Deltares

enabling delta life

Deltares

- We are working on **smart innovations** in the field of water and subsurface
- We are **the knowledge partner** of the Dutch government.
- We make our knowledge applicable **worldwide.**
- We are a **strategic partner** and **trusted advisor** internationally.
- We believe in **open source / freeware software**.

877

Number of employees

79%

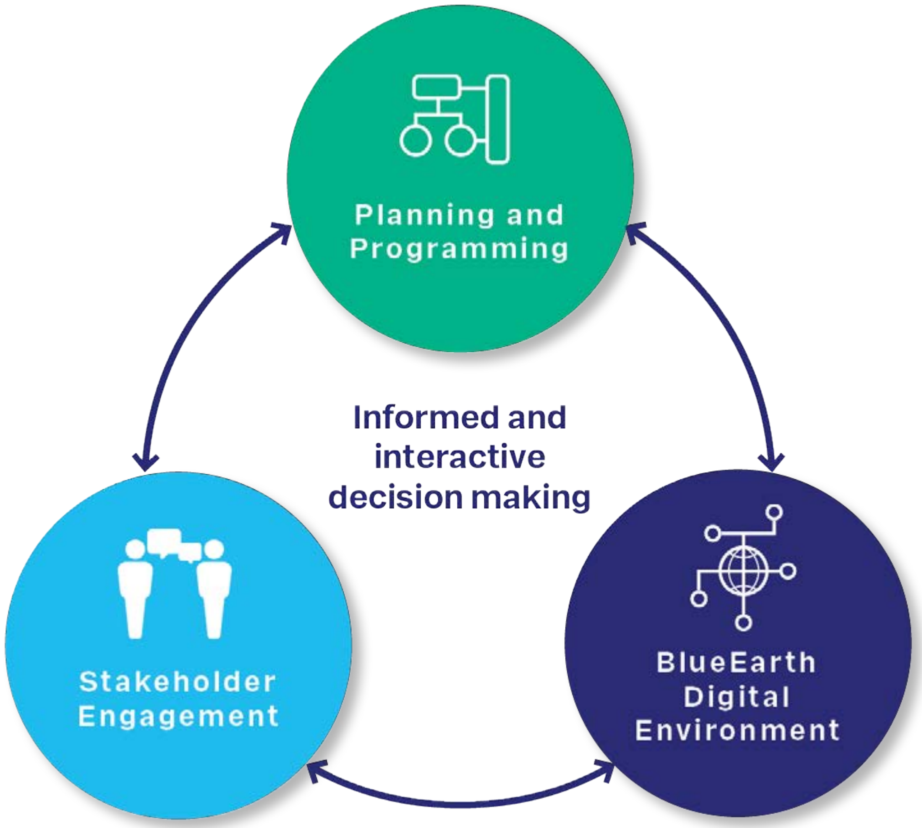
University / Ph.D.
39 nationalities

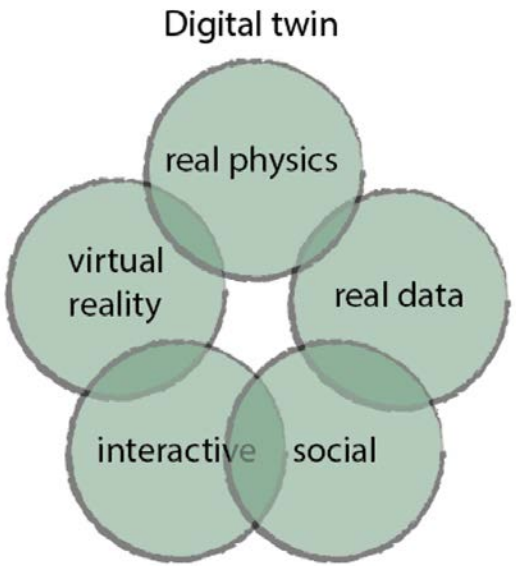
Regional offices in Abu Dhabi, Singapore and Indonesia

118 m€

Net turnover

ADB Deltares





Deltares

Yellow River – A Hydrological Basin Approach

From concept to decision-support

Albrecht Weerts

9/22/2020

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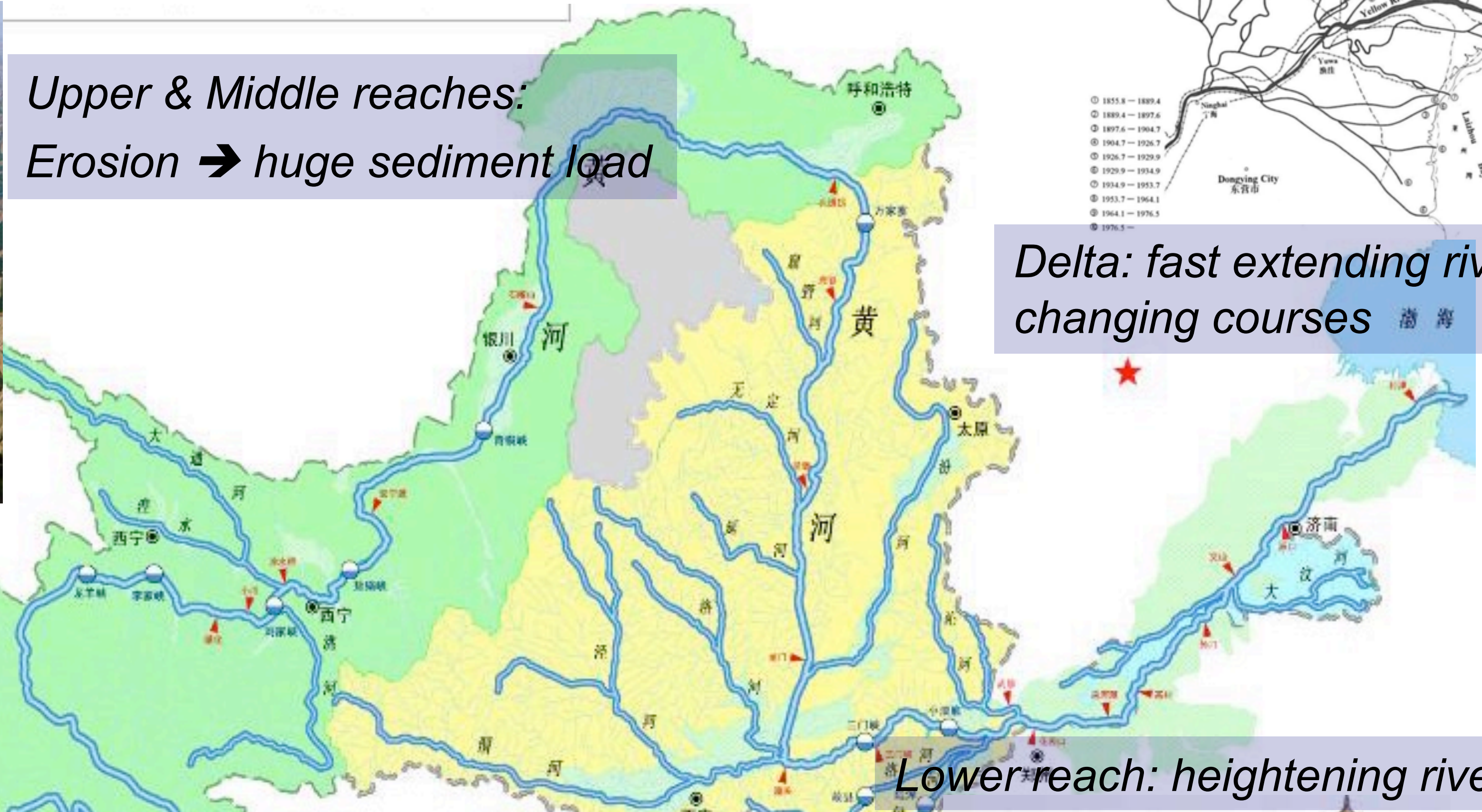
Managing water in a changing world & climate

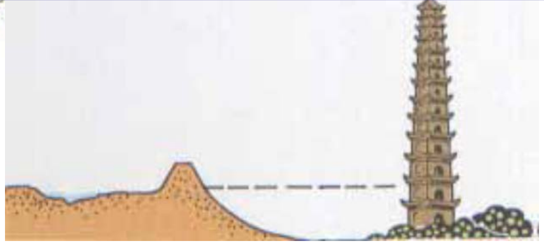
Yellow River – issues in the past



Upper & Middle reaches:
Erosion ➔ huge sediment load

Delta: fast extending river ➔ changing courses

Lower reach: heightening river bed



water quality
water resources

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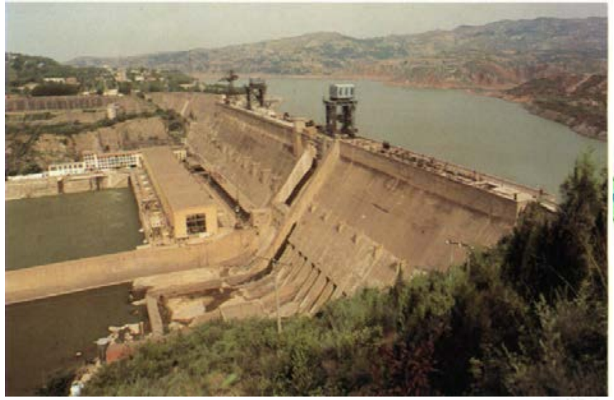
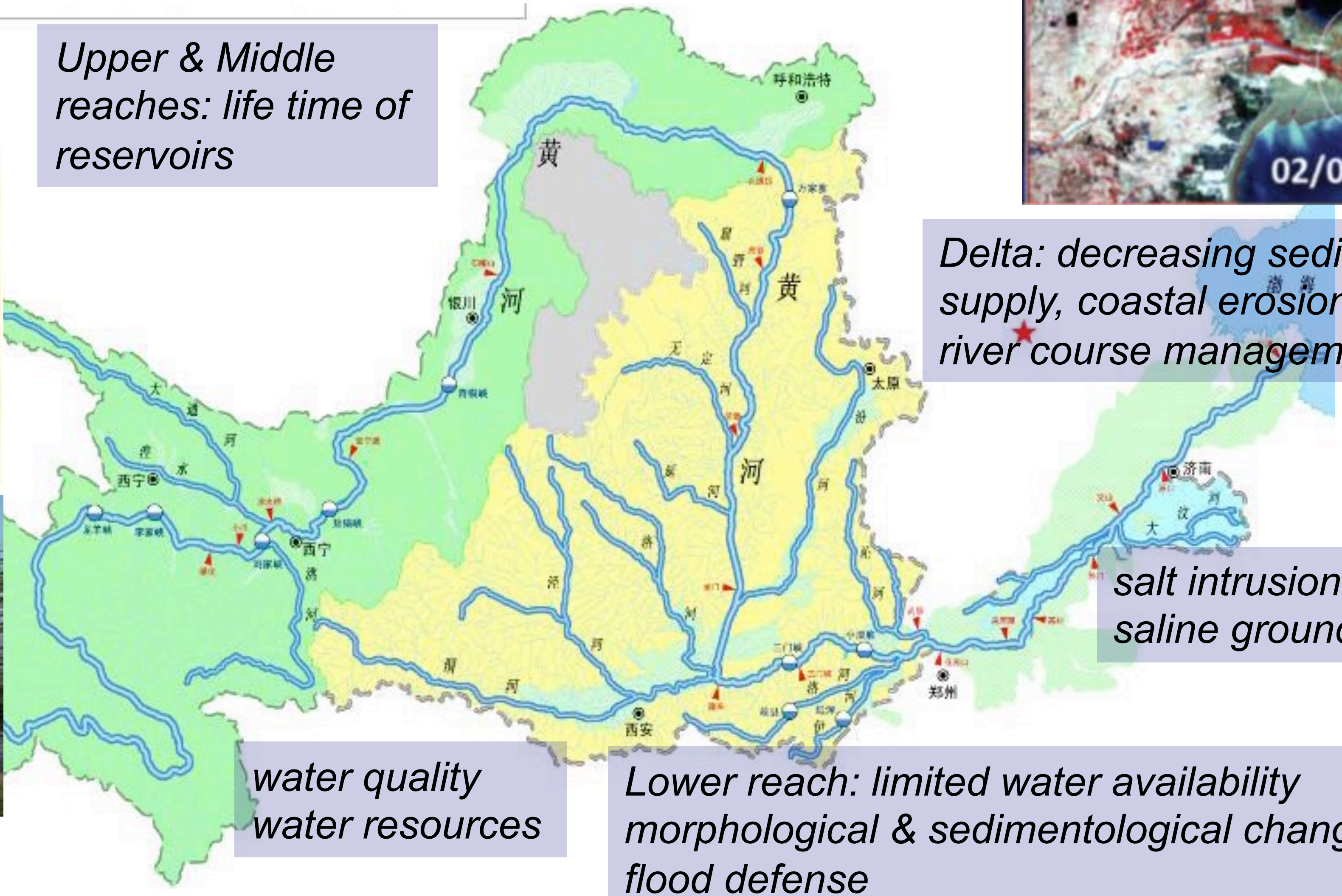
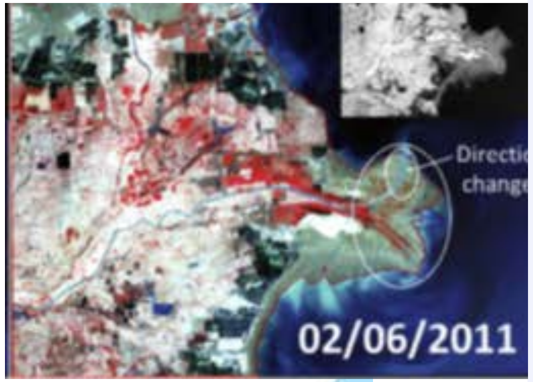
Yellow River – present & future issues



Upper & Middle reaches: life time of reservoirs





Delta: decreasing sediment supply, coastal erosion problems river course management

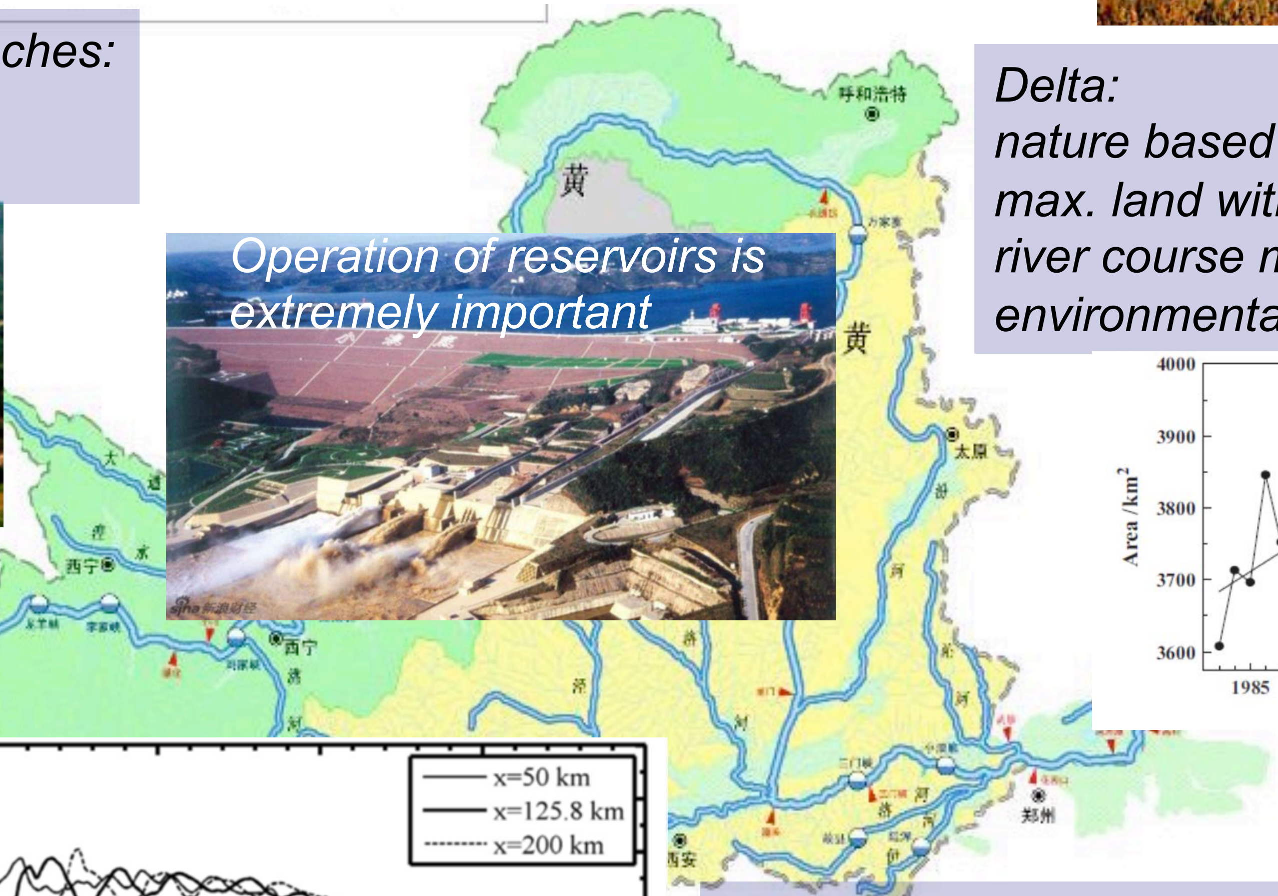
salt intrusion
saline groundwater

water quality
water resources

Lower reach: limited water availability morphological & sedimentological change, flood defense

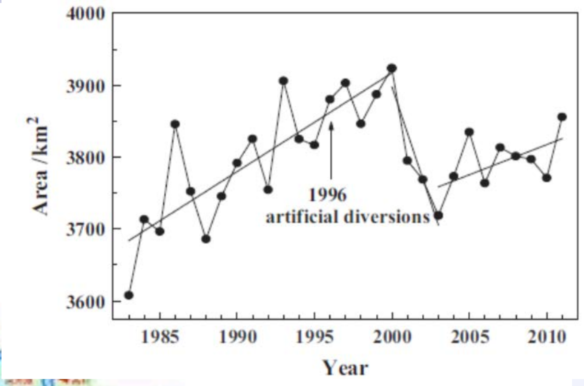
Yellow River – present & future issues

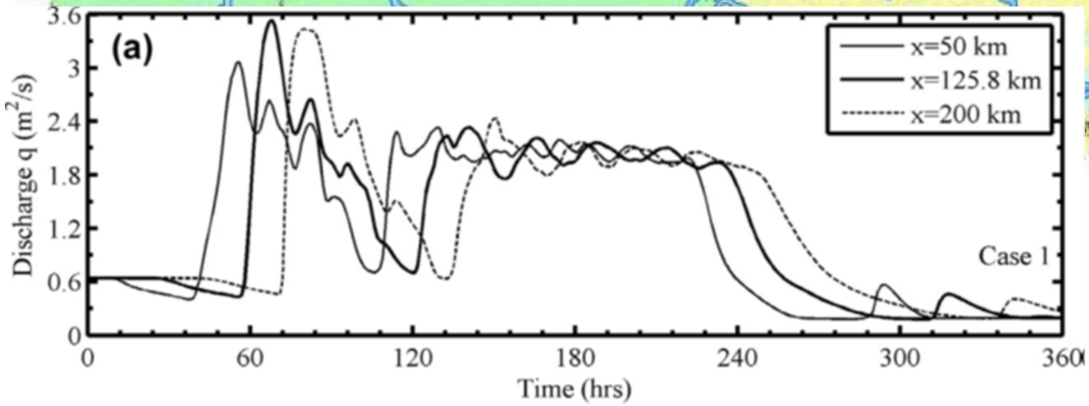
Upper & Middle reaches:
improve vegetation
sediment detention



Operation of reservoirs is extremely important

Delta:
nature based erosion control
max. land with limited sediment
river course management
environmental sediment load?





Lower reach: water needed to transport sediment? 'Room for the Yellow River'?

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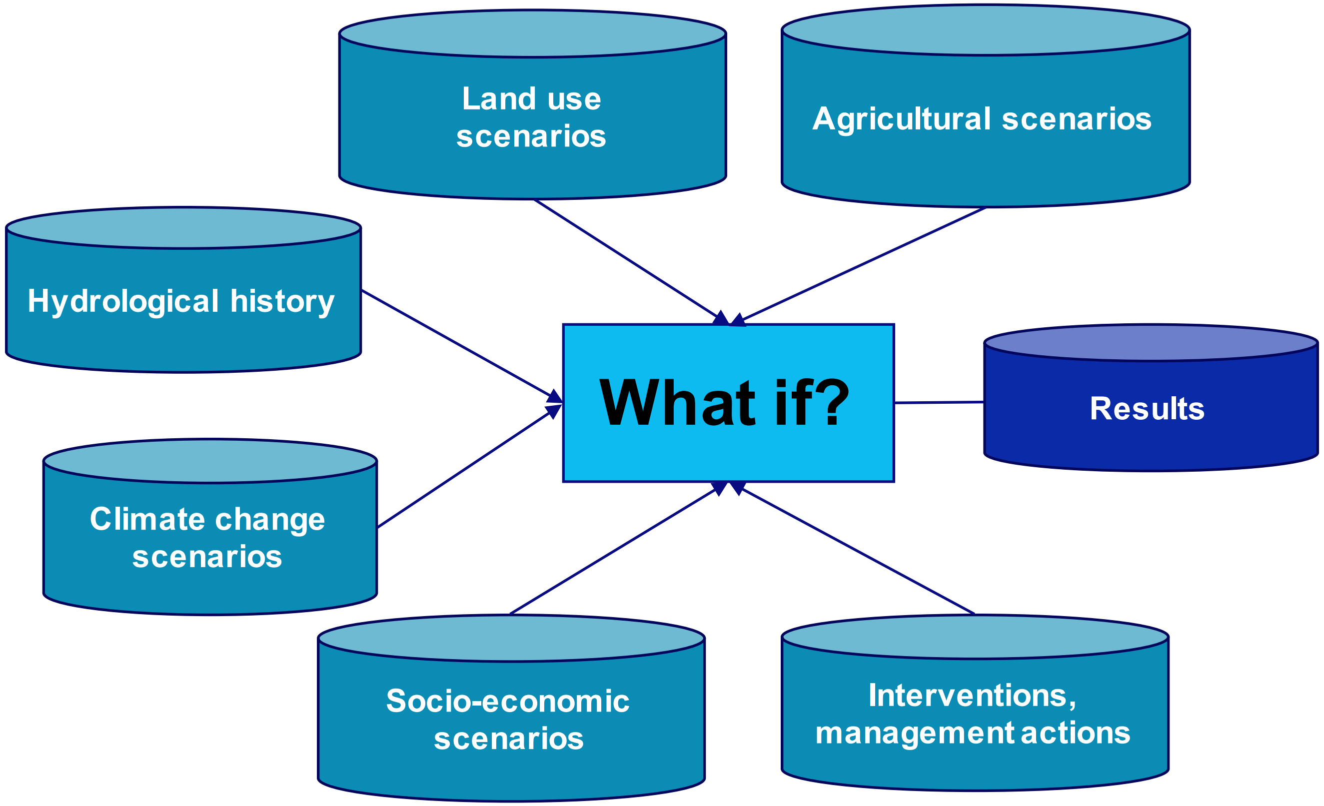
What kind of water management decisions should be supported?

- **Mitigation of drought hazard and risks**: e.g. low flows and navigation
- **Water management strategies:** e.g. reservoir management, sediment management, water quality, environmental flows
- **Climate change adaptation:** e.g. shift from rainfed to irrigated agriculture, adapted water (re-)use, adaptive pathways



Policy & planning + Real-time forecasting and warning

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What's important for river basin planning?

- **Evidence based:**
  - Common datasets = looking at the same information = having the same knowledge
  - *Using global data and (rapidly built) models could trigger the local expert dialogue on improvements, applications and local available datasets*

- **Integrated modelling approach:**
  - Many disciplines involved: hydrology, water demand + allocation, water quality, sediments, groundwater, river morphology, etc…
  - Well connected models to simulate effects and impacts correctly

- **Flexible approach:**
  - Multi-resolution: Spatial and temporal resolution adaptable to the situation
  - From global to local: Be able to incorporate local data easily
  - Tools open or open source

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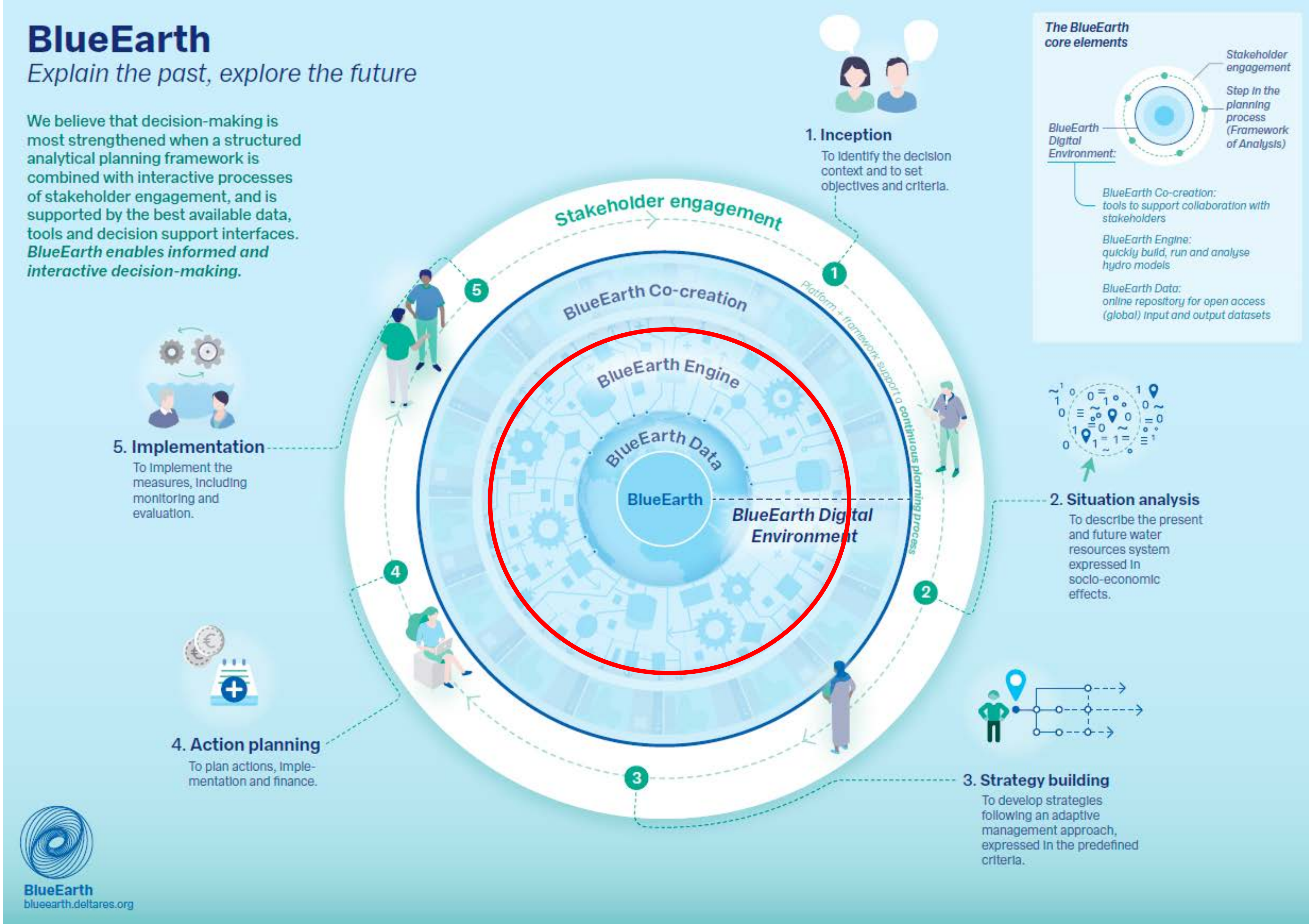
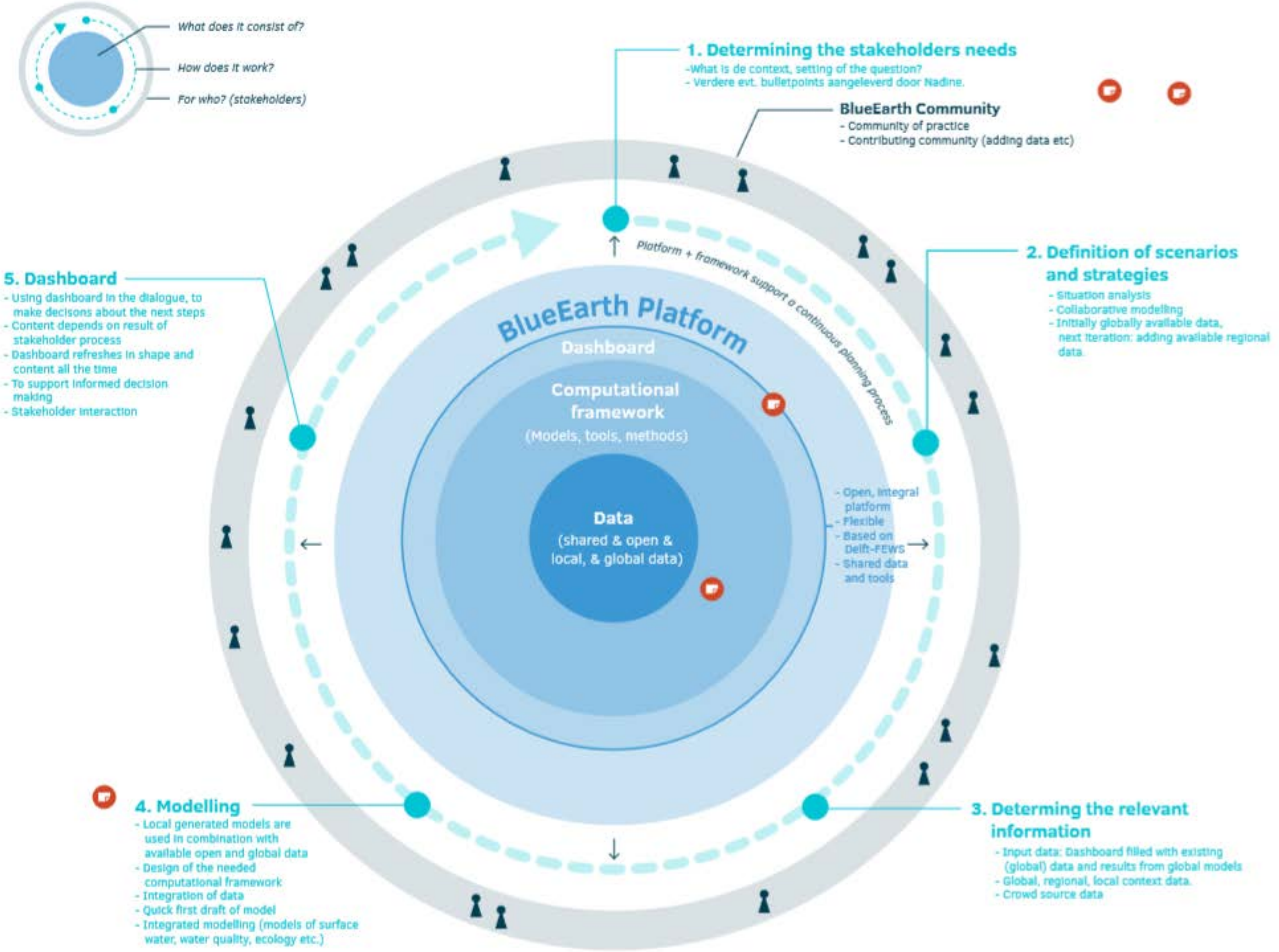
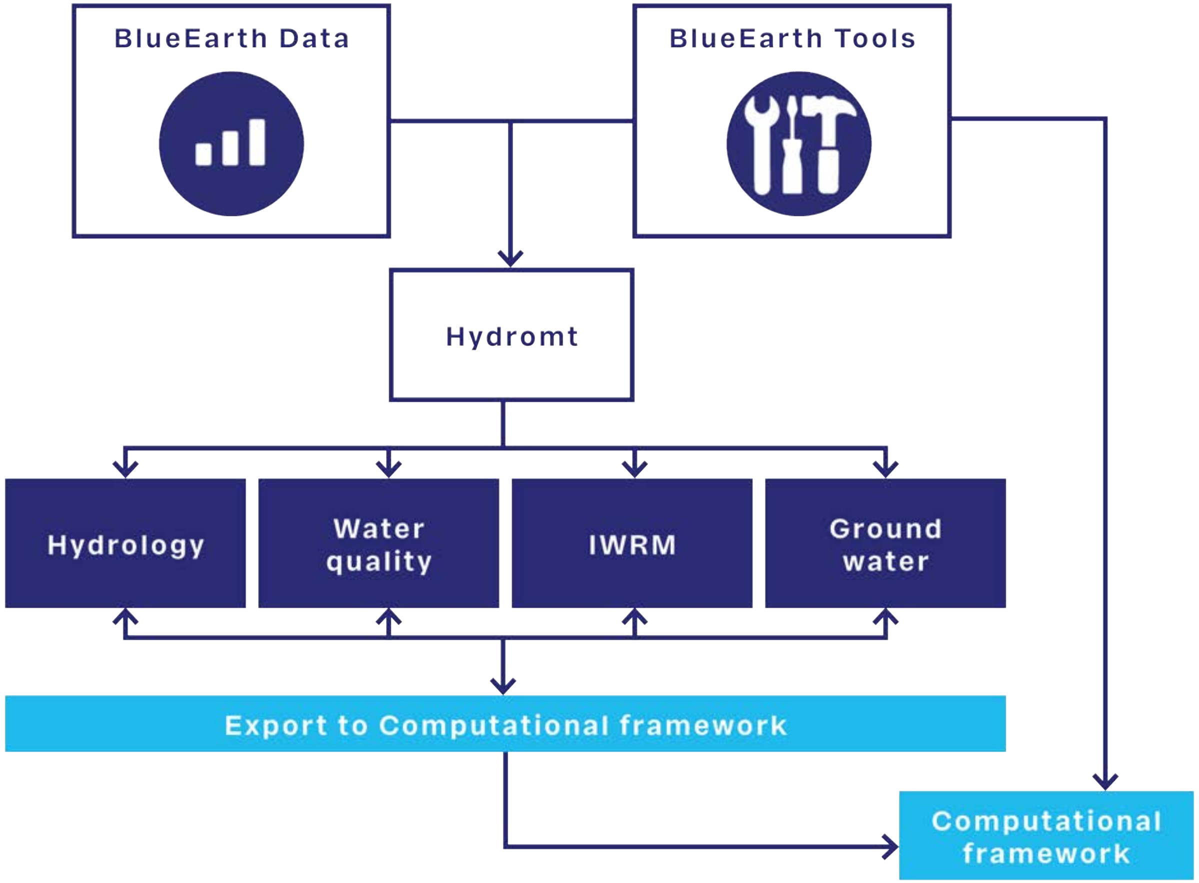


BlueEarth Engine


What does it consist of?
How does it work?
For who? (stakeholders)
1. Determining the stakeholders needs
-What is de context, setting of the question?
- Verdere evt. bulletpoints aangeleverd door Nadine.
BlueEarth Community
- Community of practice
- Contributing community (adding data etc)
Platform + framework support a continuous planning process
2. Definition of scenarios and strategies
- Situation analysis
- Collaborative modelling
- Initially globally available data, next iteration: adding available regional data.
5. Dashboard
- Using dashboard in the dialogue, to make decisons about the next steps
- Content depends on result of stakeholder process
- Dashboard refreshes in shape and content all the time
- To support informed decision making
- Stakeholder interaction
BlueEarth Platform
Dashboard
Computational framework
(Models, tools, methods)
Data
(shared & open & local, & global data)
- Open, integral platform
- Flexible
- Based on Delft-FEWS
- Shared data and tools
4. Modelling
- Local generated models are used in combination with available open and global data
- Design of the needed computational framework
- Integration of data
- Quick first draft of model
- Integrated modelling (models of surface water, water quality, ecology etc.)
3. Determing the relevant information
- Input data: Dashboard filled with existing (global) data and results from global models
- Global, regional, local context data.
- Crowd source data

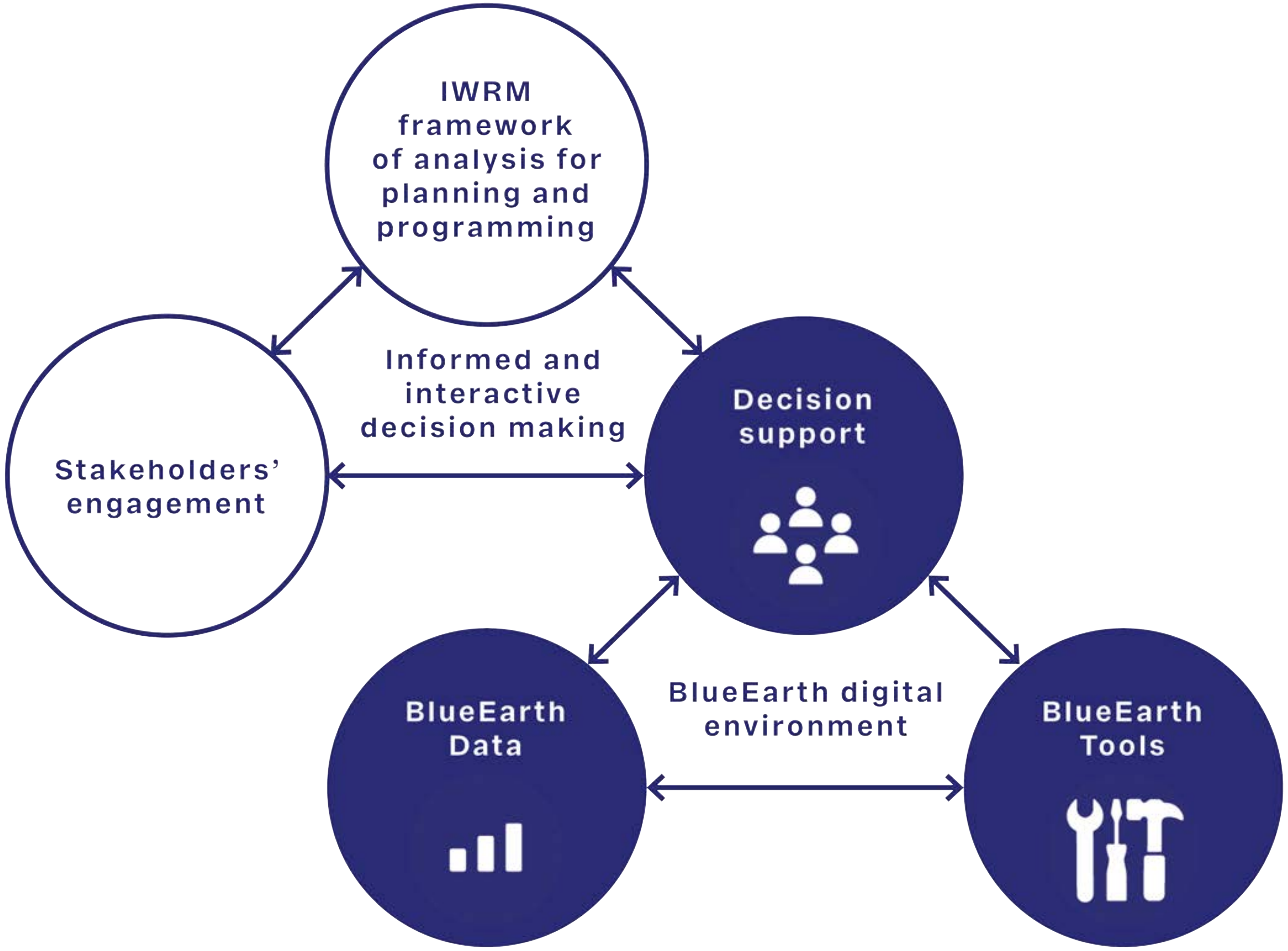
BlueEarth Tools & Computational Framework

- Blue Earth Tools are used to quickly **build**, **run** and **analyze** hydro models.
- The tools include **state-of-the-art data processing methods** to apply the models on various scales and resolution.
- The tools are developed largely in the **Open Source** domain, using the rich scientific **Python** eco-system.
- Blue Earth Tools links to Blue Earth Data. This optimizes the re-use and enhancing of existing data and allows for **seamless integration** between different models sharing the same base data.
- The main components within the Blue Earth Tools are the **Model Builder** ("hydromt") and the **Computational Framework** to integrate data and models and prepare your scenarios.



ADB Deltares

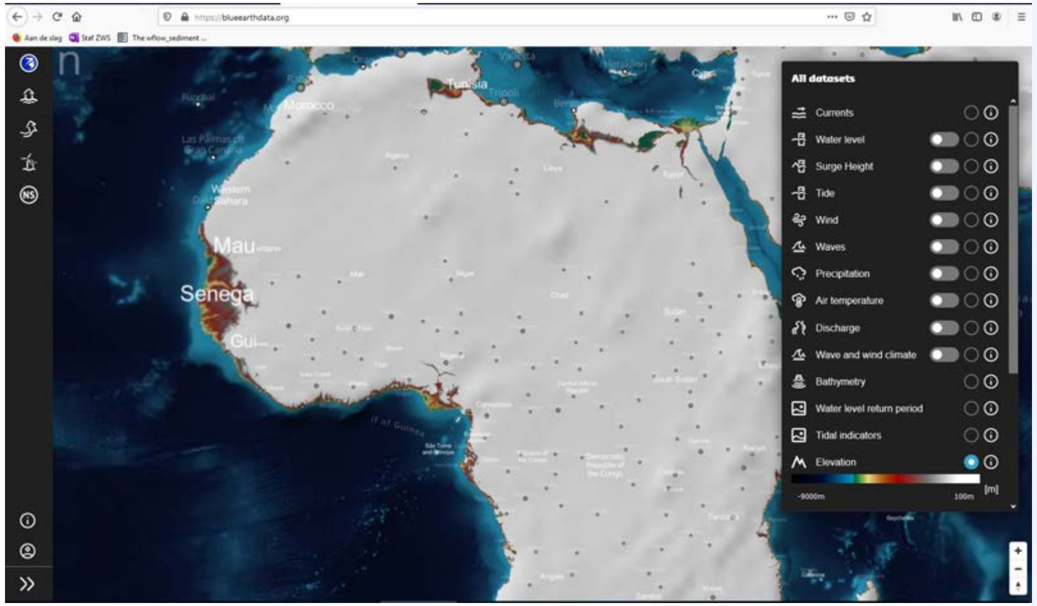
Approach and Digital Environment

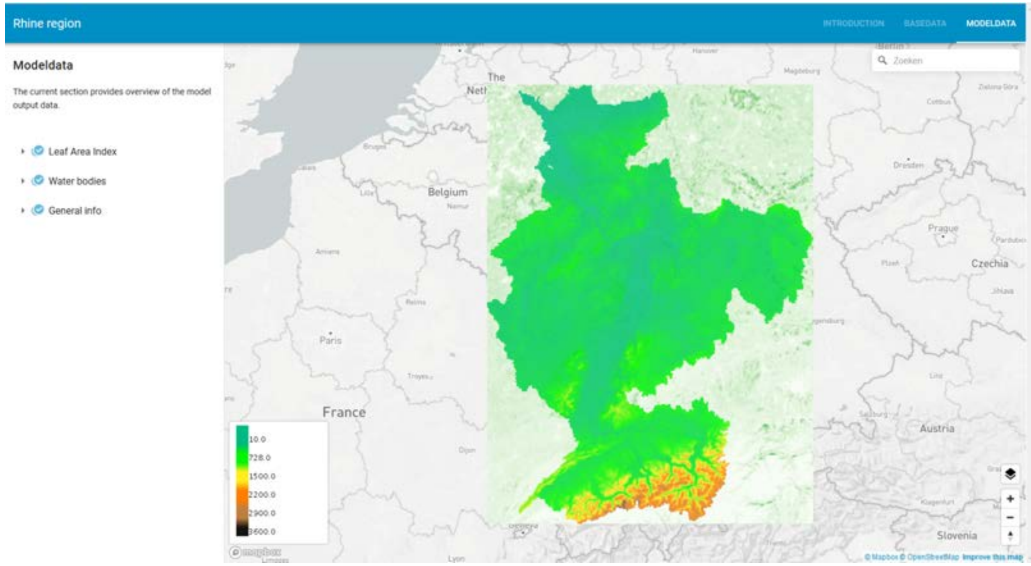


ADB Deltares

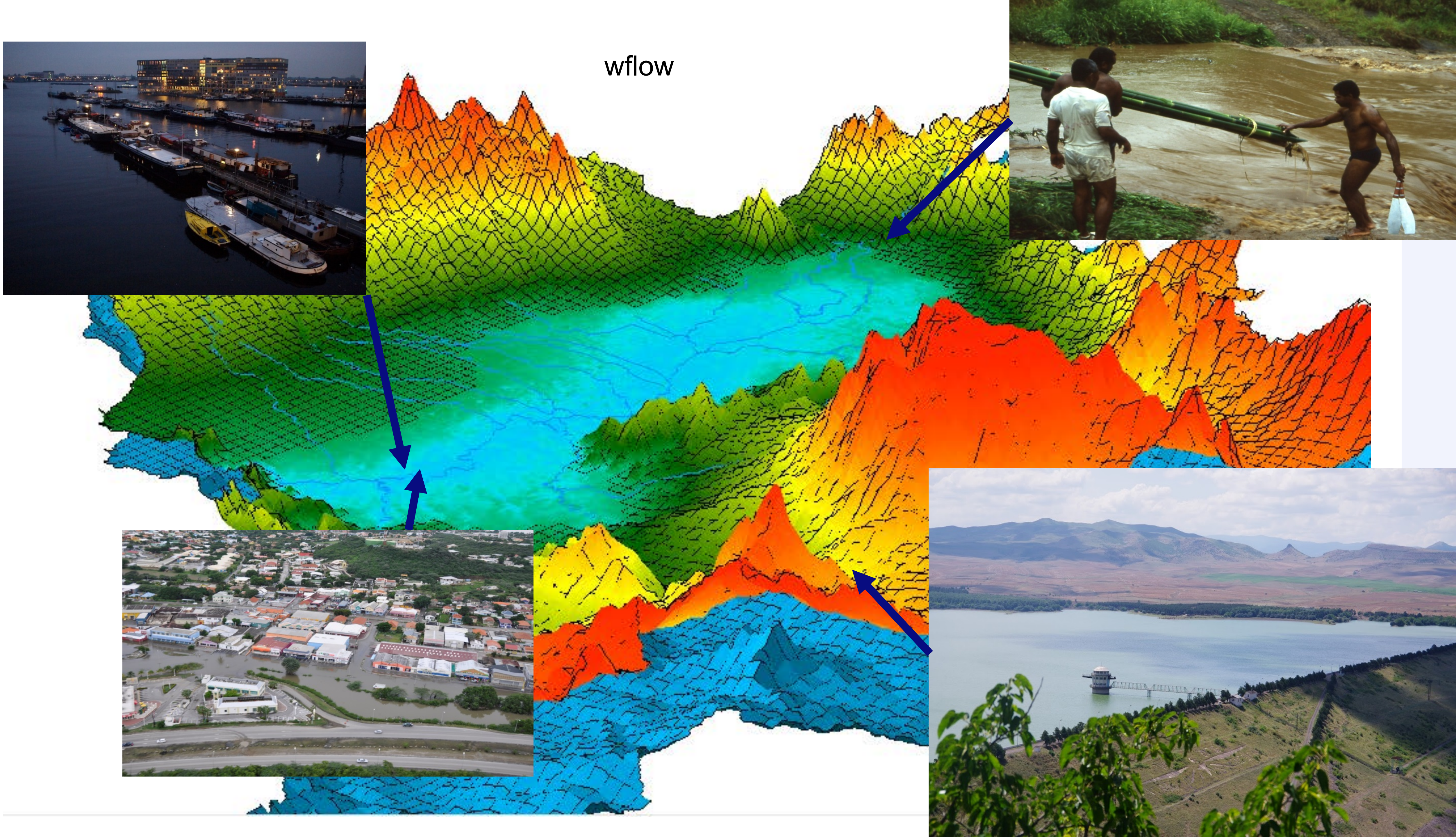
BlueEarthData.org

- BlueEarthData.org portal (Beta) is part of BlueEarth;
- A larger set of relevant static and dynamic data will be made available in 2020 for application in the models and dashboards;
- The general approach is start a project with the already globally available data, to enrich this in a later stage with local/regional data;

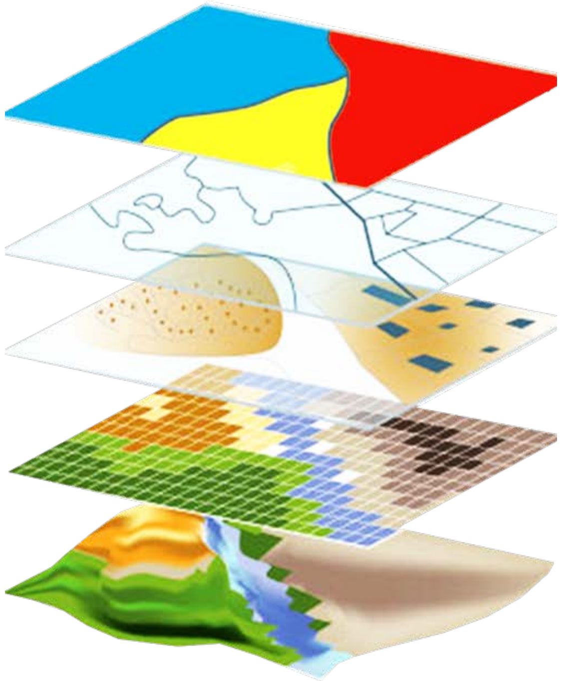


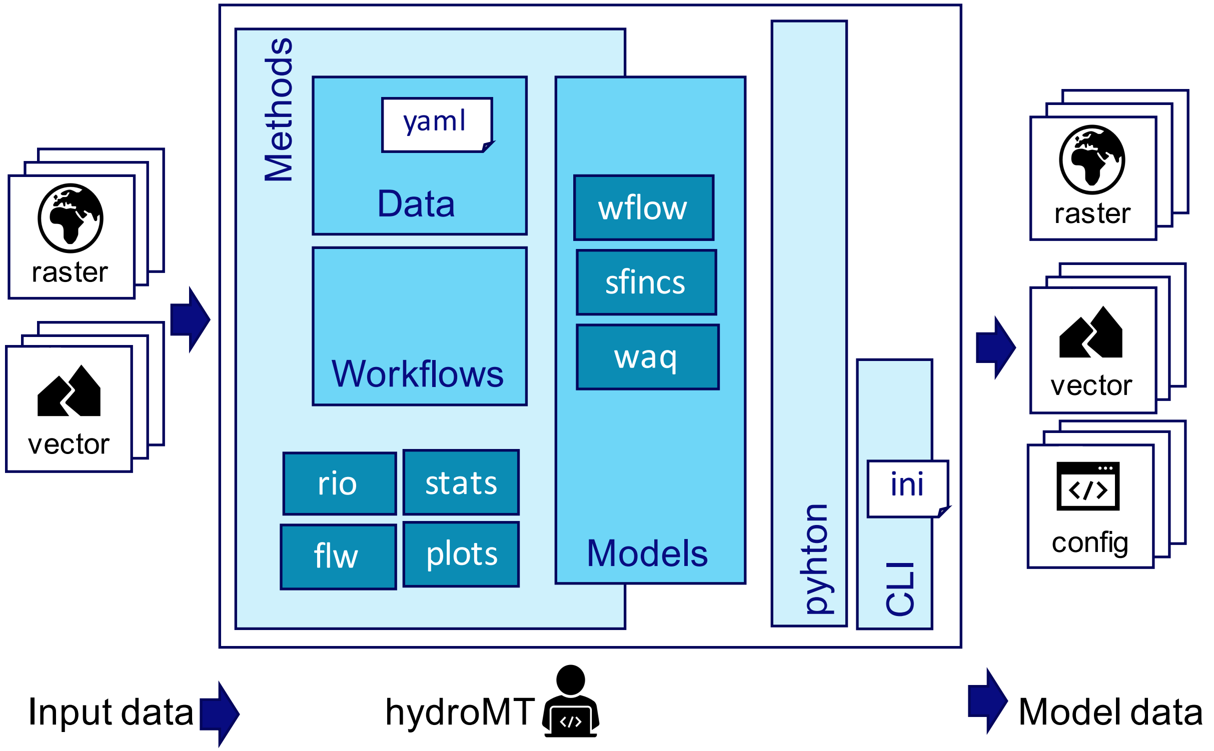


wflow

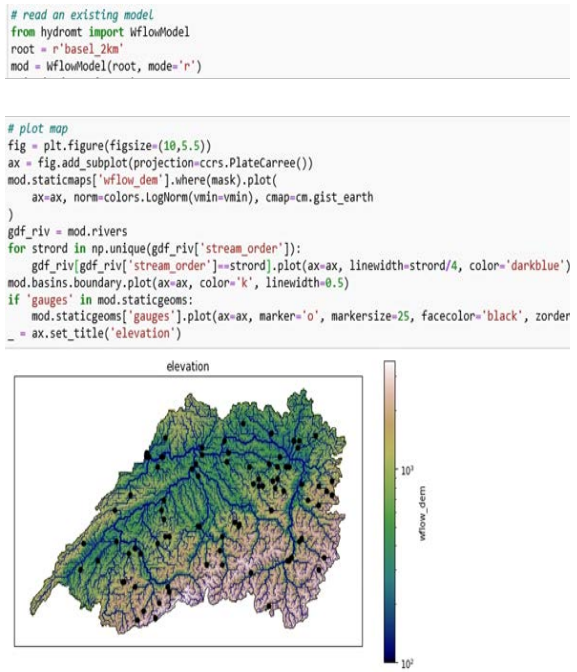


Engine for rapid model setup: Global to local





BlueEarth Engine



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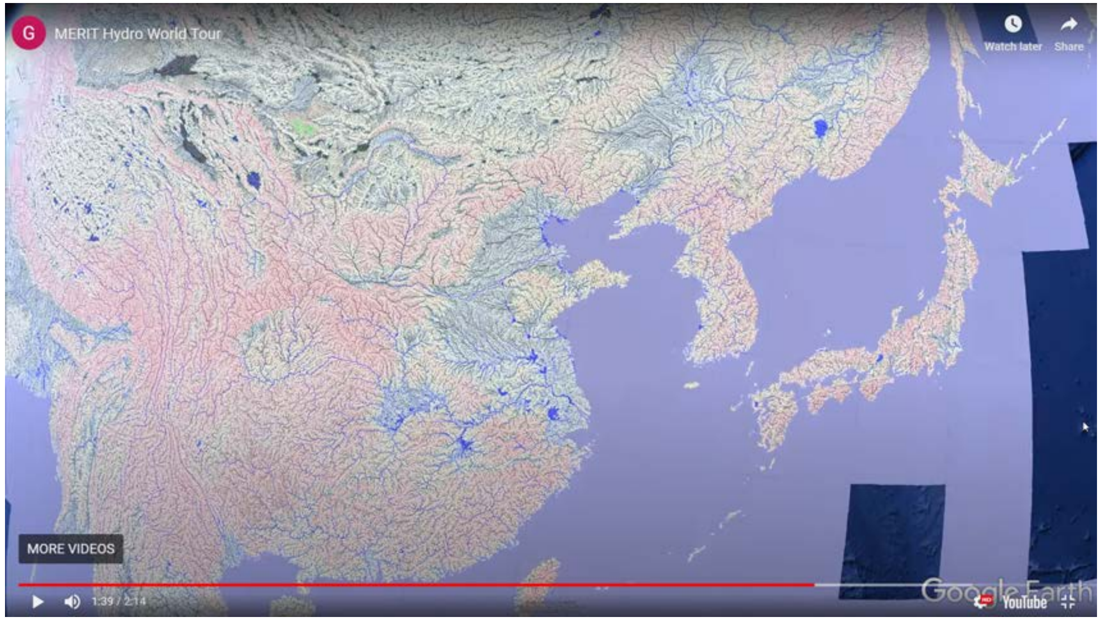
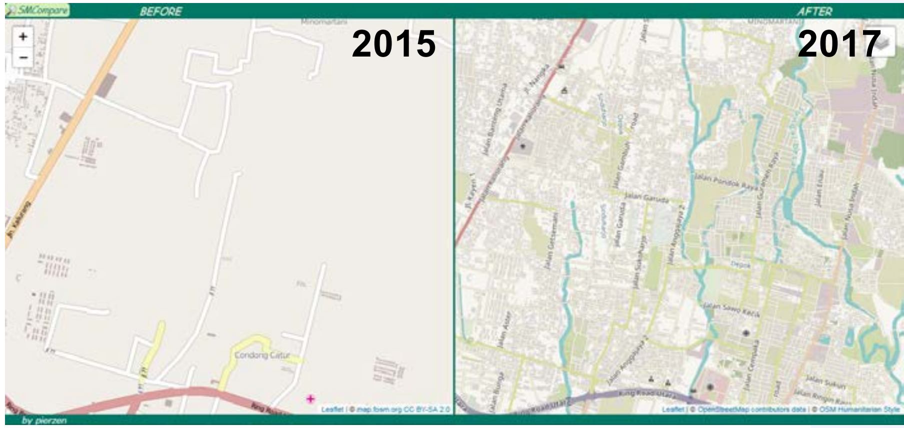
Rapid model building

- (Good) data becomes more widely available
- At higher temporal and spatial resolution

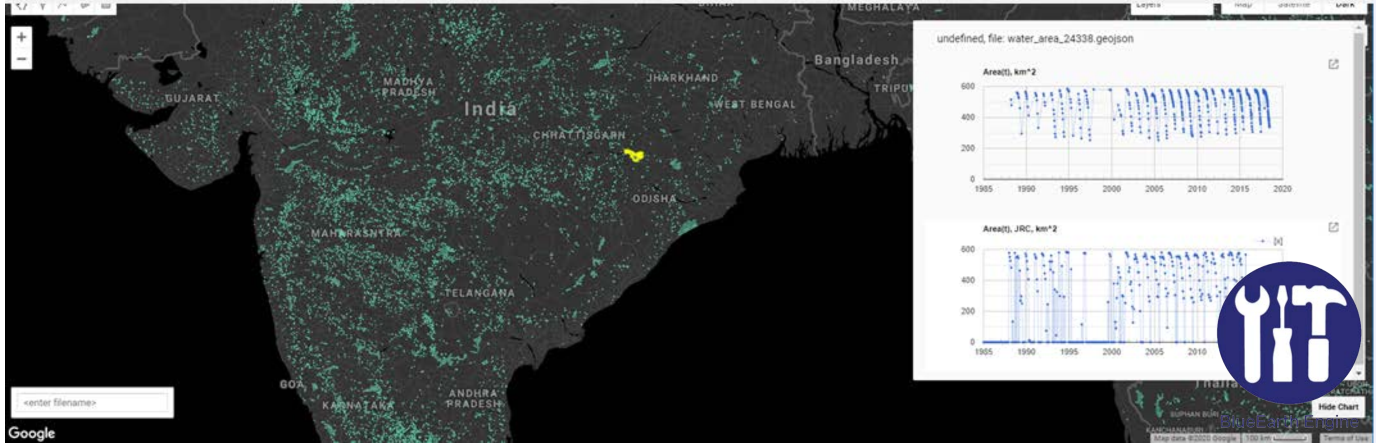


Examples of (new) datasets



Bathymetrie

Reservoir area observation from space



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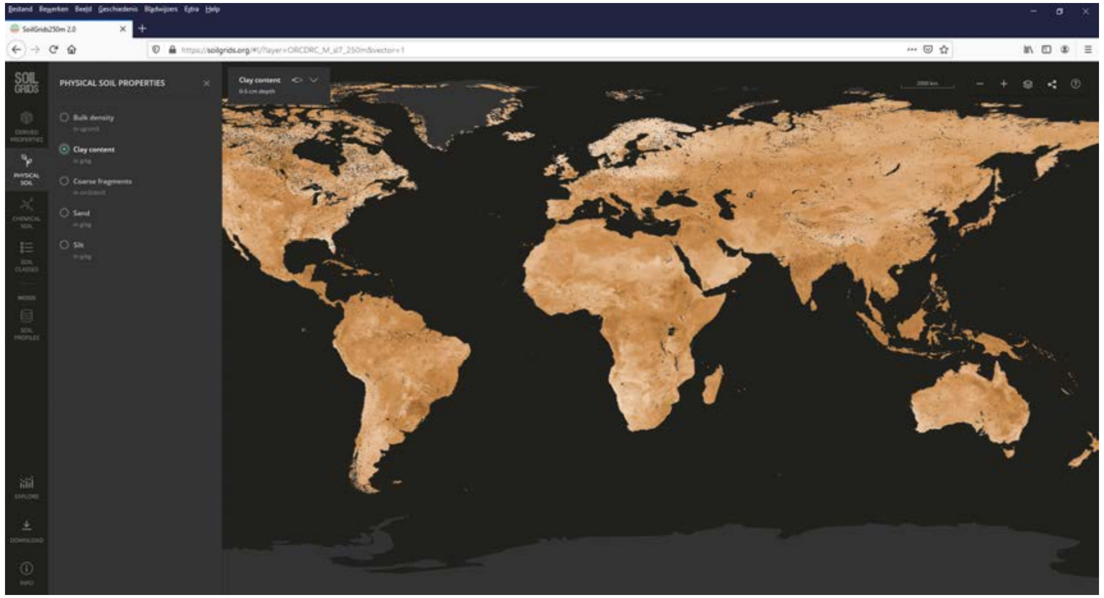
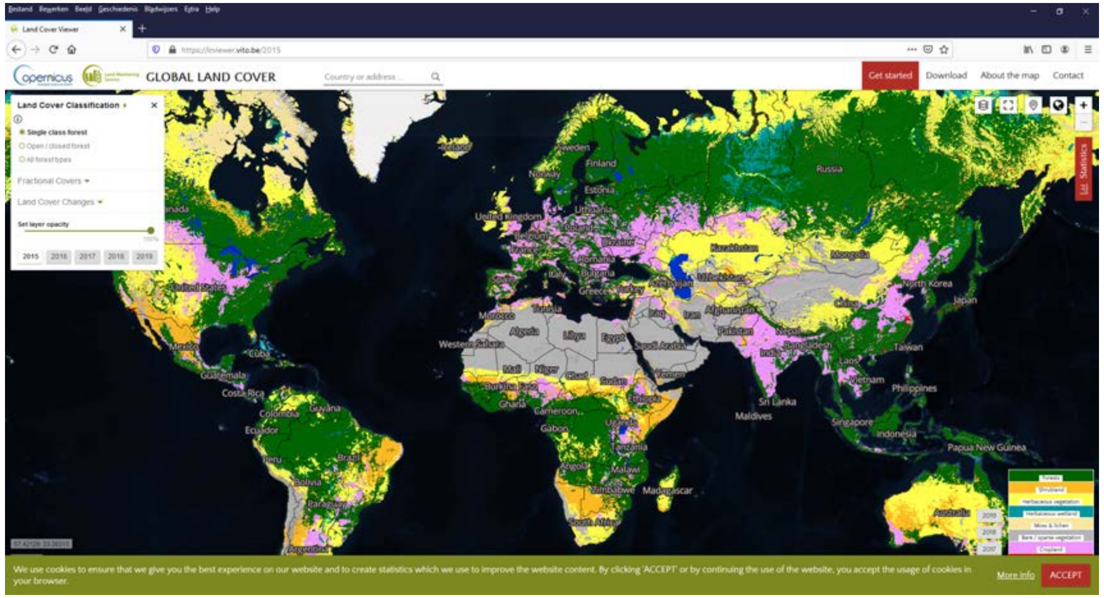
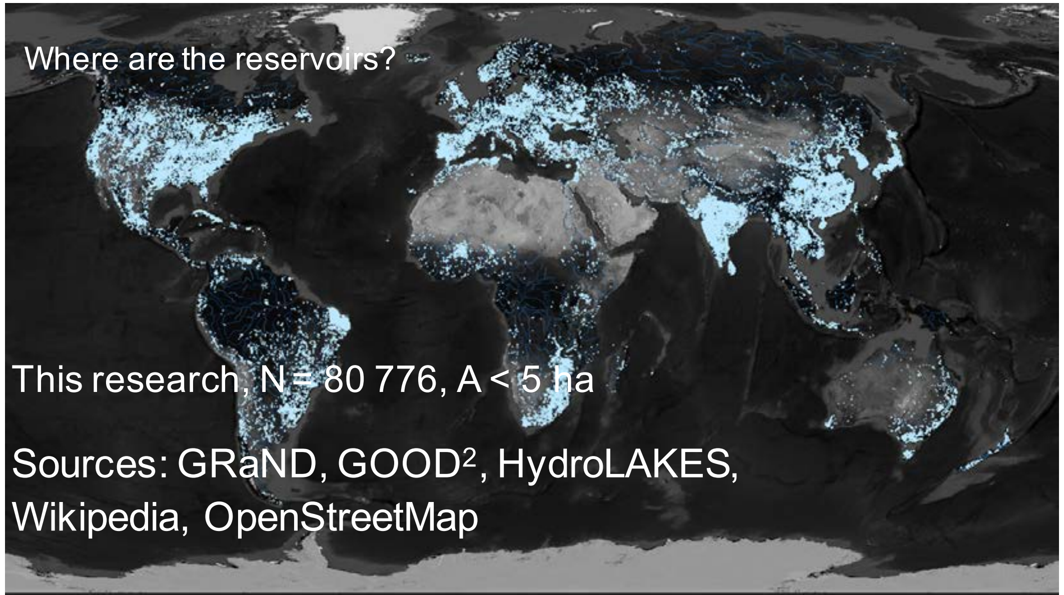
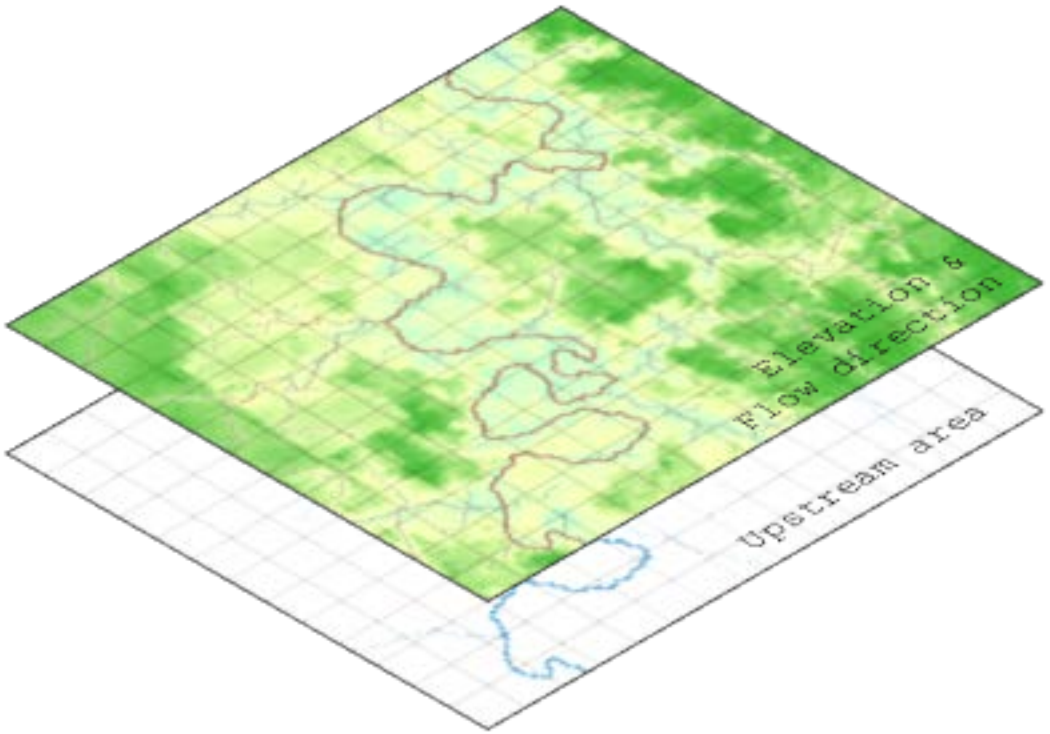
Available high resolution global data sources



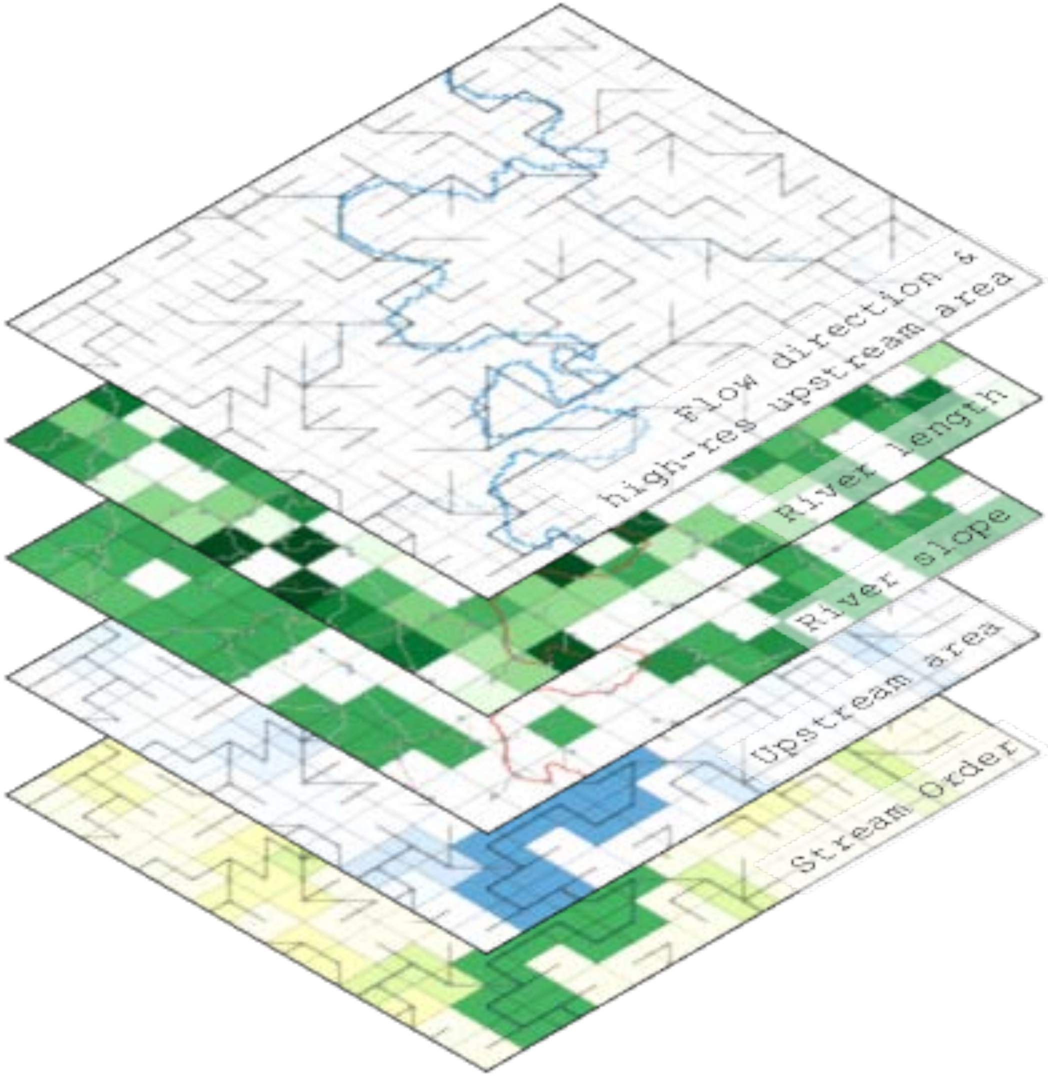




High resolution hydrography data



Upscaled model resolution hydrography and subgrid river data



Input for
-rainfall runoff model
-groundwater model
-hydrodynamic model
-water quality model

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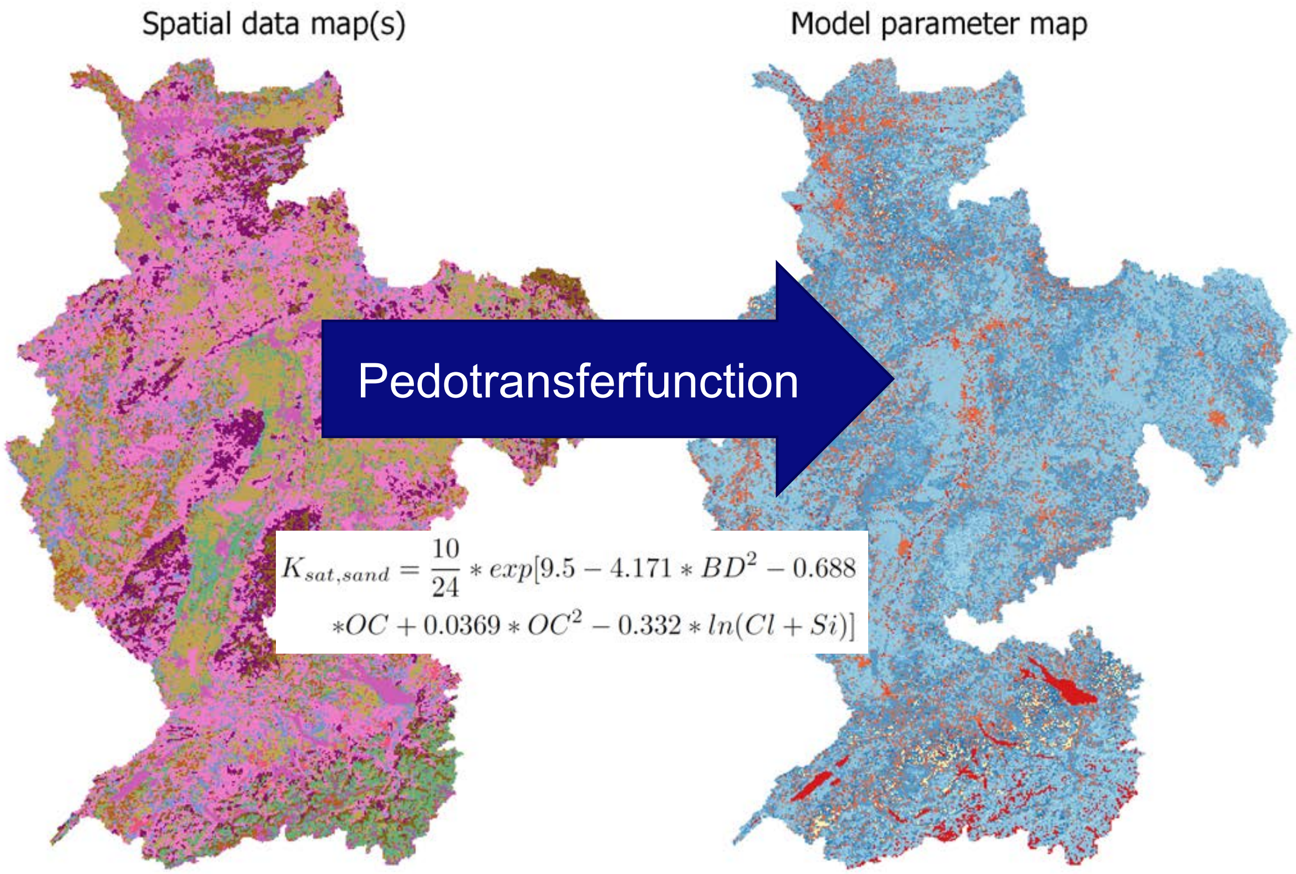
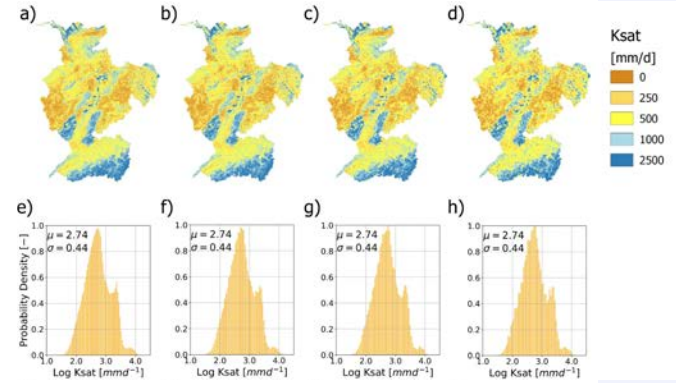
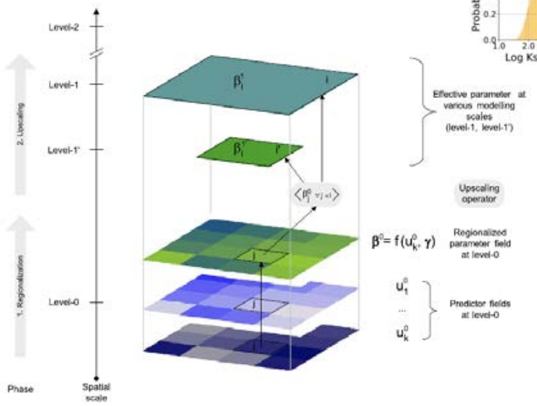
Rainfall-Runoff: wflow_sbm parameter estimation (global setup)



$$K_{sat,sand} = \frac{10}{24} * exp[9.5 - 4.171 * BD^2 - 0.688 * OC + 0.0369 * OC^2 - 0.332 * ln(Cl + Si)]$$

- Physically based model concept
- Minimal calibration
- Multi-Resolution





Imhoff, van Verseveld, van Osnabugge and Weerts. et al. 2020, Scaling Point-Scale (Pedo)transfer Functions to Seamless Large-Domain Parameter Estimates for High-Resolution Distributed Hydrologic Modeling: An Example for the Rhine River*Water Resources Research, doi: 10.1029/2019WR026807.*

Samaniego, Luis, Rohini Kumar, and Sabine Attinger. "Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale." Water Resources Research 46.5 (2010).

scalable high resolution hydrological model with global setup

KGE=Kling Gupta Efficiency metric that accounts for correlation, bias, variability


Water Resources Research

RESEARCH ARTICLE

10.1029/2019WR026807

Special Section:
Advancing process representation in hydrologic models: Integrating new concepts, knowledge, and data

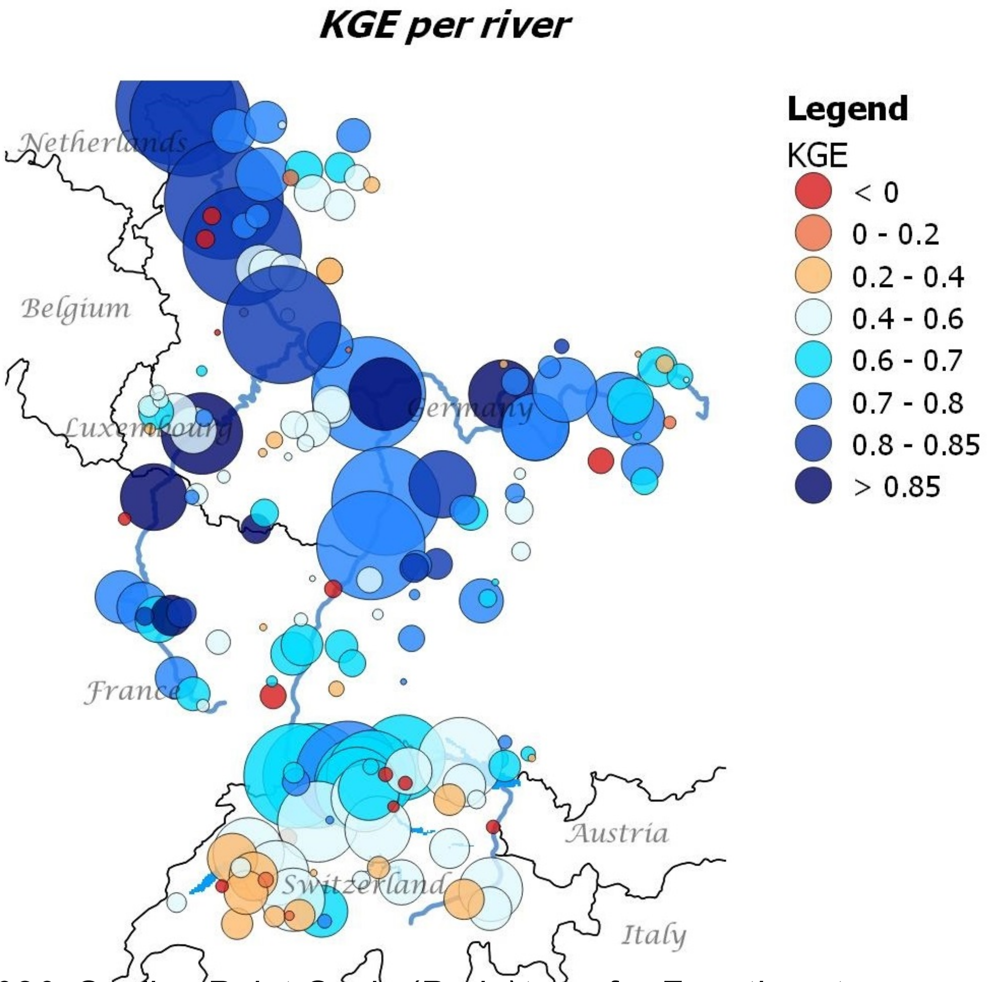
Key Points:
- Seamless distributed parameter maps can be obtained for the gridded hydrologic model wflow_sbm with transfer functions from literature
- Application of wflow_sbm with these seamless parameter maps yields simulation results with high

Scaling Point-Scale (Pedo)transfer Functions to Seamless Large-Domain Parameter Estimates for High-Resolution Distributed Hydrologic Modeling: An Example for the Rhine River

R. O. Imhoff[1,2], W. J. van Verseveld[3], B. van Osnabrugge[1,2], and A. H. Weerts[1,2]

[1]Operational Water Management, Department of Inland Water Systems, Deltares, The Netherlands, [2]Hydrology and Quantitative Water Management Group, Wageningen University & Research, Wageningen, The Netherlands, [3]Catchment and Urban Hydrology, Department of Inland Water Systems, Deltares, The Netherlands

Abstract Moving toward high-resolution gridded hydrologic models asks for novel parametrization approaches. A high-resolution conceptual hydrologic model (wflow_sbm) was parameterized for the Rhine basin in Europe based on point-scale (pedo)transfer functions, without further calibration of effective



Imhoff, van Verseveld, van Osnabugge and Weerts. et al. 2020, Scaling Point-Scale (Pedo)transfer Functions to Seamless Large-Domain Parameter Estimates for High-Resolution Distributed Hydrologic Modeling: An Example for the Rhine RiverWater Resources Research, doi: 10.1029/2019WR026807.

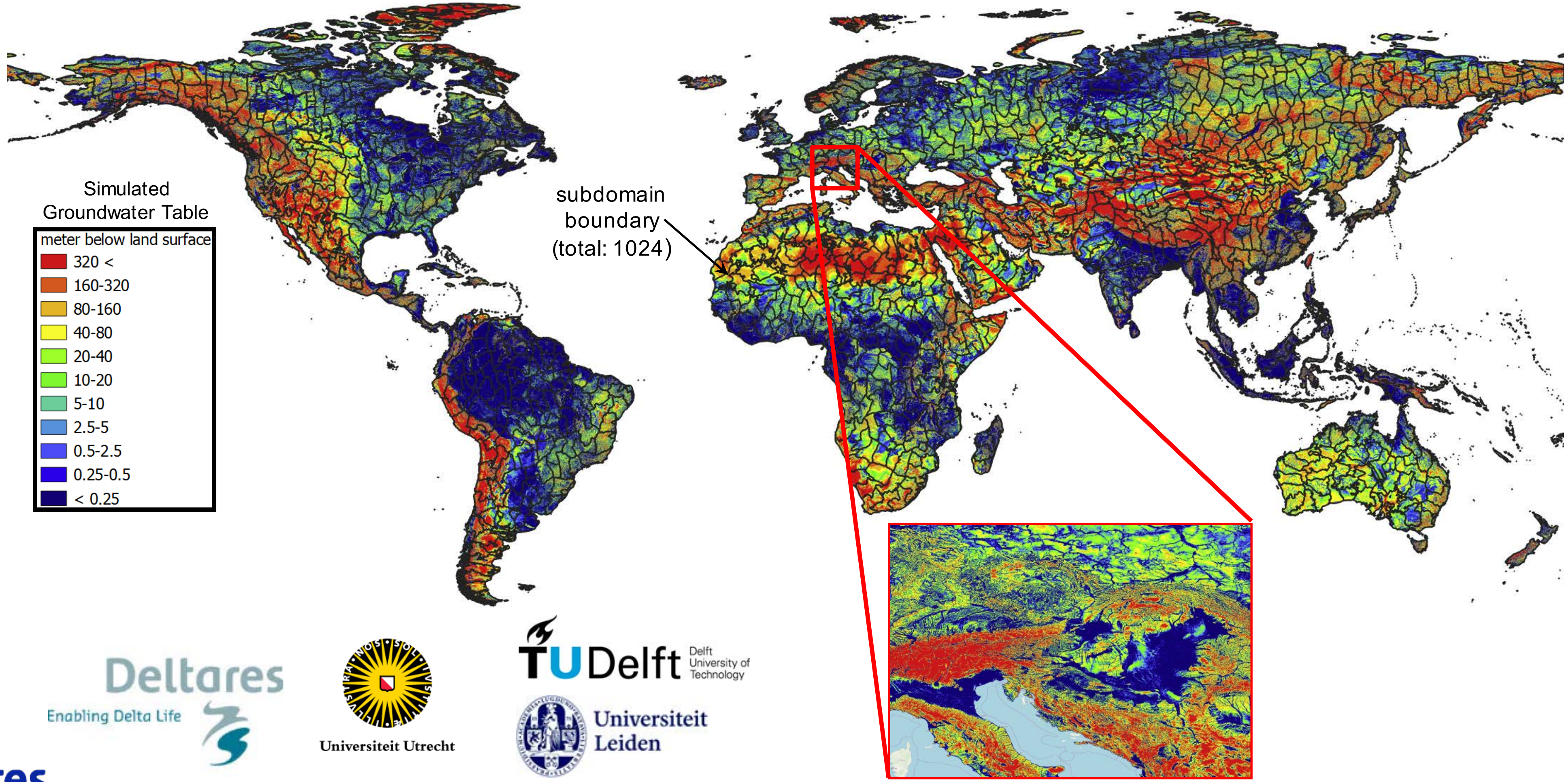
Hydrodynamic models (DELFT3D-FM)

Unstructured grid with resolution up to 1.25km

Exascale groundwater simulation

a global 1km MODFLOW model (428M cells, 2 layers)

Jarno Verkaik, Edwin Sutanudjaja, Gualbert Oude Essink, Hai Xiang Lin, Marc Bierkens



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TU Delft Delft University of Technology

Universiteit Leiden

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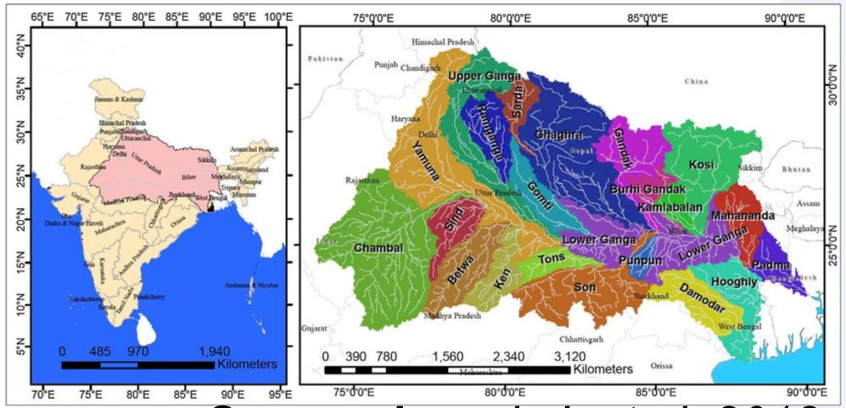
Example Ganga River



Source: Anand, J. et al. 2018

- Most densely populated river basin in the world
- Home to half the population of India (700 Mln) including two-thirds of the nation’s poor people
- Covering 4 countries and 11 states in India
- Contributes to >50% of national water use
- Highly polluted




Objective of the study

1. Strengthen capacity with respect to strategic basin planning;
2. Development set of scenarios and strategies for the Ganga basin;
3. Build a strong and accessible knowledge base;
4. Establish a multi-stakeholder engagement process to support strategic basin planning.

Title:	***Analytical Work and Technical Assistance to support Strategic Basin Planning for Ganga River Basin in India***
Financed by:	World Bank
Consortium:	Deltares, Aecom and Future Water
Period of assignment:	June 2015 – June 2018
Total contract value:	4 Mln AUD

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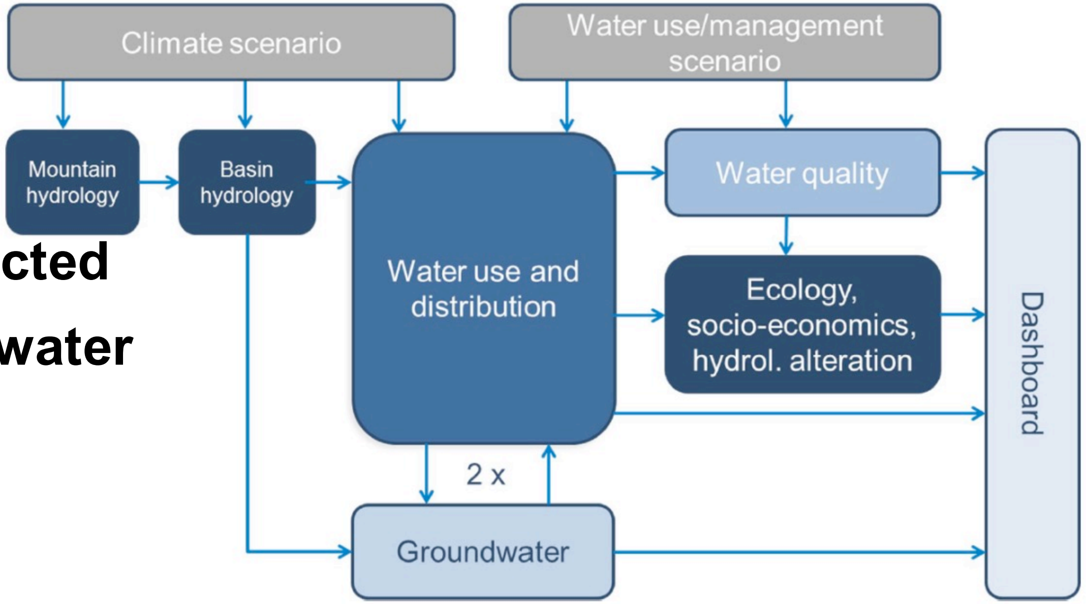
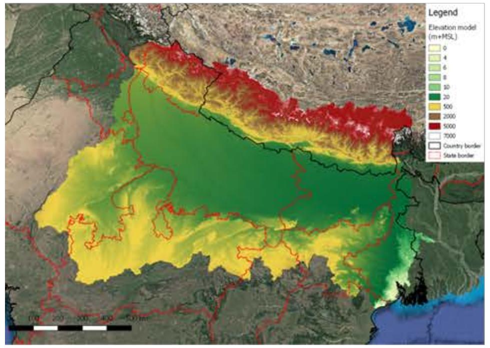
AECOM FutureWater

Model setup and workflow

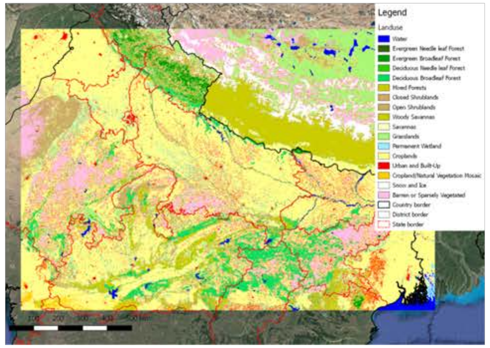


- **Integrated tools all using same base data and connected (rainfall runoff, groundwater, river basin management, water quality) integrating local data**

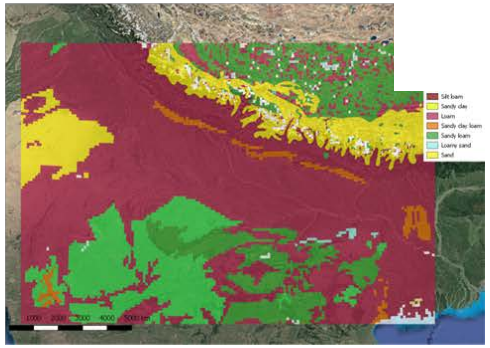
Elevation



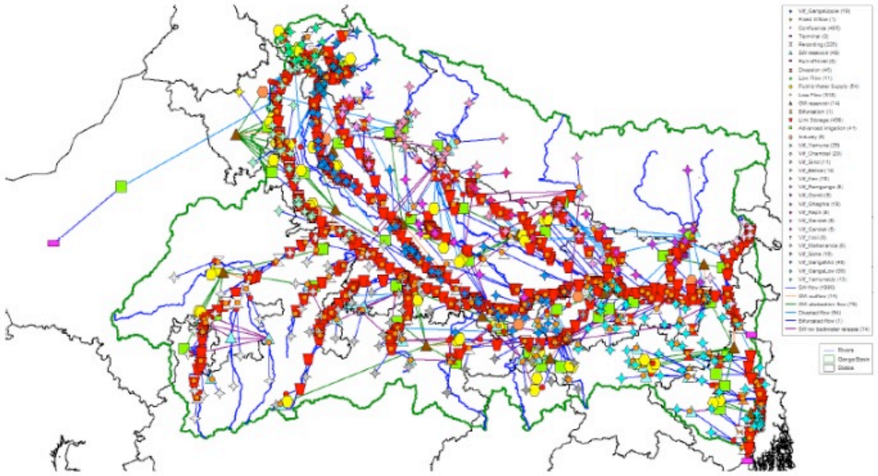
Landuse



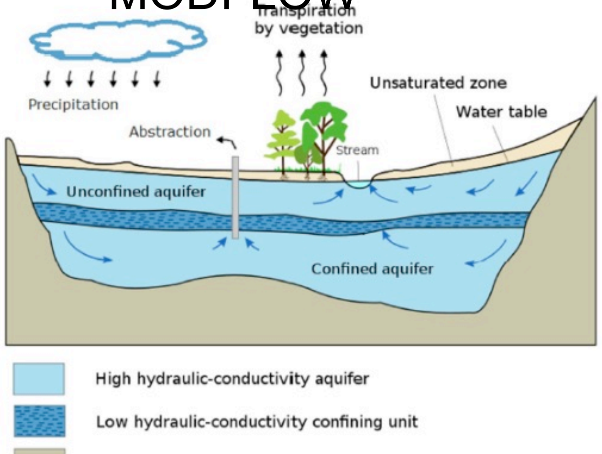
Soil



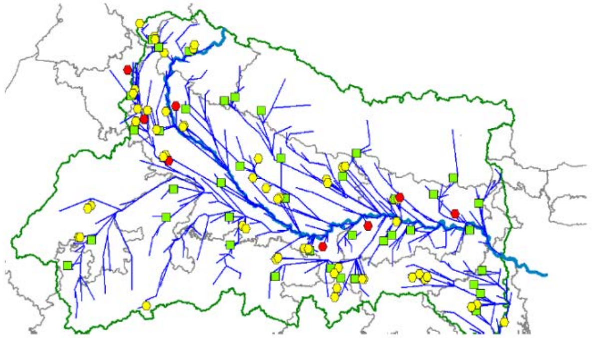
Wflow + Ribasim



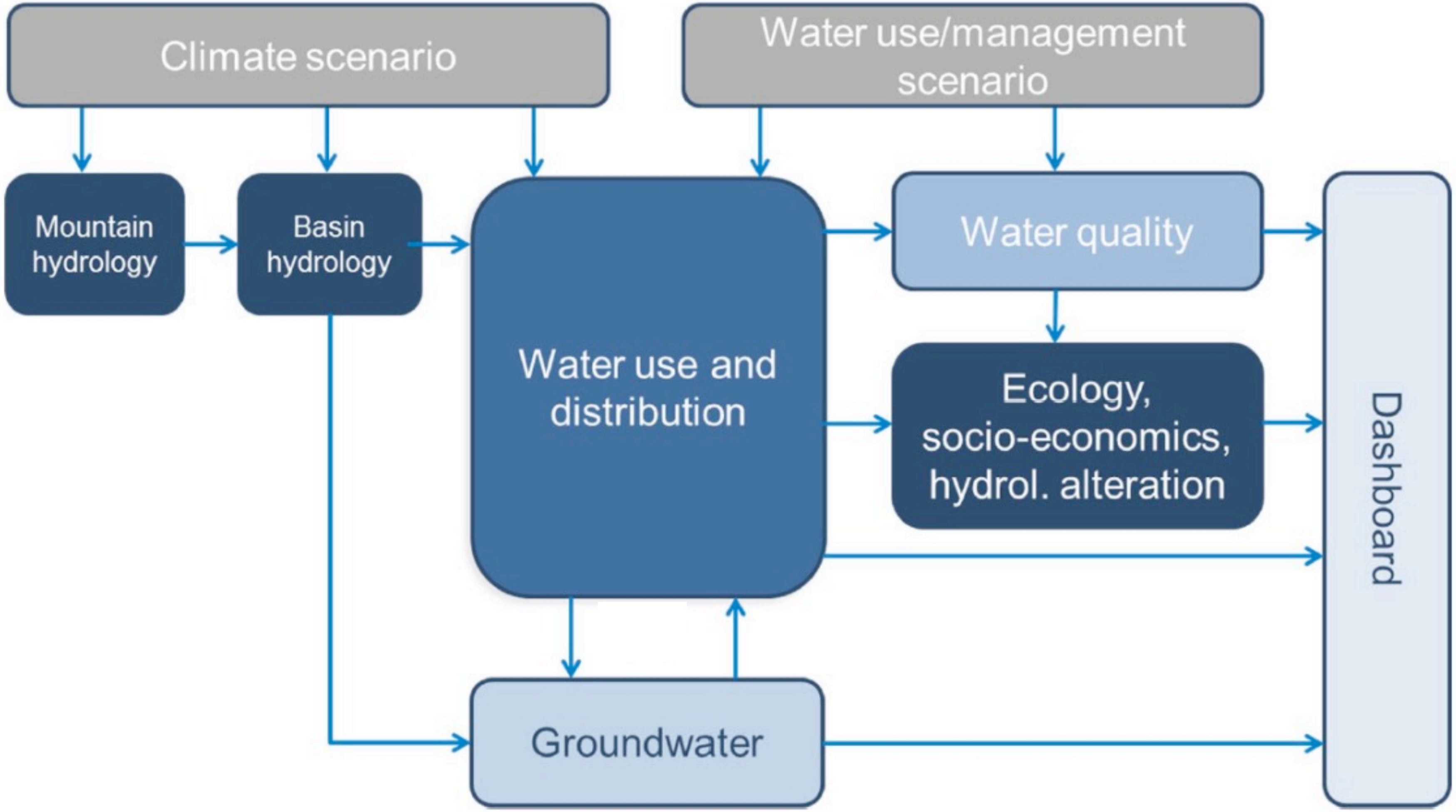
MODFLOW



D-WAQ



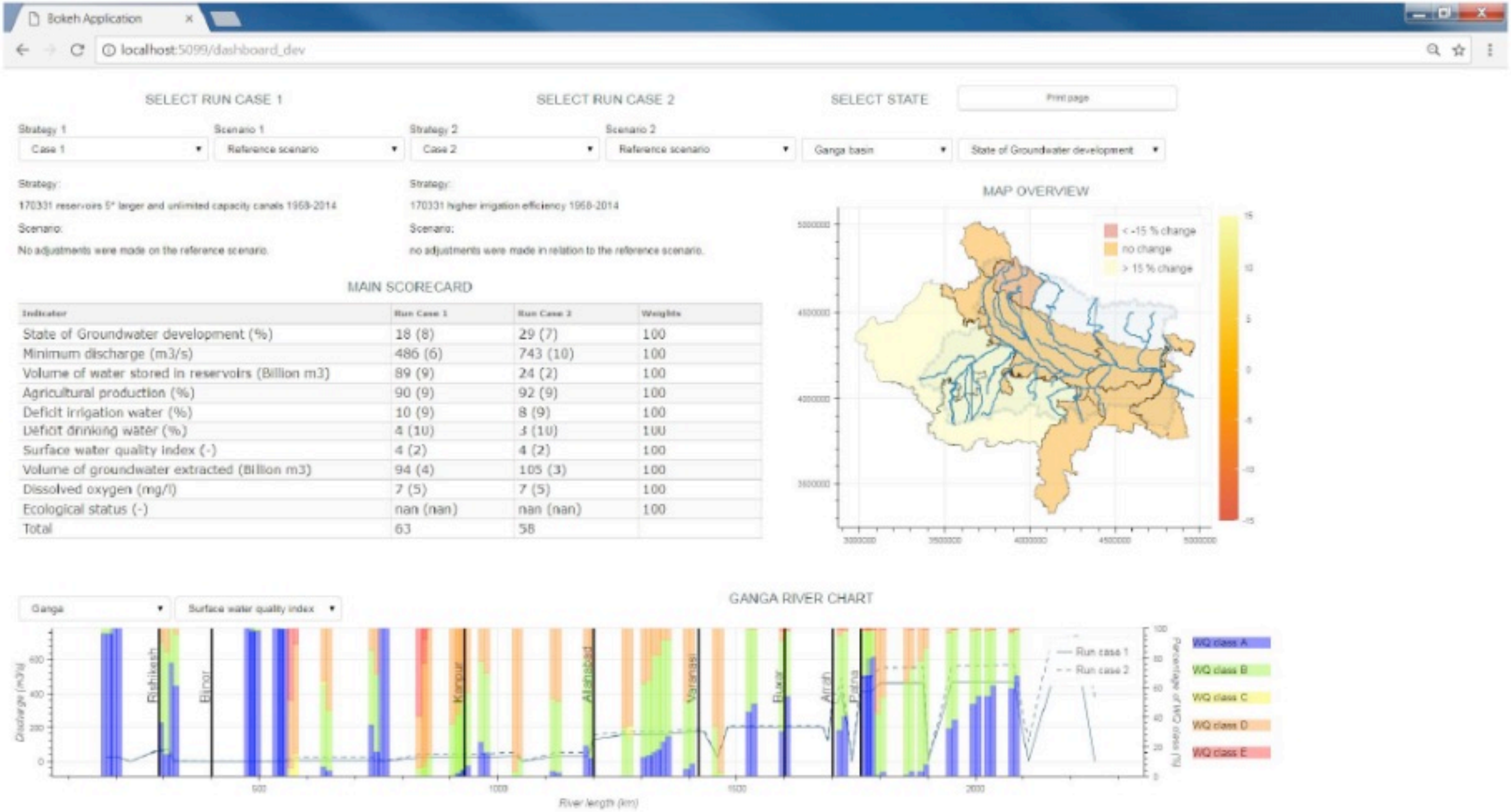
Ganga river basin model workflow



Scenario and strategy assessment with stakeholders

Indicator	Code
State of Groundwater development (% critical areas)	GW overext.
Lowest discharge (m3/s)	Low Q
Volume of water stored in reservoirs (Billion m3)	Res.Store
Agricultural crop production (% of area harvested)	Agr.Harv.
Deficit irrigation water (%)	IRR deficit
Deficit drinking water (%)	DR deficit
Surface water quality index (-)	WQ index
Volume of groundwater extracted (Billion m3)	GW used
E-flow: Ecological status (-)	E-ecol
E-flow: Hydrological status (-)	E-hydr
E-flow: Socio-Economic status (-)	E-socio

Scenario and strategy assessment: dashboard



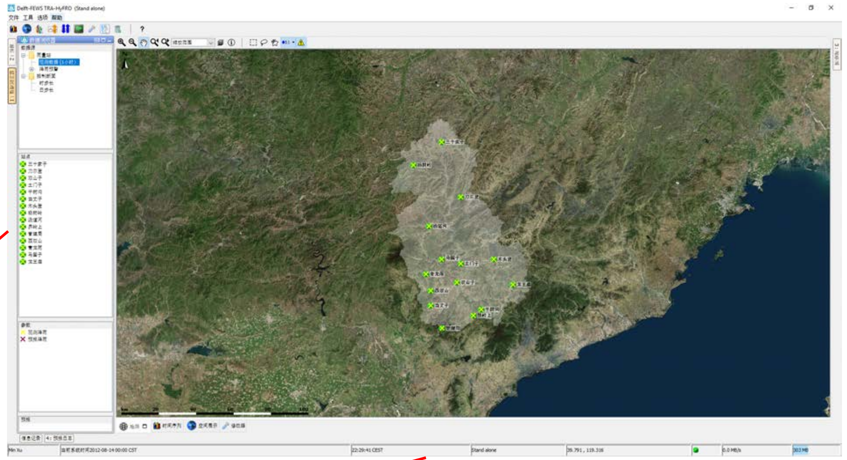
Indicator	Run Case 1	Run Case 2	Weights
State of Groundwater development (%)	18 (8)	29 (7)	100
Minimum discharge (m3/s)	486 (6)	743 (10)	100
Volume of water stored in reservoirs (Billion m3)	89 (9)	24 (2)	100
Agricultural production (%)	90 (9)	92 (9)	100
Deficit irrigation water (%)	10 (9)	8 (9)	100
Deficit drinking water (%)	4 (10)	3 (10)	100
Surface water quality index (-)	4 (2)	4 (2)	100
Volume of groundwater extracted (Billion m3)	94 (4)	105 (3)	100
Dissolved oxygen (mg/l)	7 (5)	7 (5)	100
Ecological status (-)	nan (nan)	nan (nan)	100
Total	63	58	

Ongoing developments

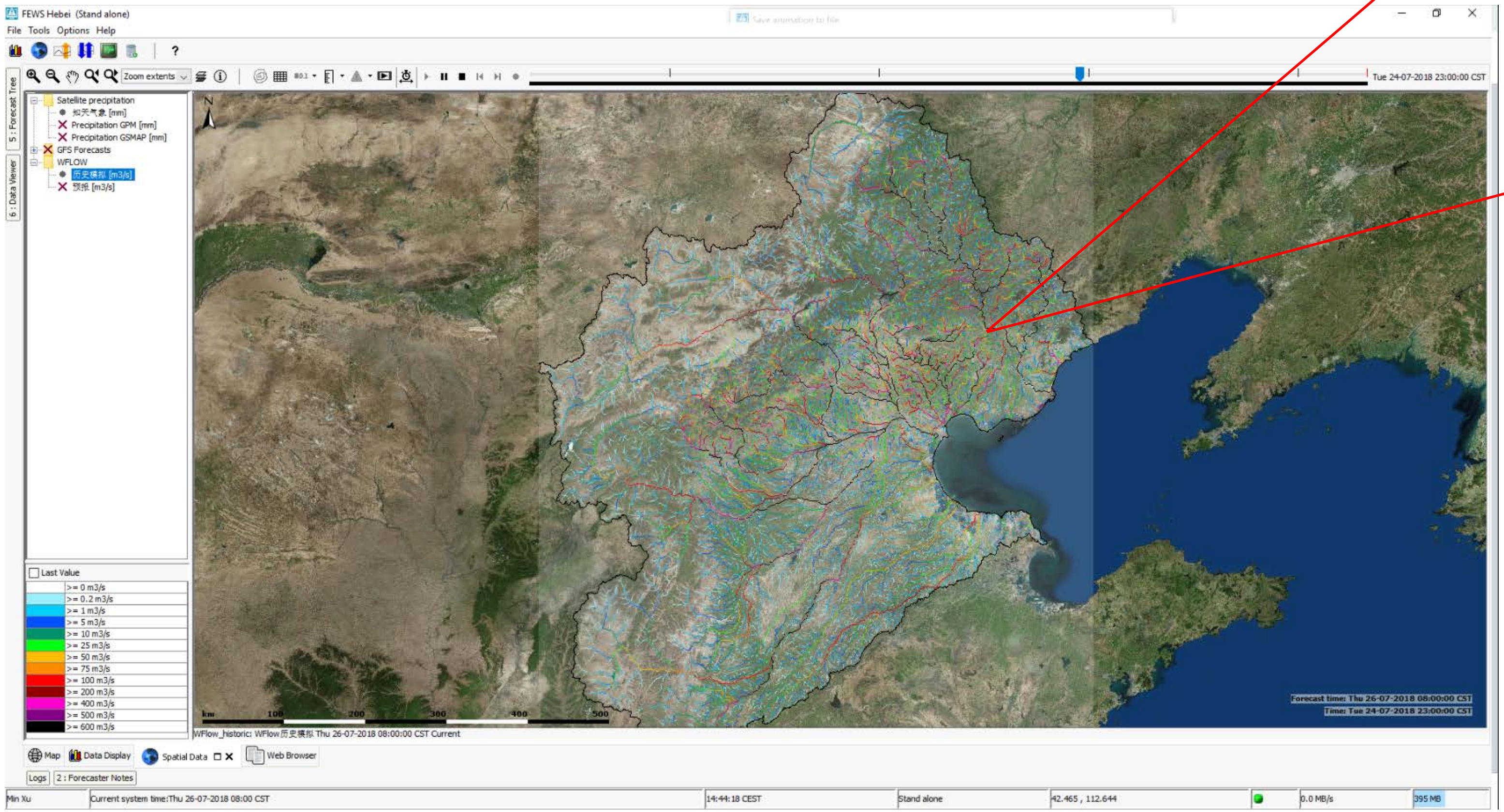
Rapid model setup Hai River Basin (wflow demo)

Taolinkou streamflow forecast project

- 500x500m resolution

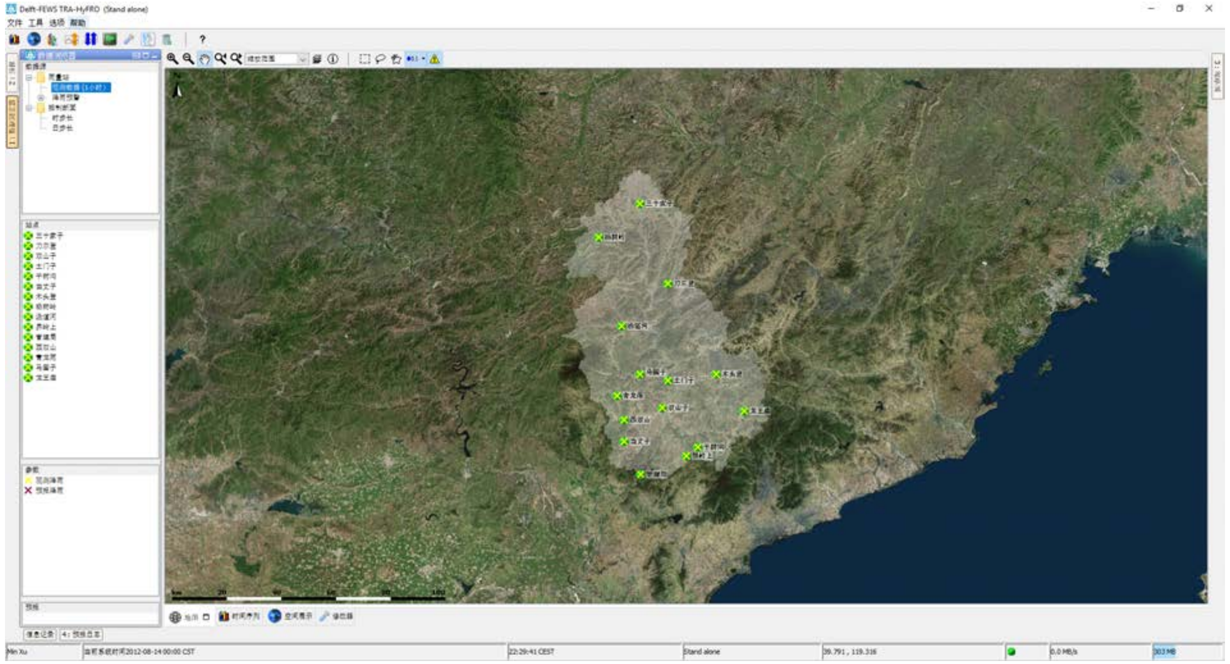


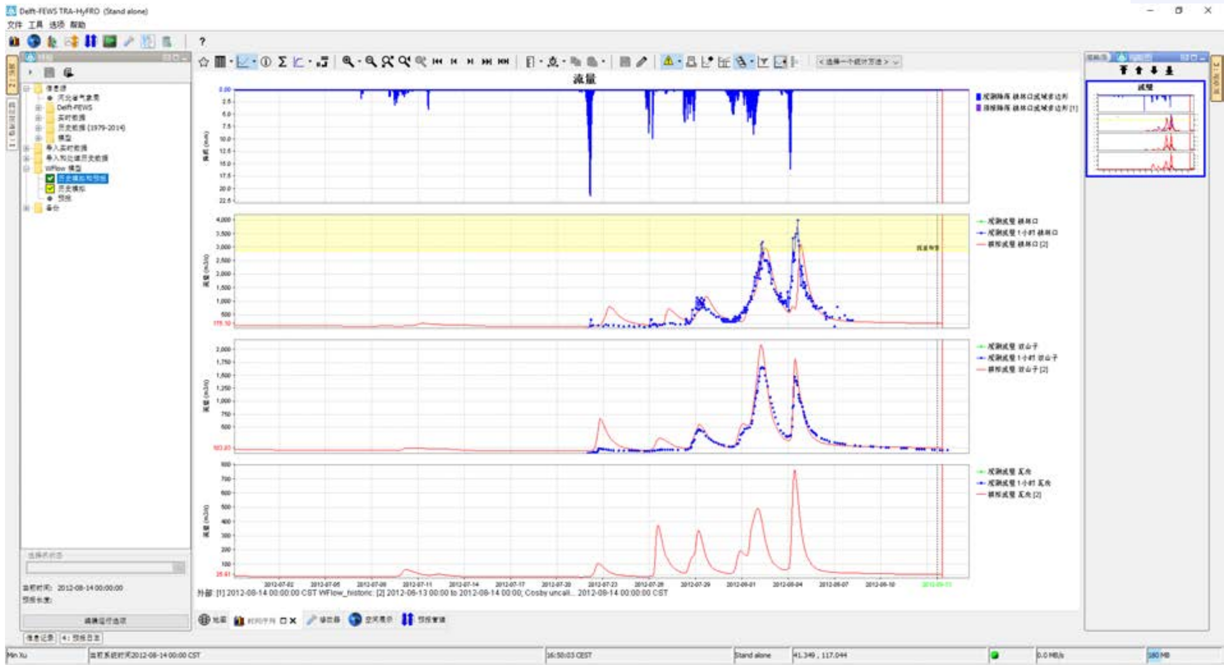
- 1x1km resolution
- Uses open source data
- Coupled with local meteo forecast from Beijing Zhitian Technology



Piloting Taolinkou reservoir streamflow forecast

- Multi-function reservoir: water supply (domestic water and irrigation) (1), flood control (2), hydro-power (3)
- Introduce meteo forecast in hydro forecast (most of the river catchment uses observation to run simulation towards the future and update with the most recent rainfall observation)
- With the meteo forecast, the lead time is increased
- Selection of multiple data sources (both observation and forecast) for comparison
- Distributed (wflow) model takes advantage of grid (open) data (the client didn’t provide any data, except limited data for rain gauges and 2 hydro stations
- Challenge of quick peak rise and fall within several hours

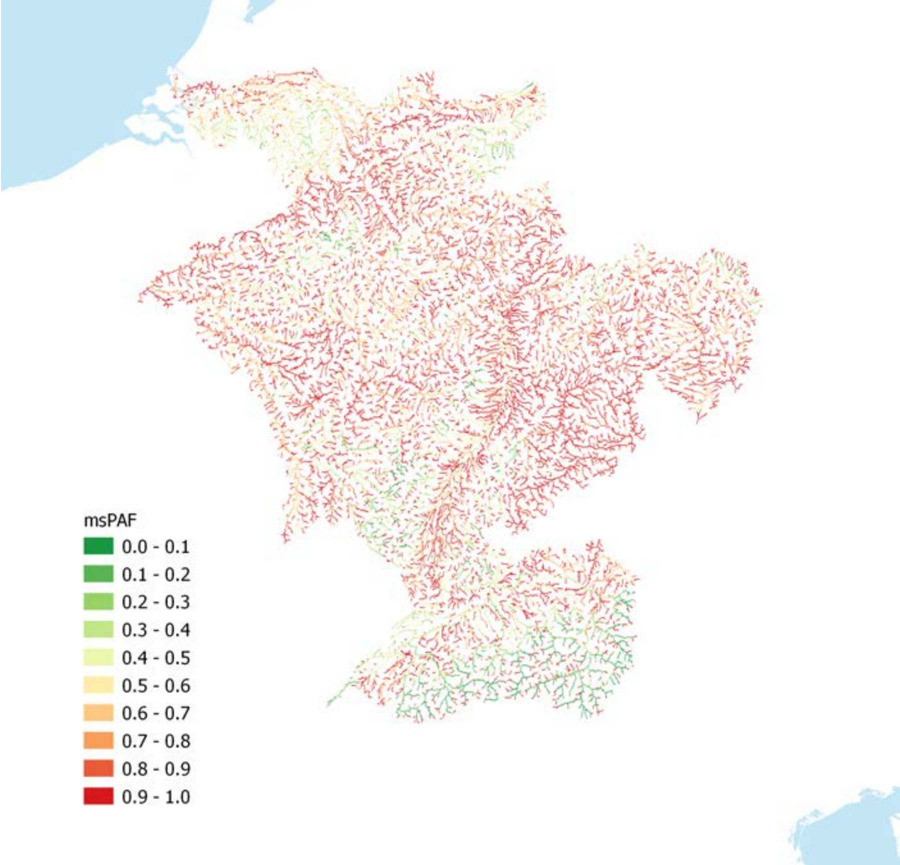




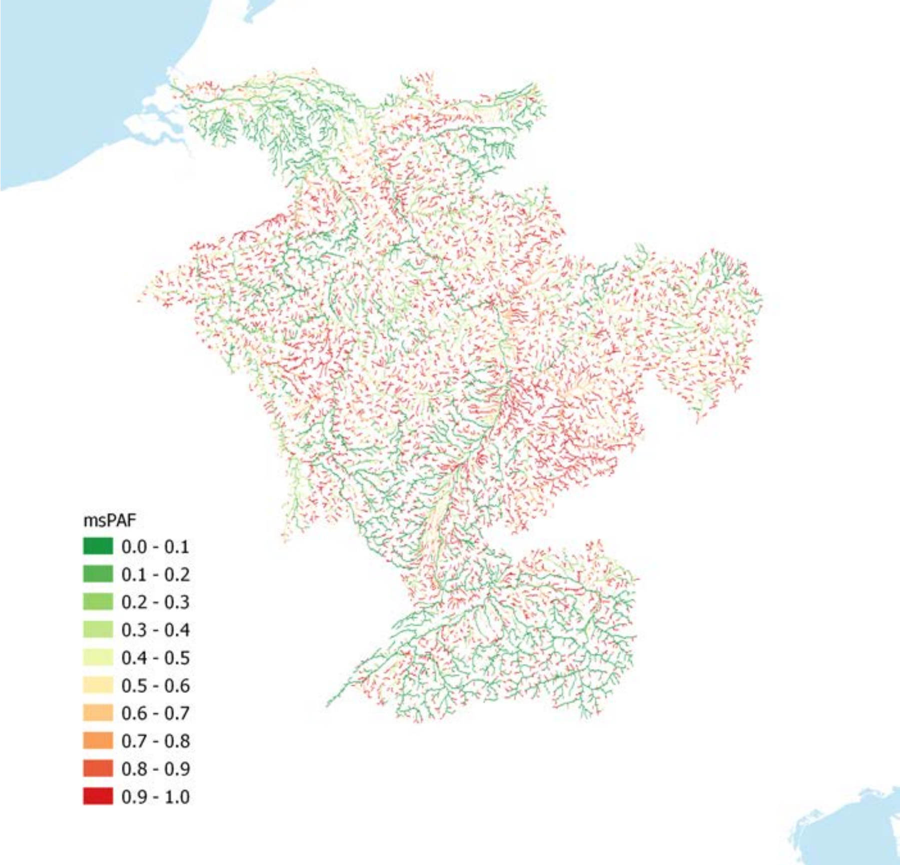
Rapid model setup from global to local (D-WAQ, water quality)

BlueEarth Engine

Water Quality indicator (max)



Water Quality indicator (min)



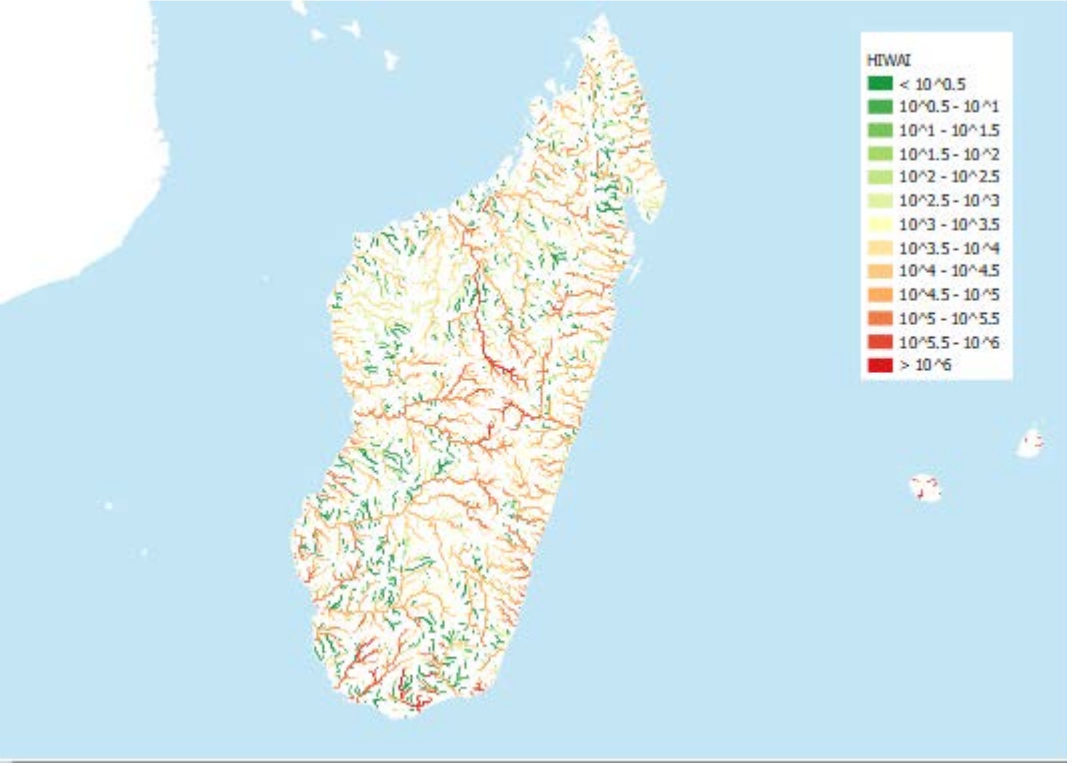
Work for CHR

msPAF is an indicator for toxicity from chemicals

Deltares

Use hydrological wflow_sbm model set up (Imhoff et al Water Resour. Res. 2020, van Verseveld et al., 2020 GMD in prep, Wannasin et al., J of Hydrol Regional studies submitted 2020ab)

Rapid model setup from global to local (D-WAQ, water quality)

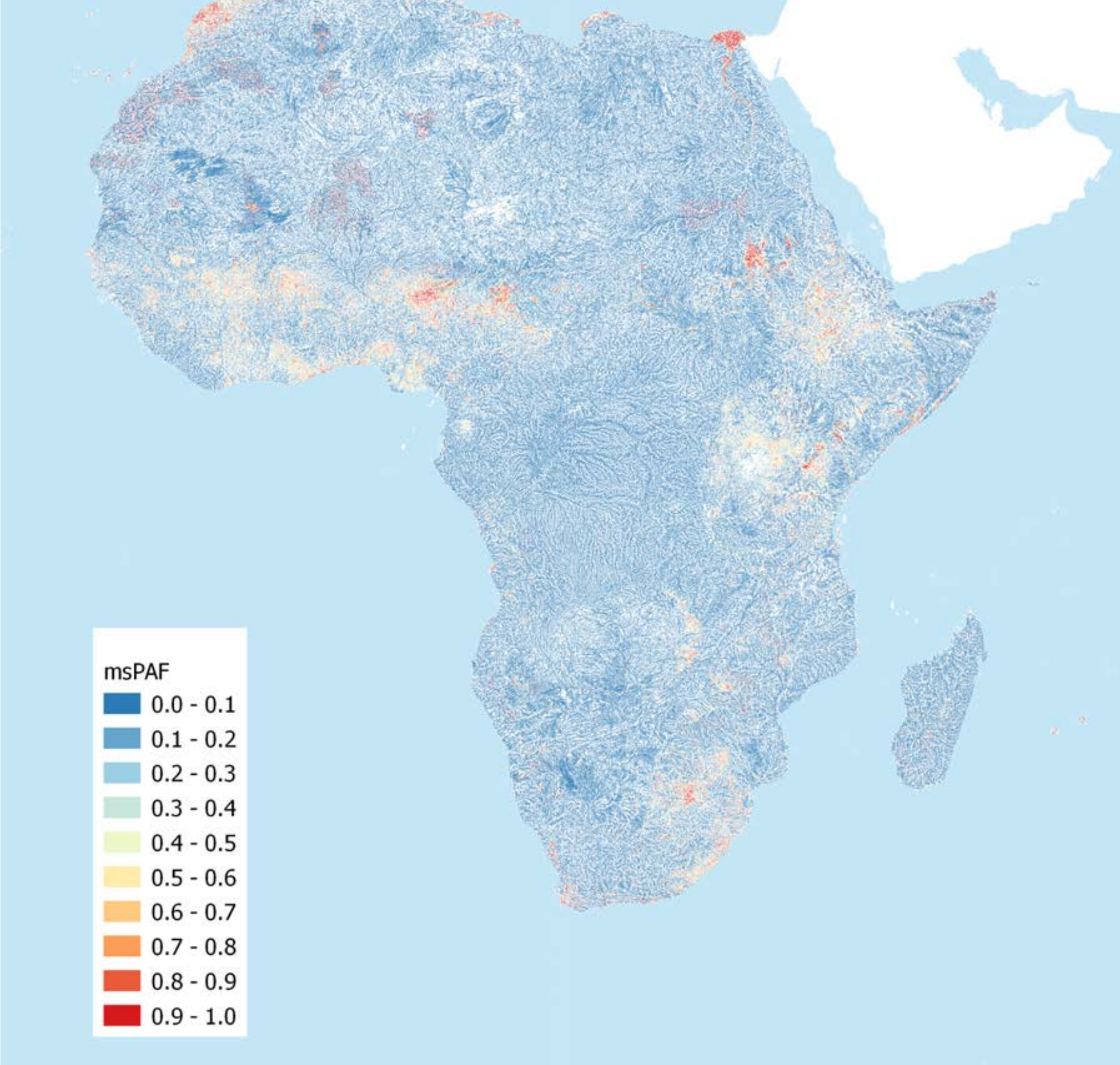


(HIWAI is proxy for chemicals in river)

Related to UN Global Water Quality Assessment

Deltares

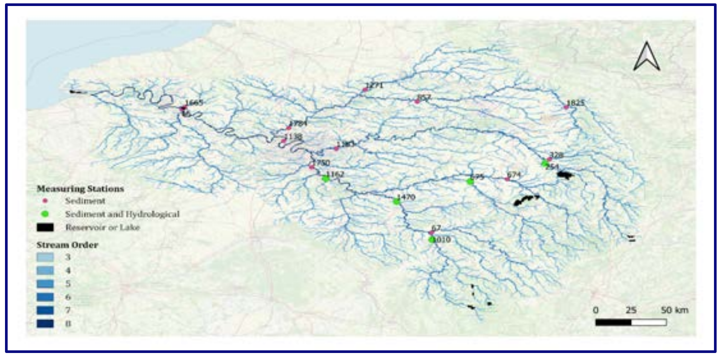
BlueEarth Engine

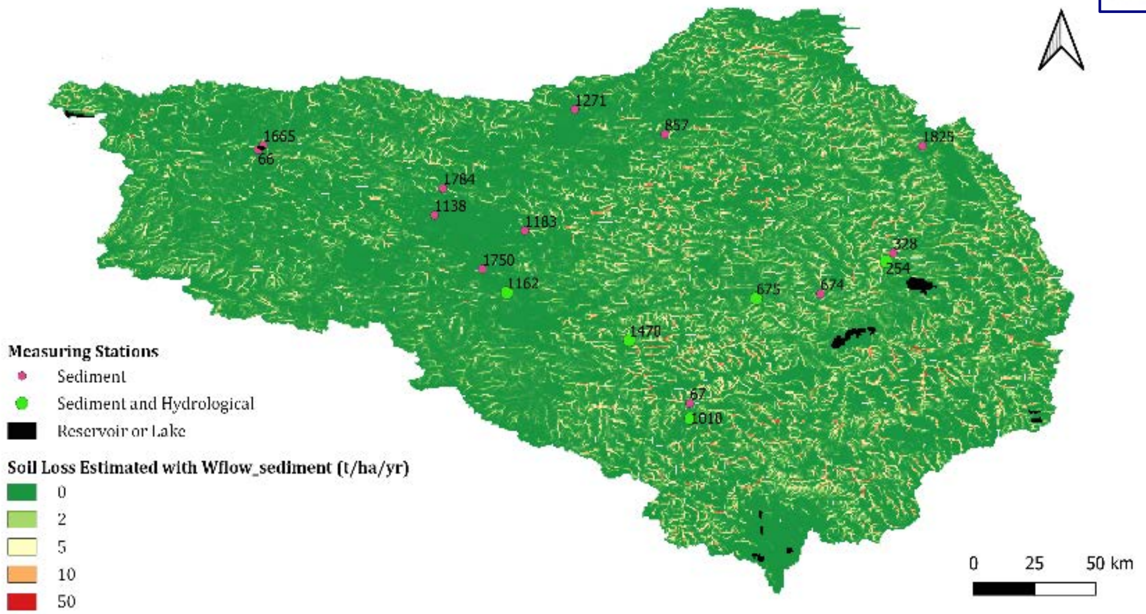


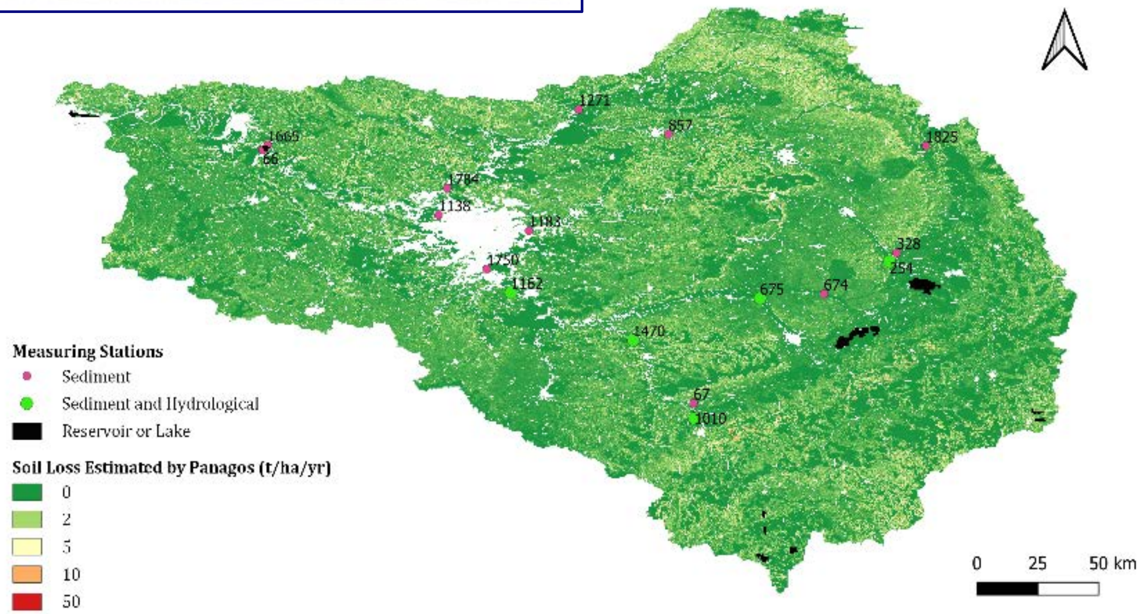
msPAF is an indicator for toxicity from chemicals

Soil loss

Work by Helene Boisgontier







	Wflow Sediment – EPIC*	Wflow Sediment - Renard & Foster*	Litterature
Mean Field Erosion (t/ha/yr)	0.91	1.05	0.94 (Panagos, 2013)
Mean Hillslope Erosion (t/ha/yr)	0.52	0.63	X
Basin Erosion (t/ha/yr)	0.08	0.08	0.075 (Lemoine, 2015)

* EPIC and Renard & Foster are two methods to compute the Soil Erodibility coefficient (KUSLE)

Sectoral water use

- Distinction between household, industrial, livestock and agricultural water use
- Down-scaling based on population density and (CORINE in Europe) land-use datasets

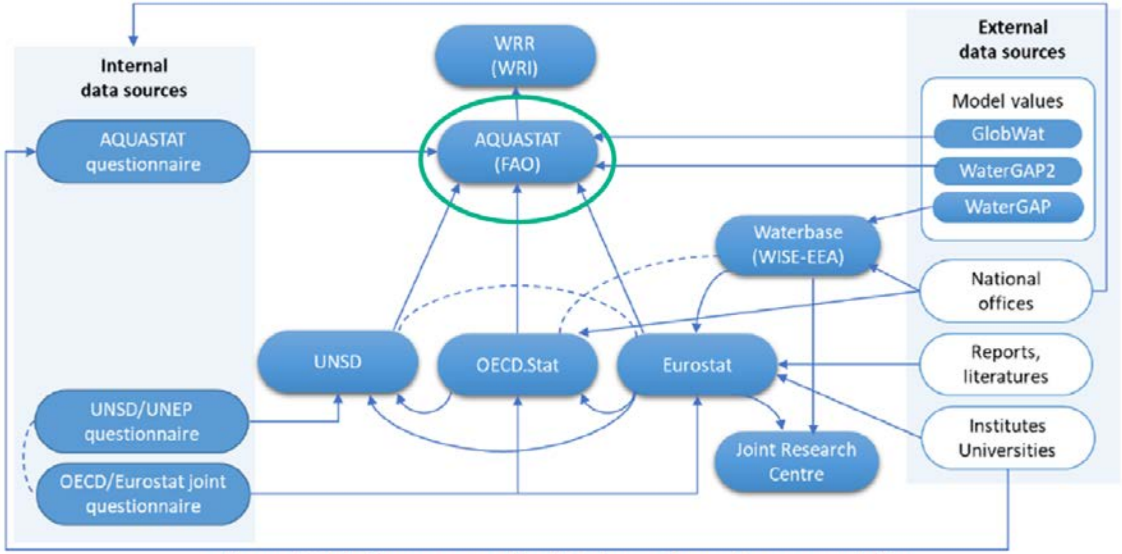
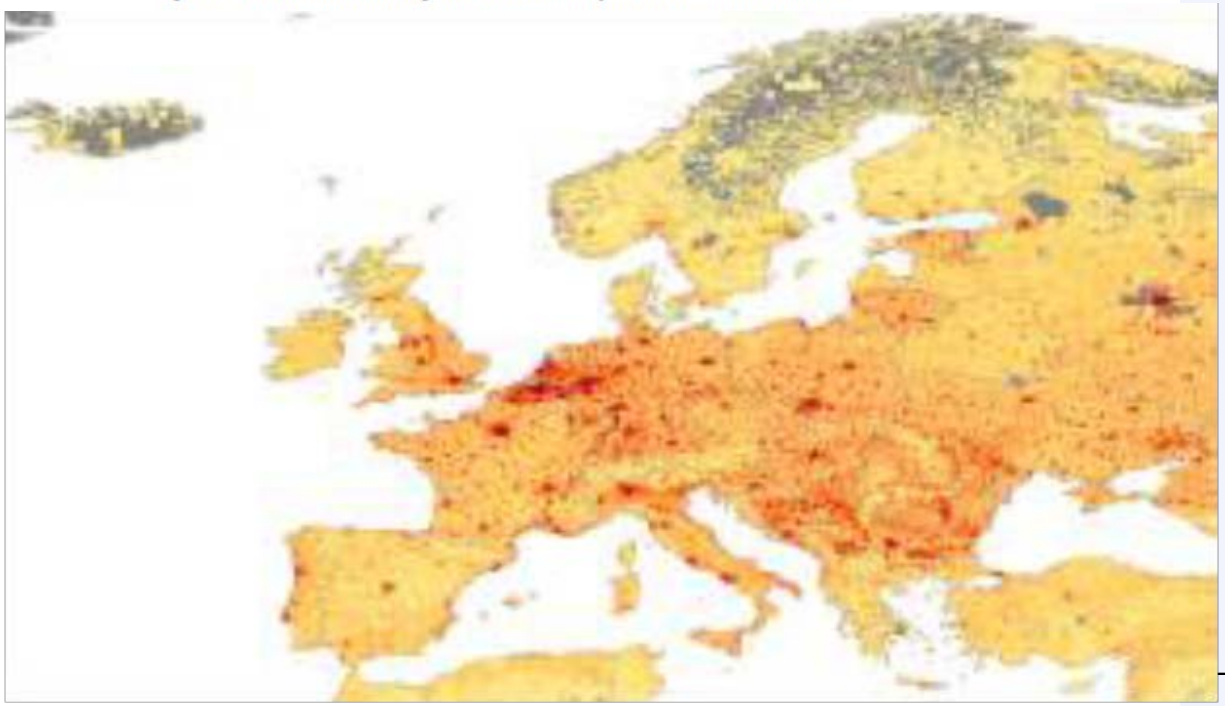


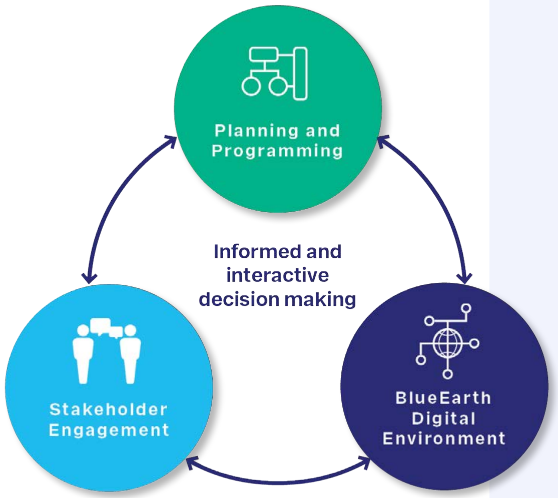
Figure 4 Relations among the databases for water use variables



Conclusions / Recap

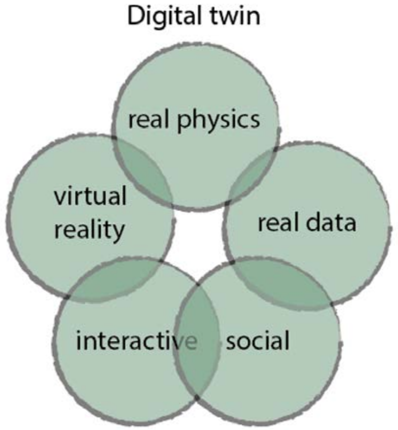
- **Reservoir management key in YR –** Water resources, water quality, sediment problems in the whole YR system need to be considered together

- **Policy – informed decision making (e.g. support adaptation pathways)**
  - Evidence based (measurements, sharing information stakeholders, combine global and local data)
  - Integrated modelling (rainfall-runoff, groundwater, water demand, management, reservoir management, water quality, river hydromorphodynamics)
  - Flexible (rapid, multi resolution, open or open source tools)



- **Operational Water Management**
  - Operational forecasting system (using integrated/linked models using similar setup, tailored data management system e.g. Delft-FEWS, real-time control reservoirs)

  ⇒ Next talk by Nadine Slootjes



Digital twins (for monitoring, understanding and stakeholder dialogue)

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