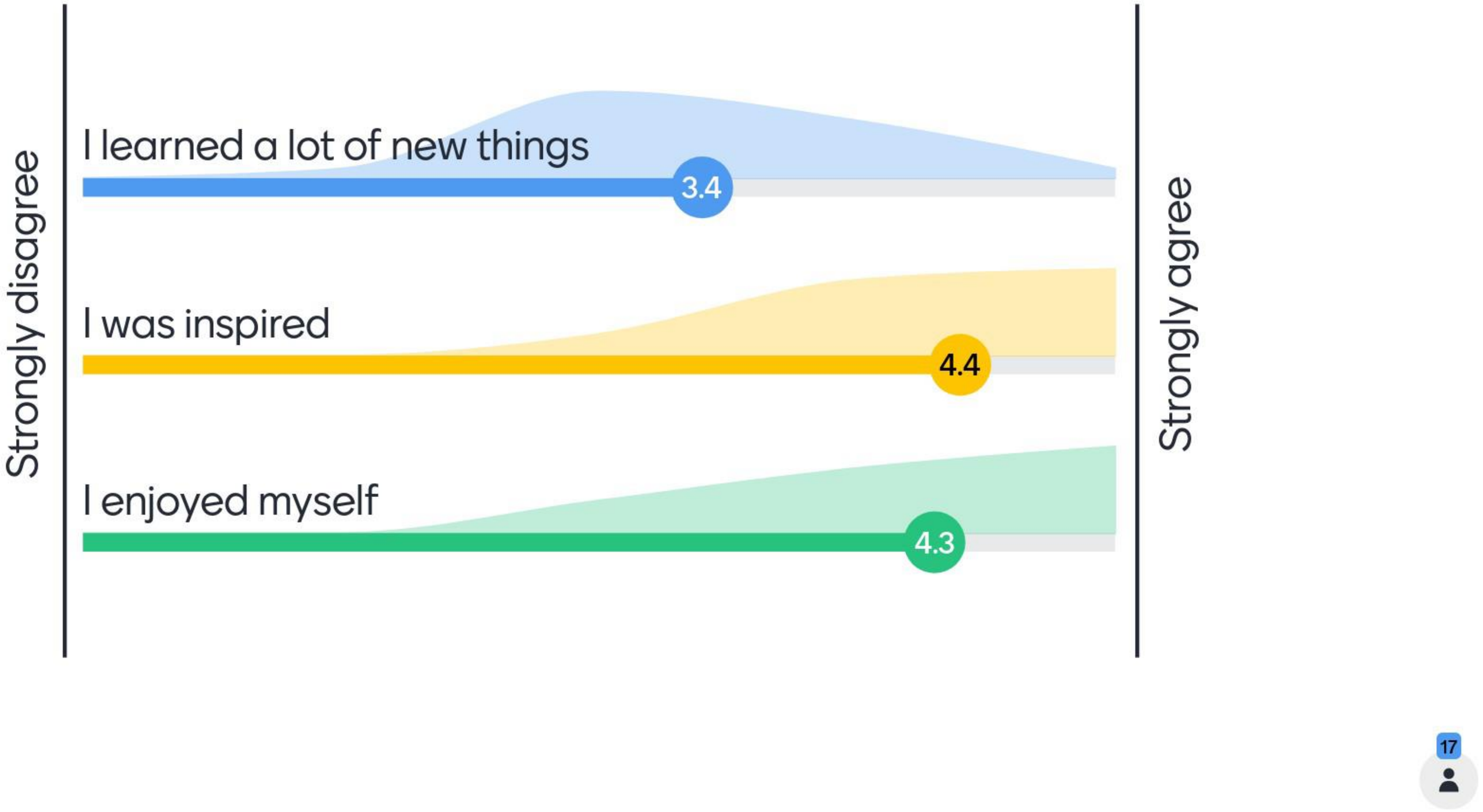
Open discussion

Did you enjoy the lightning talks session?



Who, where, what?

What is your job title?

22

Which river and/or sea system are you trying to model?

Venice Lagoon	North Sea	Po Delta
Po River Delta and coastal area	Adriatic Sea	Elbe
North Sea, German Bight, Elbe Estuary	Rhine	Scheldt-estuary

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Which river and/or sea system are you trying to model?

Venice lagoon

Water quality in German waterways, e.g. Moselle, Rhine

lagoons in general

Elbe estuary

North Adriatic

Minho Lima and Douro rivers

Elbe River

Elbe

Indonesian sea

29

Which river and/or sea system are you trying to model?

- Curonian lagoon
- any system
- Elbe
- Danube - Black Sea
- Lagoons,
- The Ebrie Lagoon, widest lagoon of West Africa
- Guadalquivir
- Oder River - Baltic Sea
- Rhine

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Which river and/or sea system are you trying to model?

Venice LagoonPo river Delta and coastal areas

Western Scheldt

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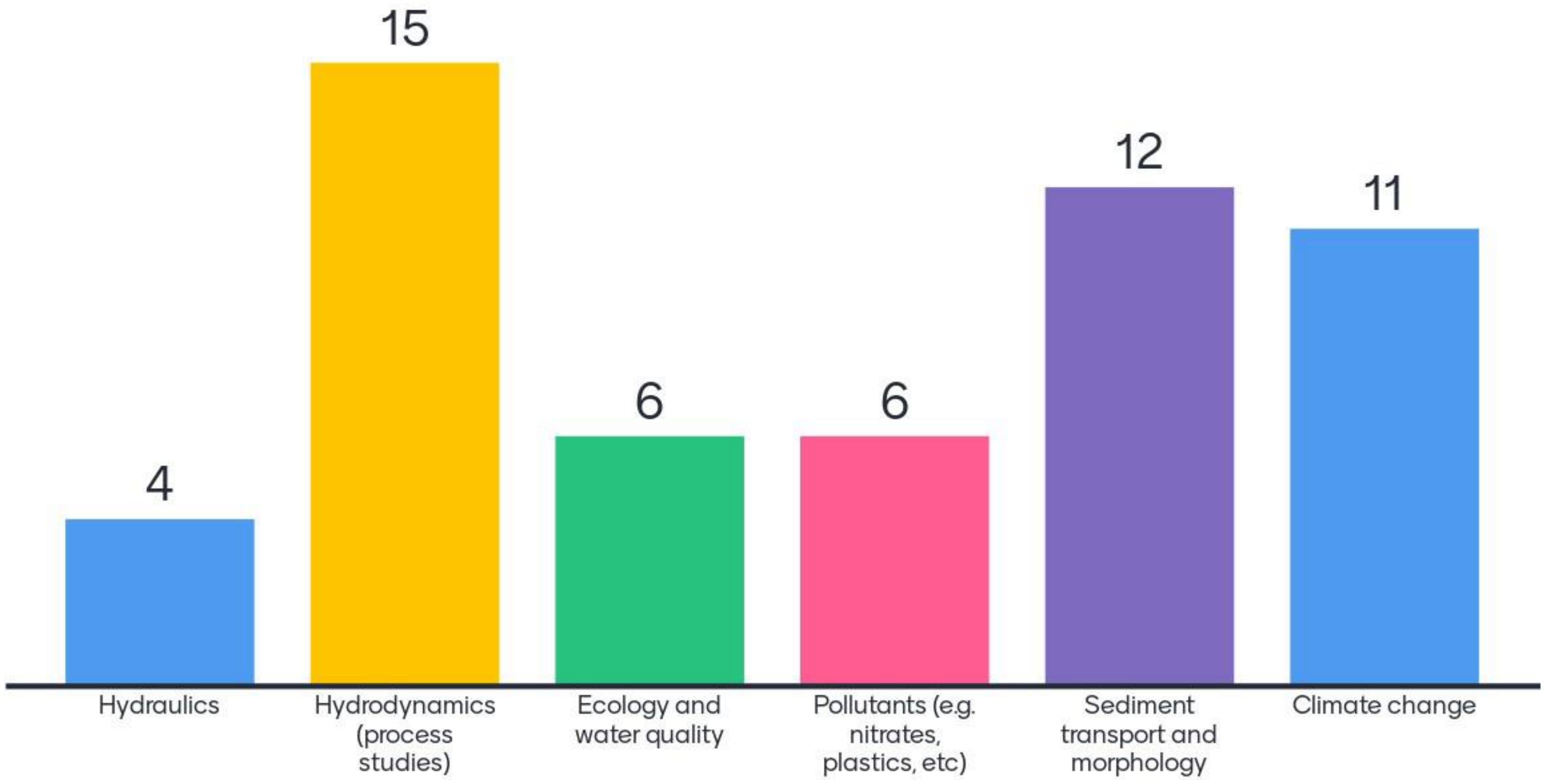
What are your scientific interests?



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What OTHER scientific interests do you have?

numerical methods
flood forecasting
marine pollutiants
system connectivity
ecological interactions
geology
climate change effects
lagoon processes
drainage basin modelling
open sea and ocean models
transport modelling
marine litter
modeling of time scales
catchment hydrology
consolidation
snow modelling
integrated modelling
remote sensing
science communication
dense water
model evaluation
operational modelling
numerics
fairness of modelling dat
mixing dynamics
storm surge modeling
vegetation interaction
saltwater intrusion
floodplain sedimentation
data management
developing of models
evaporation
eo data
lagoon-sea feedbacks
ocean modeling
bed forms
extreme events

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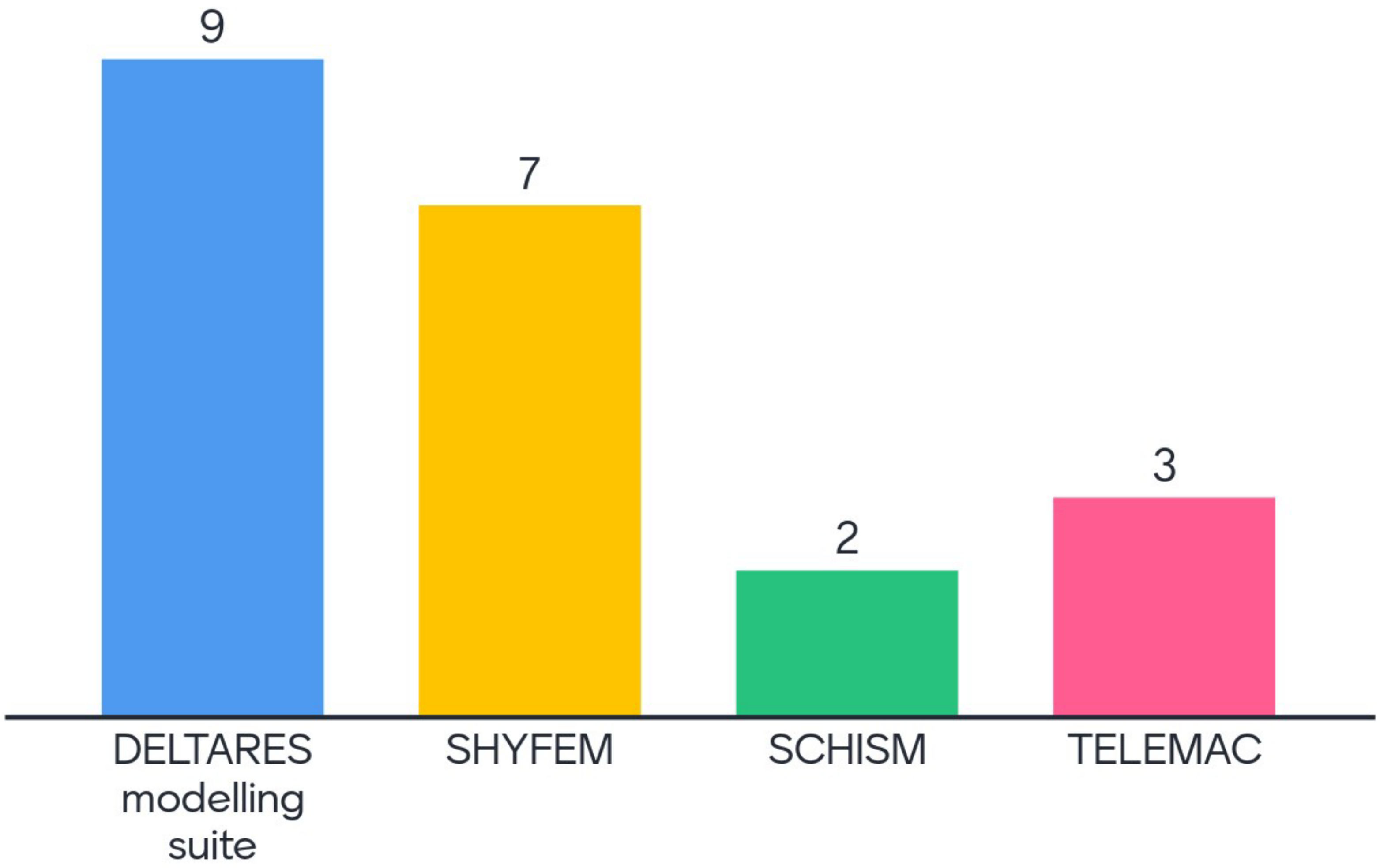
Modelling tools and data sources

Which simulation software are you using?



Which OTHER simulation software are you using?

flow3d
remote sensing
maxent
xbeach
gotm
swat
ecosmo
ssiim
measurements
eutro-wasp
swash
sed3d
larsim
bfm
qsim
openfoam
ltrans
sms
swan
roms
untrim
national repositories
dumux
rma
national agencies
wam
wwm

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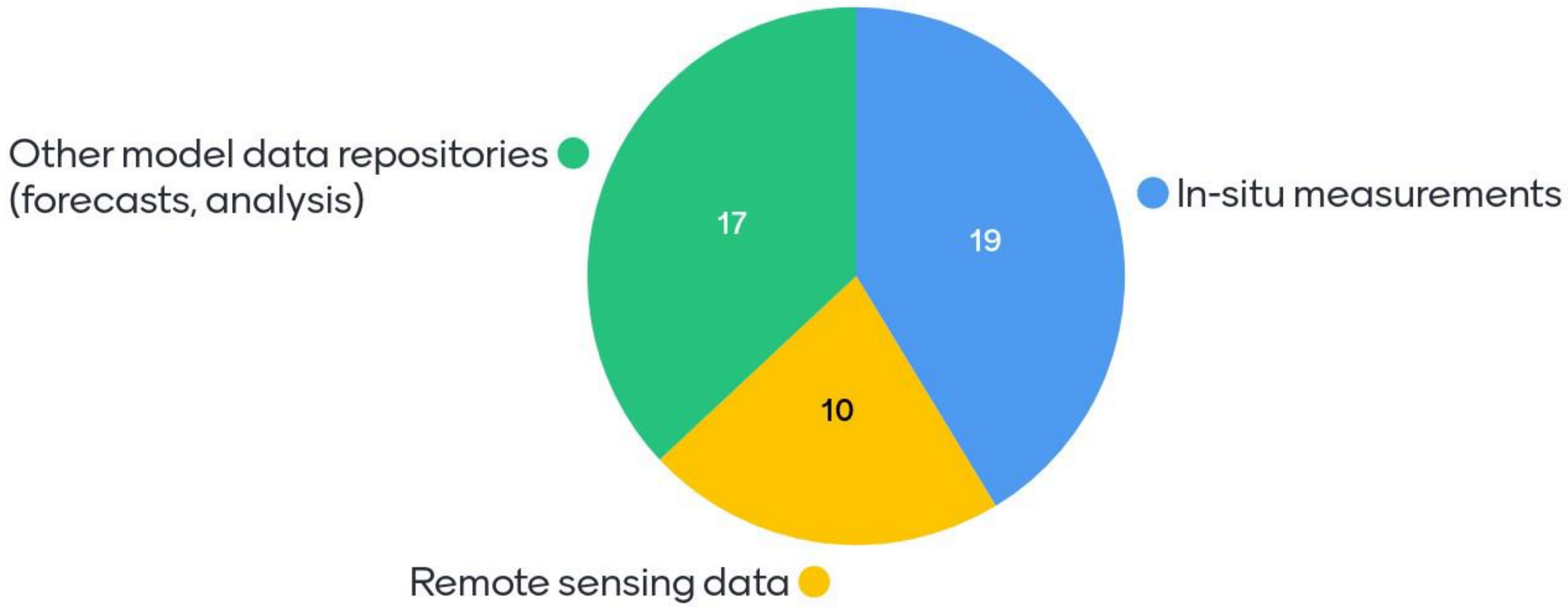
What type of data do you use in your model implementations?



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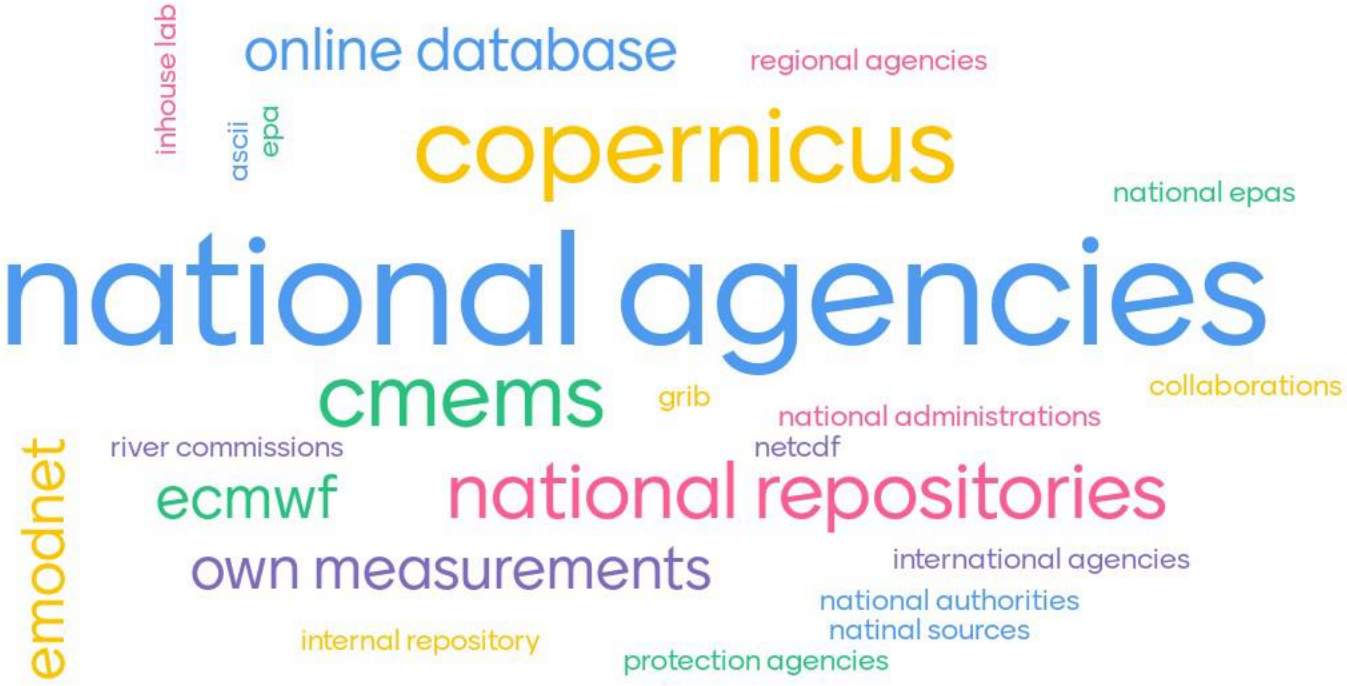
Where do you get your data? (e.g. COPERNICUS, national repositories, national agencies, international agencies/initiatives, etc.)



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What data formats do you work with mostly? (e.g. ascii, netCDF, grib, etc.)

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HOT TOPICS, PROBLEM SOLVING AND CHALLENGES

What are your main challenges and bottlenecks when modelling river-sea systems?

coupling systems	morphodynamics	lack of data (continuous)
computation time	compound floods	full coupling
cross-scale approaches	integrated modeling	valid representation of morphodynamics

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What are your main challenges and bottlenecks when modelling river-sea systems?

- Calibration of models
- wet-dry in sigma
- integrated modelling
- long term simulation
- validation of spatial processes with point data
- lack in continuous data
- complexity and uncertainty
- coupling processes
- Sediment transport

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What are your main challenges and bottlenecks when modelling river-sea systems?

- need to reduce computational costs
- full coupling different time and spatial scales
- computational costs
- full parallelization
- real time observations
- Computation time
- supended sediments
- benchmark
- calibration

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What are your main challenges and bottlenecks when modelling river-sea systems?

- define uncertainties
- complexity of ecosystems (complex vs smiple models)
- efficient integrated modelling on heterogeneous hardware
- integrate data of global models into my local model
- quantification of uncertainty in complex models
- high spatial resolution data
- No

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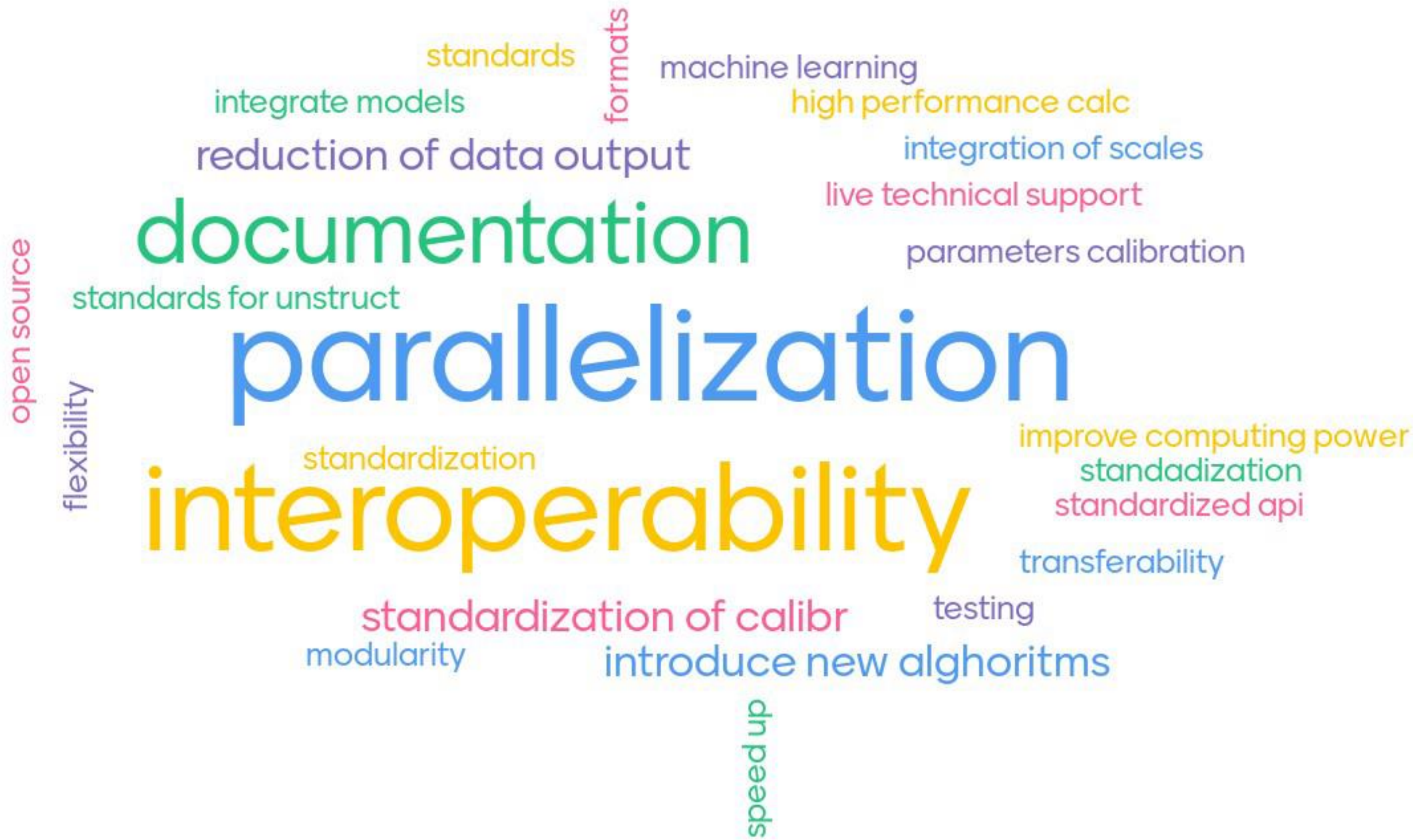
What should the technical focus for future model developments be?



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What are the scientific hot topics for future studies through models?

climate change	morphodynamics	cumulative impacts
downscaling	water basin feedbacks	climate change
navigation	tipping points	river-sea continuum

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What are the scientific hot topics for future studies through models?

- biodiversity
- historic states of river-sea-systems
- Mars
- tipping points
- communication of modeling results
- global effects on local areas
- interdisciplinary modelling
- uncertrainty
- marine litter

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What are the scientific hot topics for future studies through models?

- modeling of uncertainty
- saltwater intrusion
- fine suspended sediments
- human adaptation
- use of water and availability
- social-driven land-ocean continuum models
- flood boundaries
- navigation and effects on bottom
- water scarcity

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What are the scientific hot topics for future studies through models?

Linking coastal processes with river basin dynamics (coastal erosion, nutrient dynamics, pollution)

sediment management

compound floods

Adaptation to climate change

contamination (solved and sediment connected)

communication of results

no

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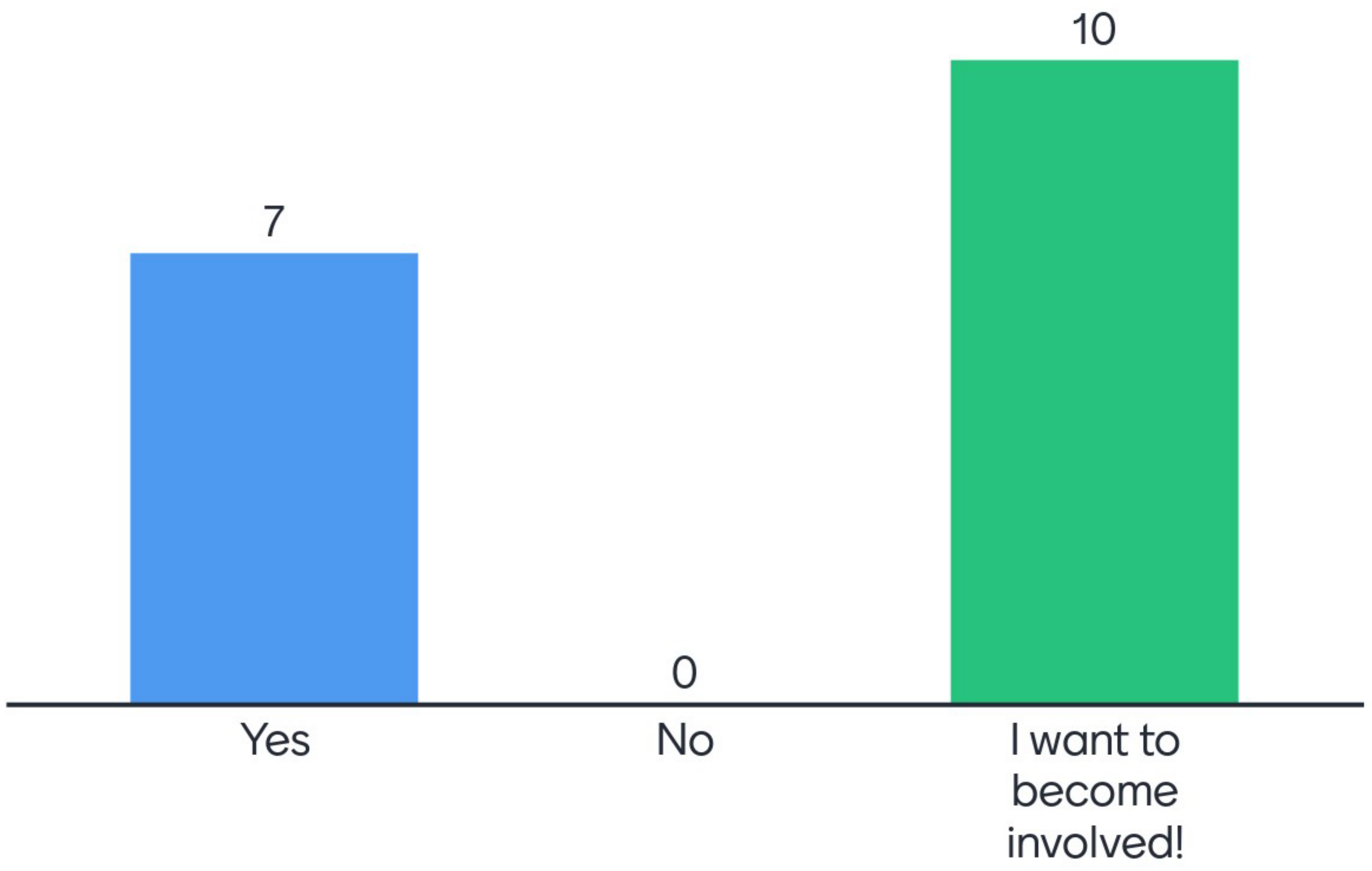
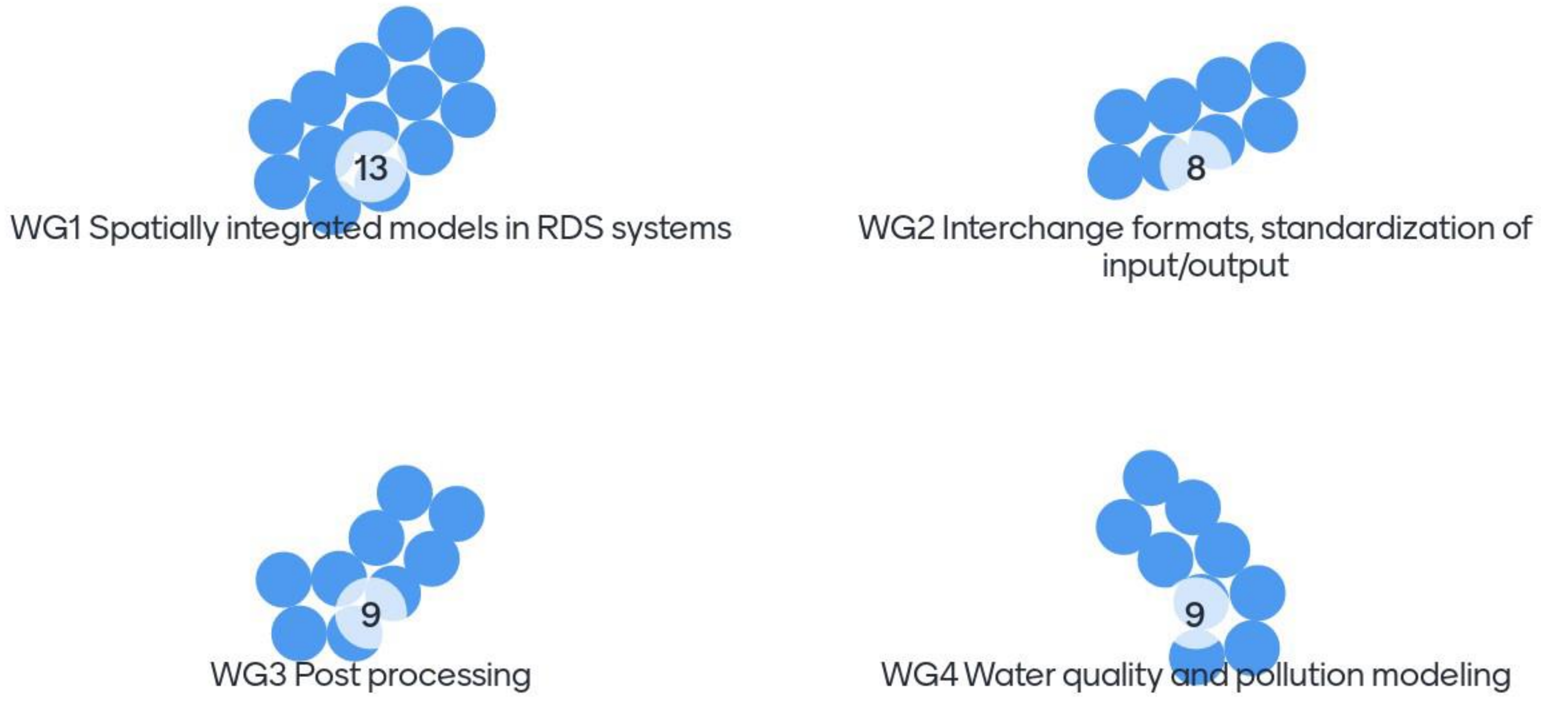
INVOLVMENT IN THE DANUBIUS ACTIVITIES

Are you involved in the DANUBIUS-RI?



Which WG discussion would you like to participate in?



Suggest a new WG topic

- Extreme events
- Operational modelling
- Model interconnections
- Operational modelling
- Numerics

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How could the DANUBIUS-RI community support you?

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How else could the DANUBIUS-RI community support you?

- increase networking opportunity
- Sharing tools and models/modules and training
- international (global) networking to similar efforts
- working together on common challenges
- common code developement
- foster exchange on current topics
- User forum
- networking and collaboration

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Wrap-up

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Contact details

Debora Bellafiore	debora.bellafiore@ve.ismar.cnr.it
Georg Umgiesser	georg.umgiesser@ismar.cnr.it
Francesca De Pascalis	francesca.depascalis@ve.ismar.cnr.it
Joost Icke	Joost.Icke@deltares.nl
Björn Backeberg	Bjorn.Backeberg@deltares.nl