
(Credits: ANP)

Deltares

Integrated hydro–social modeling at catchment scale

A case for the Rhine basin

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Utrecht University

Context

Global trends

- Increasing variability of water availability → Less reliable sources
- Increasing pressure on available water resources → Higher demand of water

This requires

- Planning at river basin scale
- Integration of hydrological and social data & models
- Efficient multi-stakeholder communication & collaboration

This asks for a comprehensive approach for data, tools and effective stakeholder dialogues

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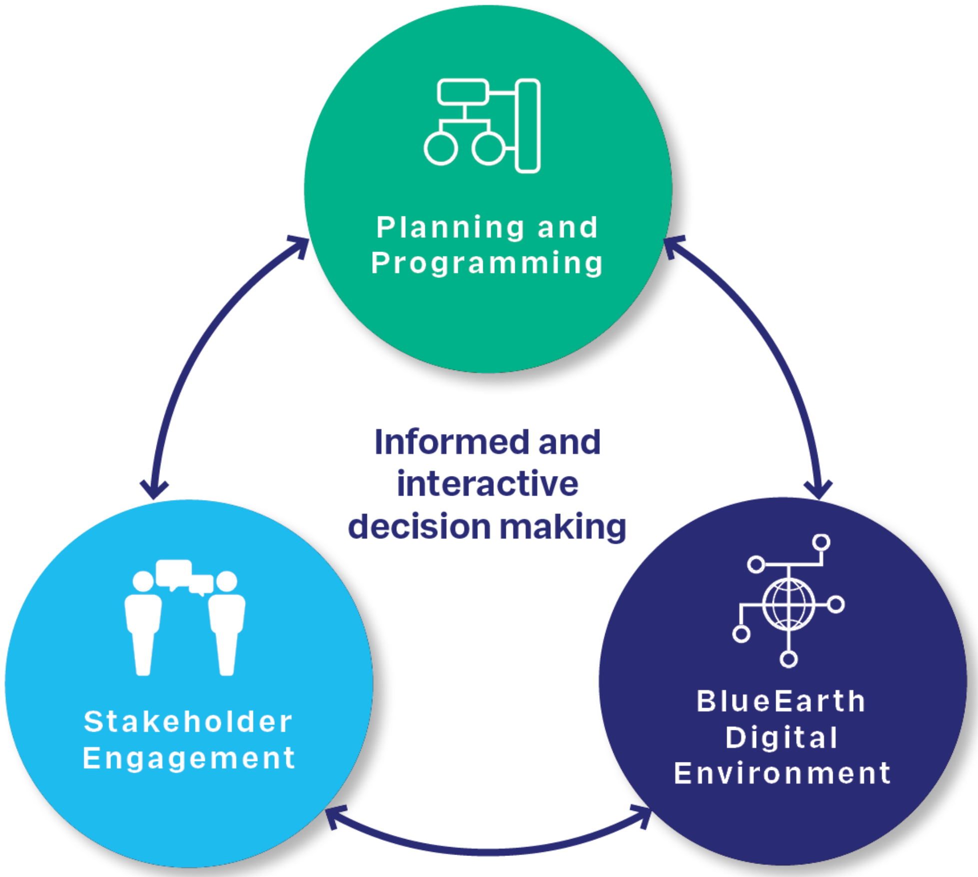
Need for a hydro-socio-planning-tool

- Taking into account both **climate change** and **socio-economic change** impacts
- Need for **integrated** modelling approach for socio-hydrological processes
- Generating insights in w**ater availability and demand** at basin scale
- Contribution to:
  - Climate resilient transnational river basin planning
  - Development of water scarcity management strategies

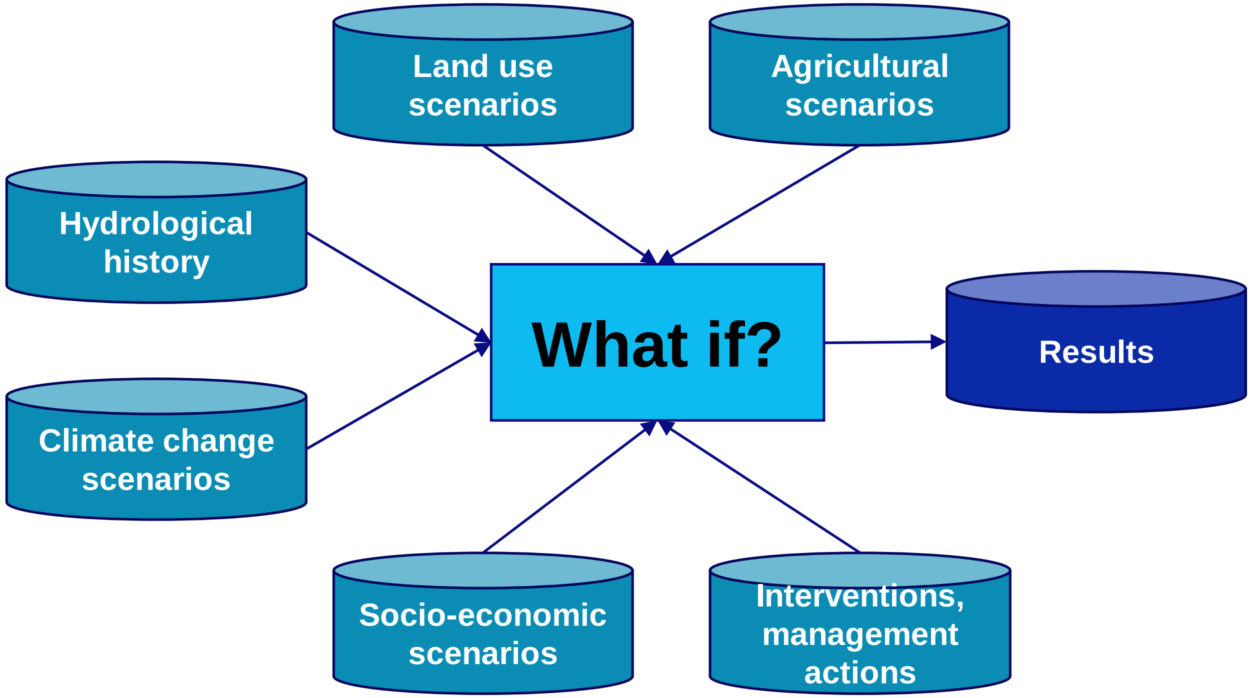


What kind of decisions could be supported by the tool?

- **Mitigation of drought hazard and risks**:
  e.g. low flows and navigation

- **Water management strategies:**
  e.g. reservoir management

- **Climate change adaptation:**
  e.g. shift from rainfed to irrigated agriculture, adapted water (re-)use



What's important for transnational 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, WQ + sediments, GW, …
  - 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

The case study for the Rhine

- Transboundary cooperation in the Rhine river basin
- Three international commissions: ICPR, CCNR, CHR

Credits photo: Erik Pennekamp

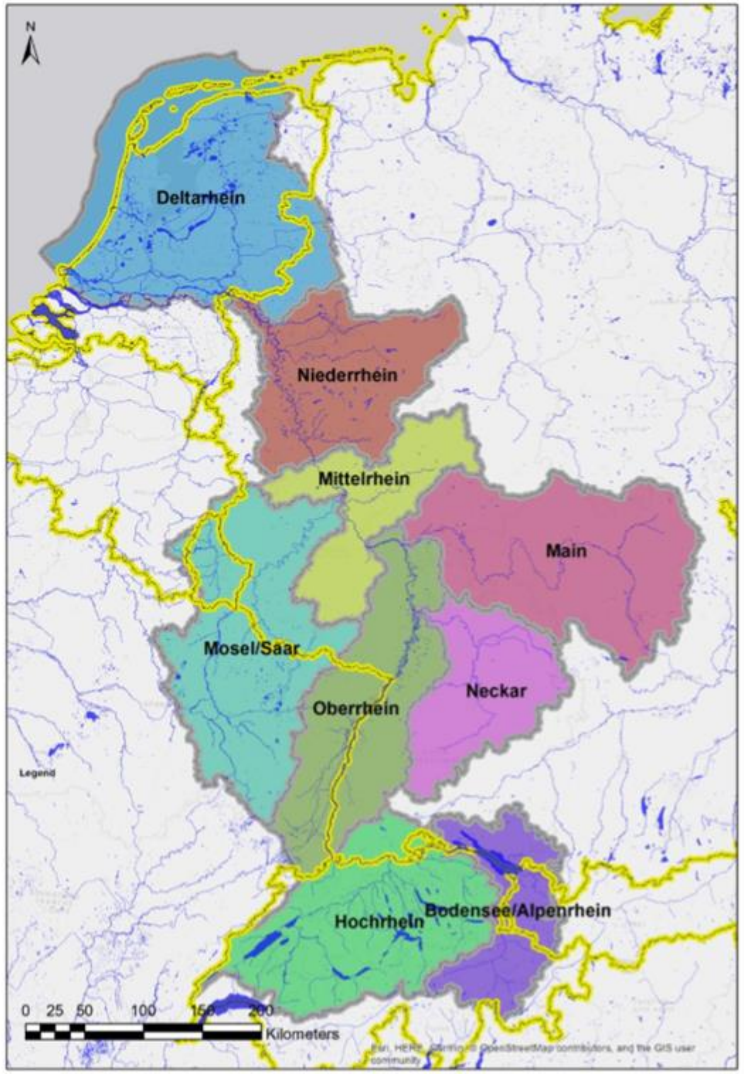


Figure: Geographical delineation of the Rhine river basin (Ruijgh et al, 2019)

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The case study for the Rhine

- Collection of open data → BlueEarth Data portal

  Constructing water demand data

- Quick setup of linked models → BlueEarth Engine

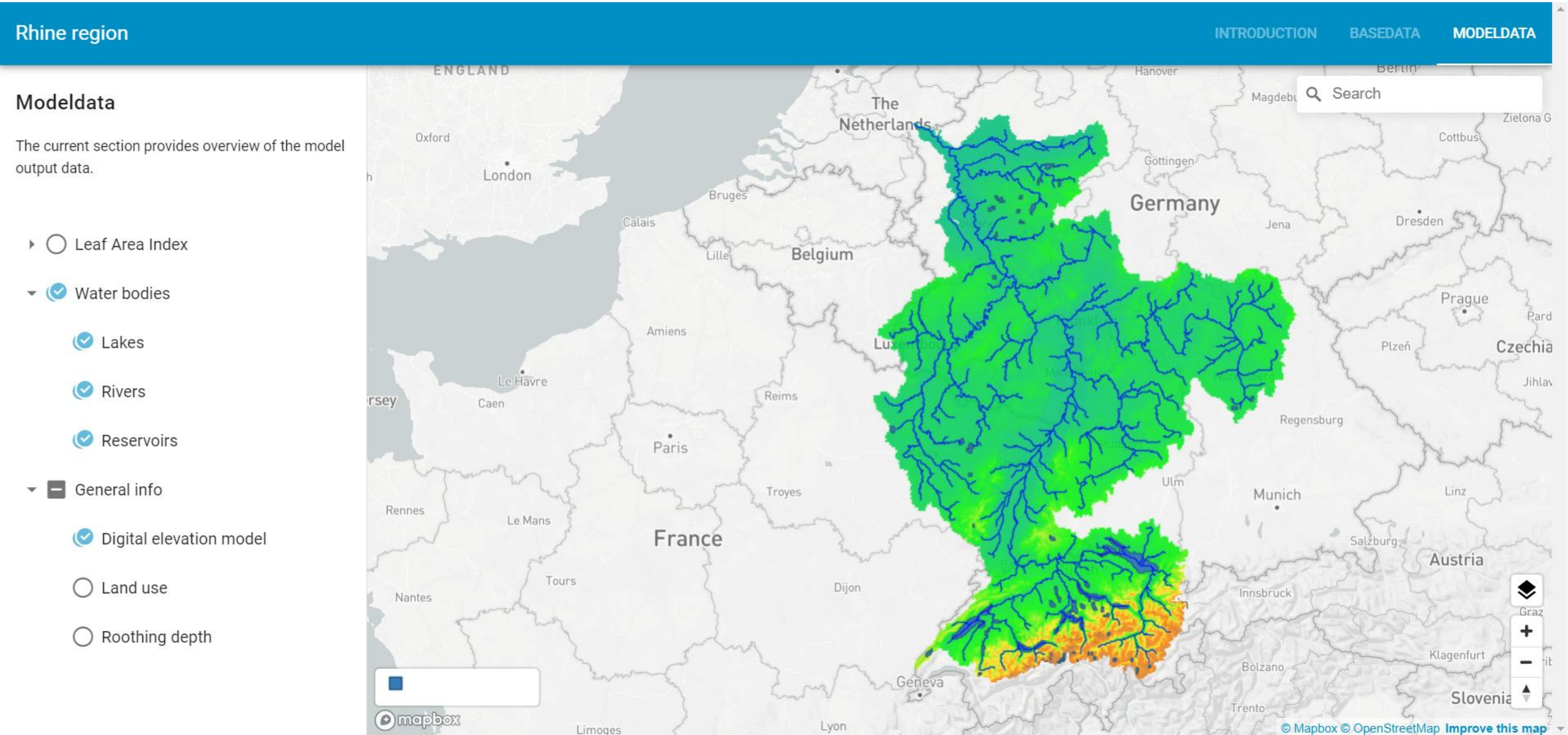
  Hydrology, demand & allocation, WQ, …

- Use of existing (global) models → PCR-GLOBWB

- **Brought together in 1 framework → BlueEarth**

Data:
Easy access to reliable (global)

BlueEarth Data



BlueEarth

Data:
Constructing a global water demand dataset

BlueEarth Data

- Water resources models require reliable gross and net water demand data
- Hyper-resolution water resources models are being developed, but high-resolution (~1km) global water demand data does not exist
- Therefore a flexible framework to define high-resolution water demand building upon existing concepts (Wada et al., 2011) and global datasets
- Global datasets enable global / continental modelling

Wada, Y., van Beek, L.P.H., Viviroli, D. et al. Global monthly water stress: 2. water demand and severity of water stress. Water Resources Research, 47(7), 2011) and datasets

Data:
Collection of reliable global water demand data

BlueEarth Data

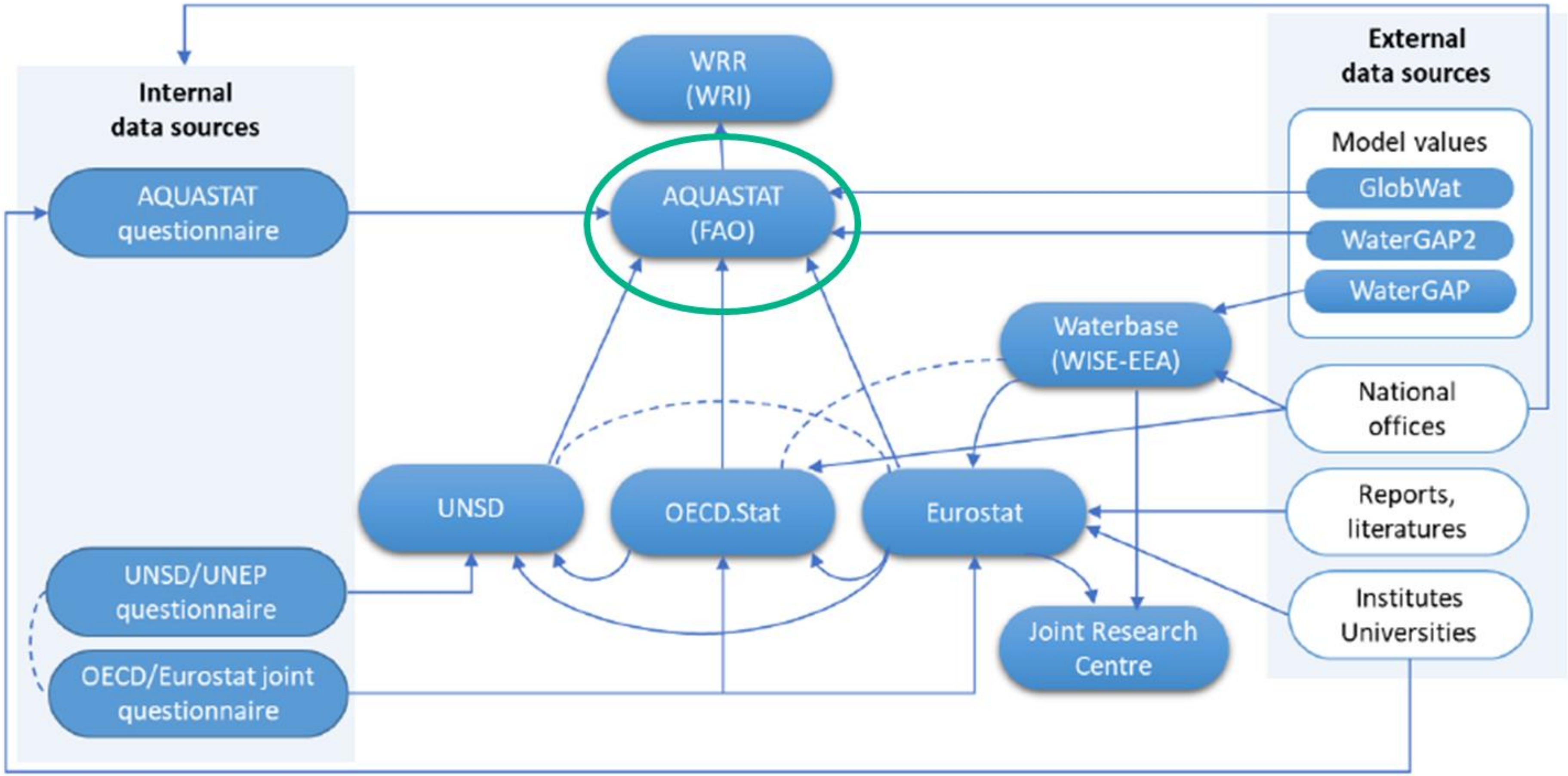
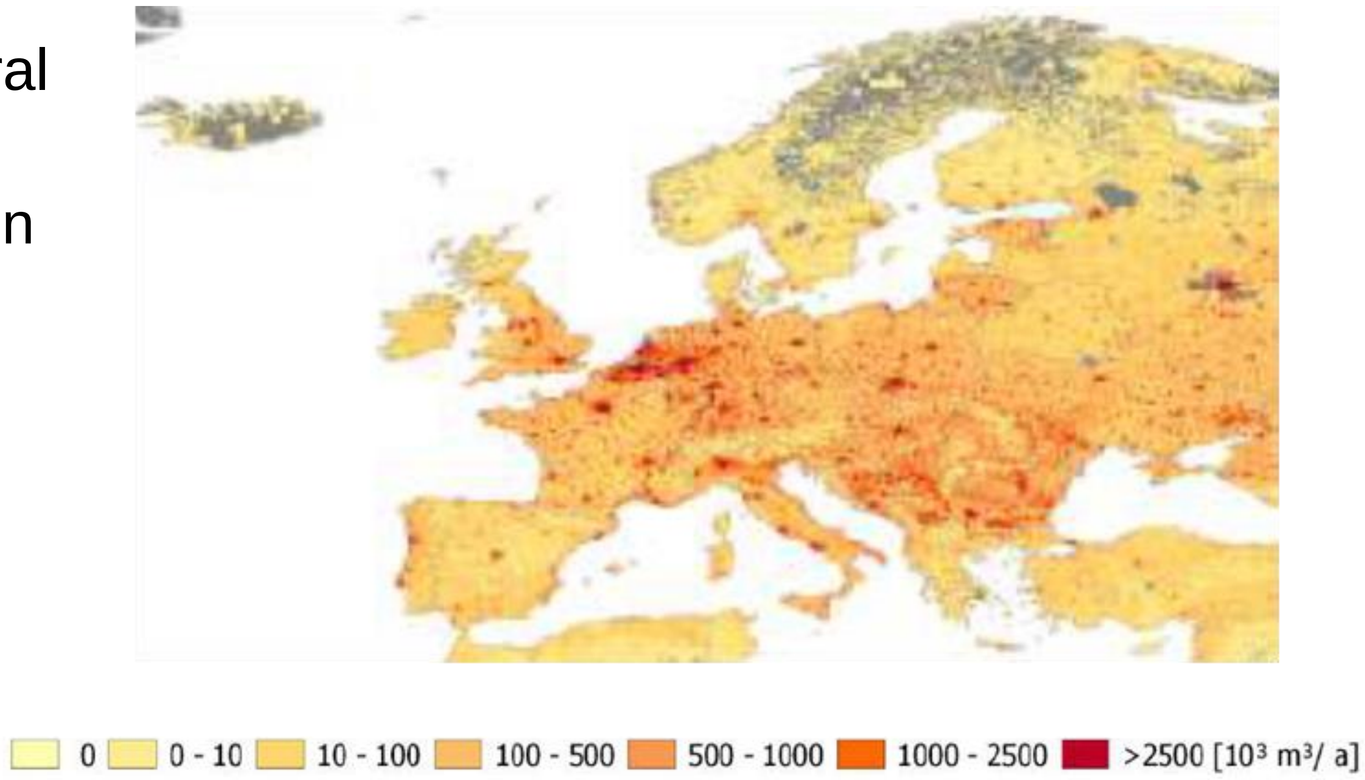


Figure 4 Relations among the databases for water use variables

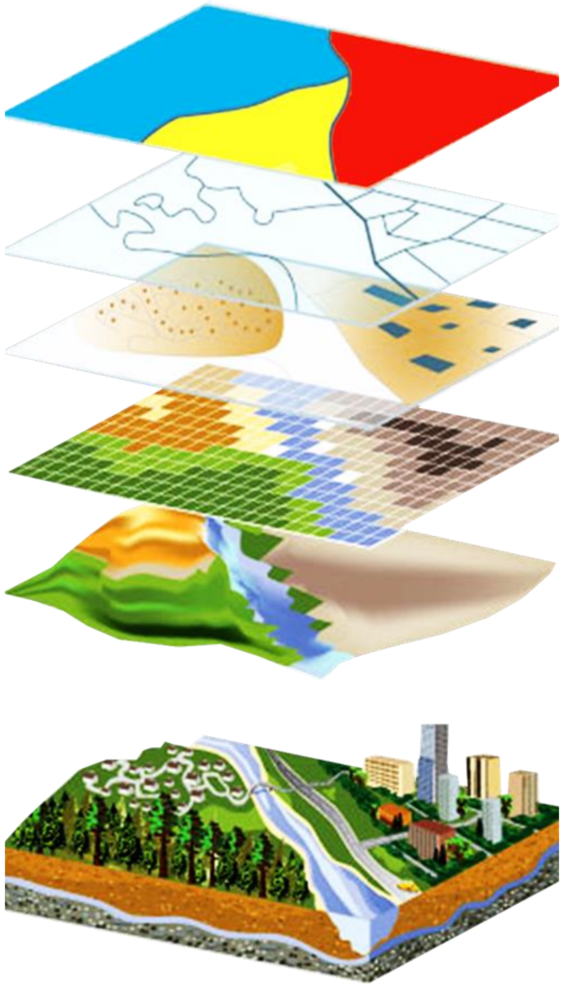
Data:
Sectoral water use

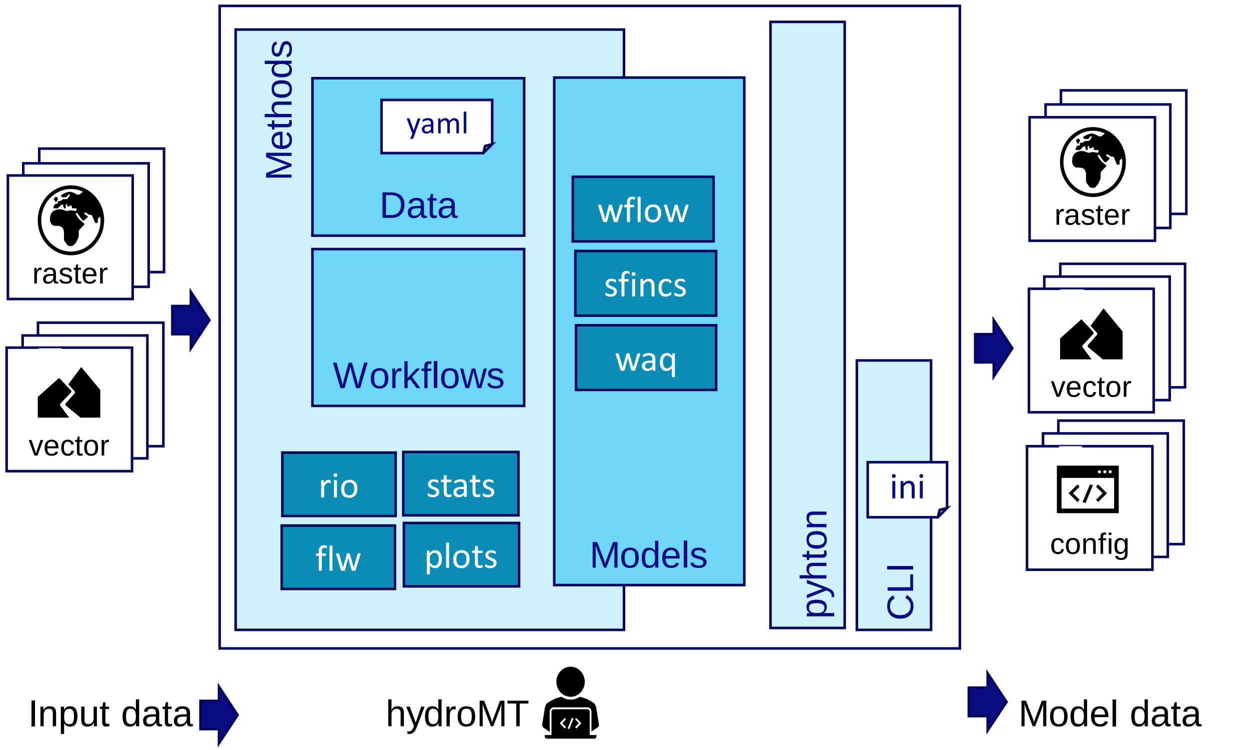
BlueEarth Data

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



Engine for rapid model setup: Global to local

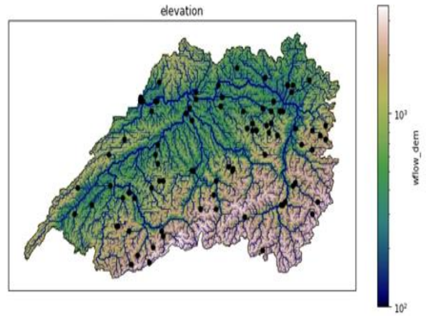




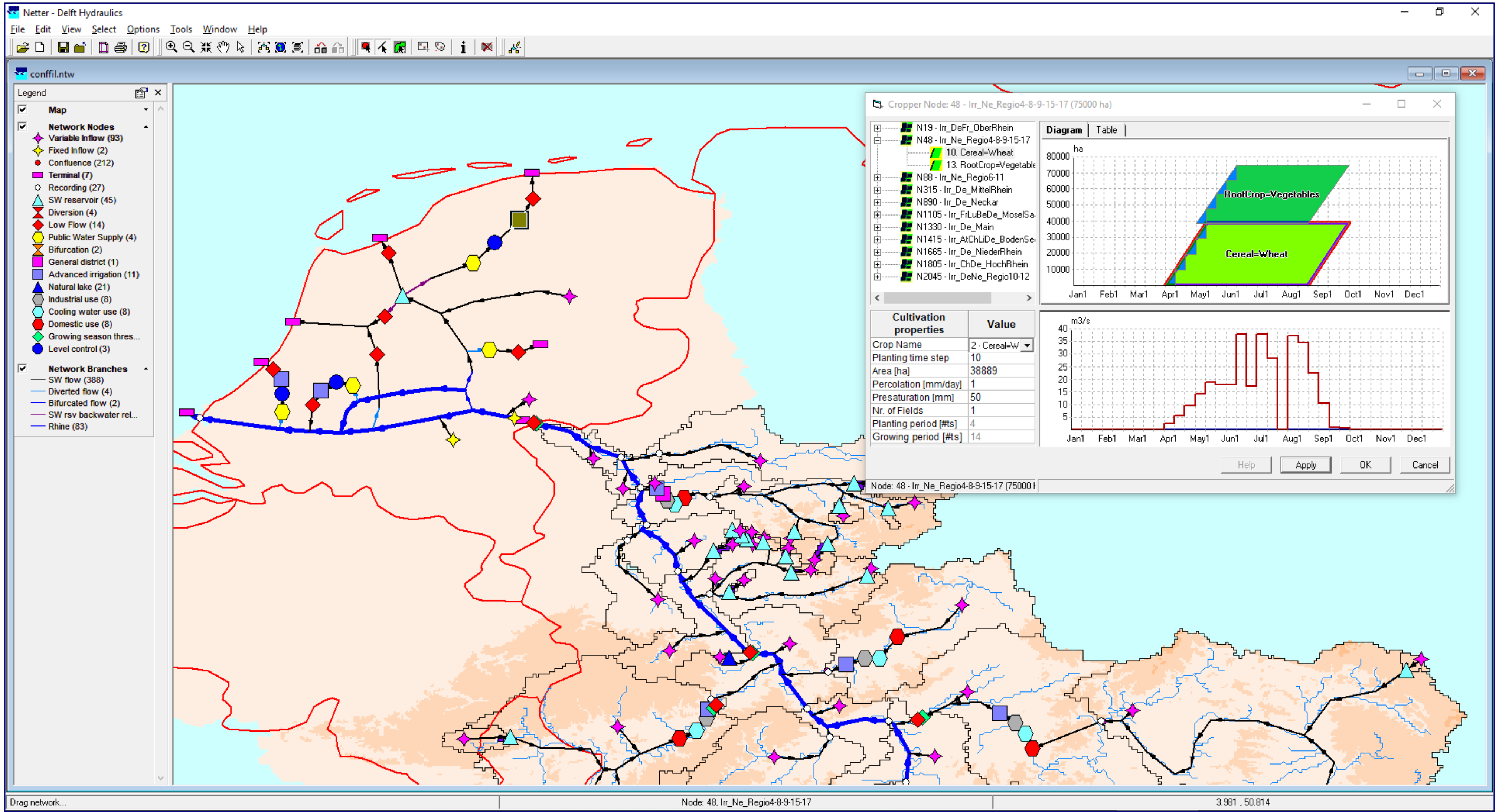
BlueEarth Engine

```python
# read an existing model
from hydromt import WflowModel
root = r'basel_2km'
mod = WflowModel(root, mode='r')
```

```python
# plot map
fig = plt.figure(figsize=(10,5.5))
ax = fig.add_subplot(projection=ccrs.PlateCarree())
mod.staticmaps['wflow_dem'].where(mask).plot(
    ax=ax, norm=colors.LogNorm(vmin=vmin), cmap=cm.gist_earth
)
gdf_riv = mod.rivers
for strord in np.unique(gdf_riv['stream_order']):
    gdf_riv[gdf_riv['stream_order']==strord].plot(ax=ax, linewidth=strord/4, color='darkblue')
mod.basins.boundary.plot(ax=ax, color='k', linewidth=0.5)
if 'gauges' in mod.staticgeoms:
    mod.staticgeoms['gauges'].plot(ax=ax, marker='o', markersize=25, facecolor='black', zorder
_ = ax.set_title('elevation')
```



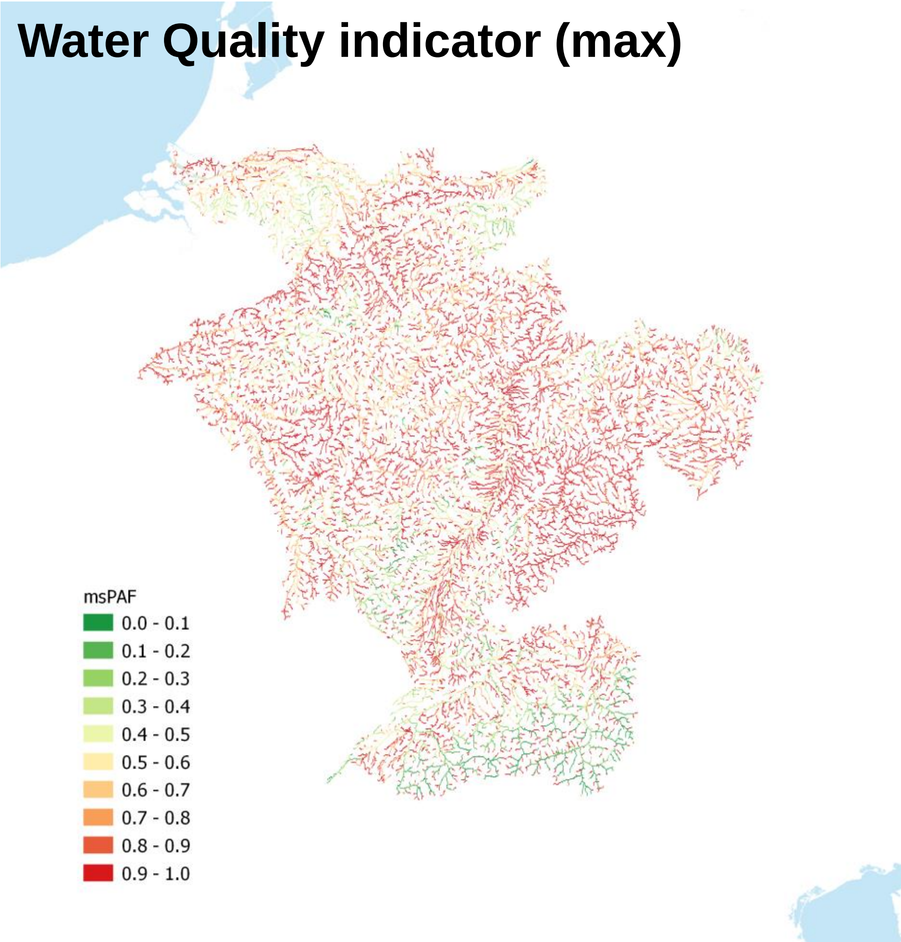
Engine:
Rapid model setup from global to local

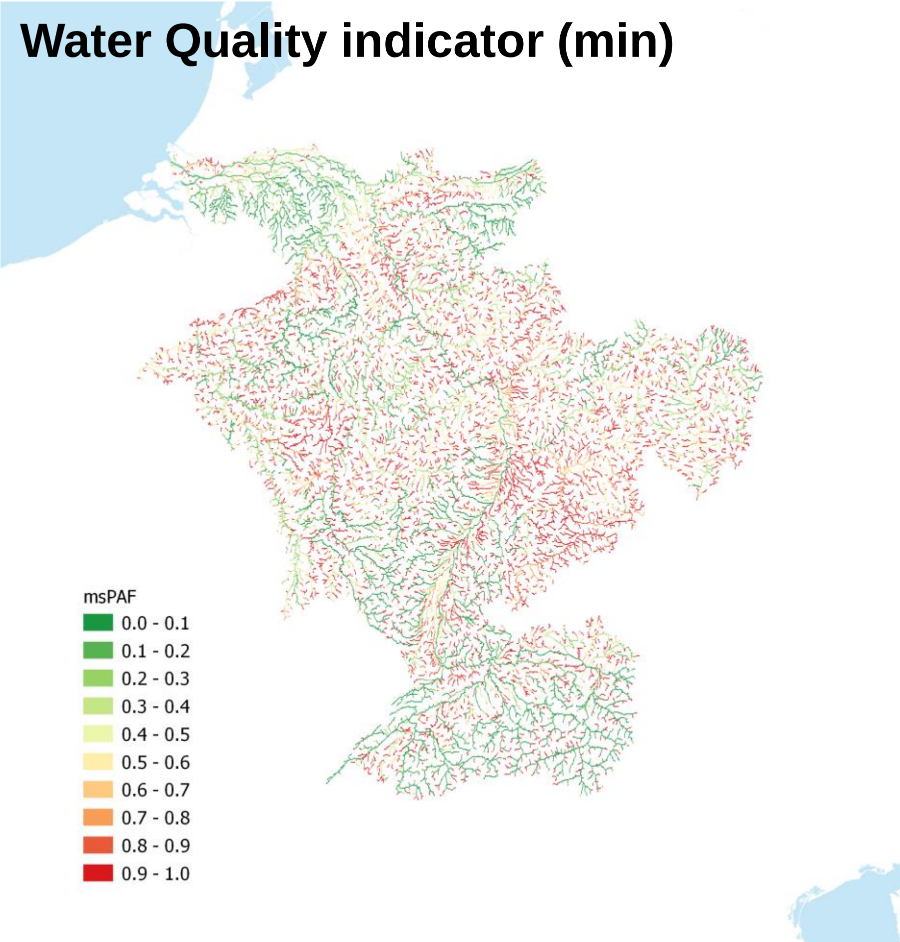


BlueEarth Engine

BlueEarth

Engine:
Rapid model setup from global to local





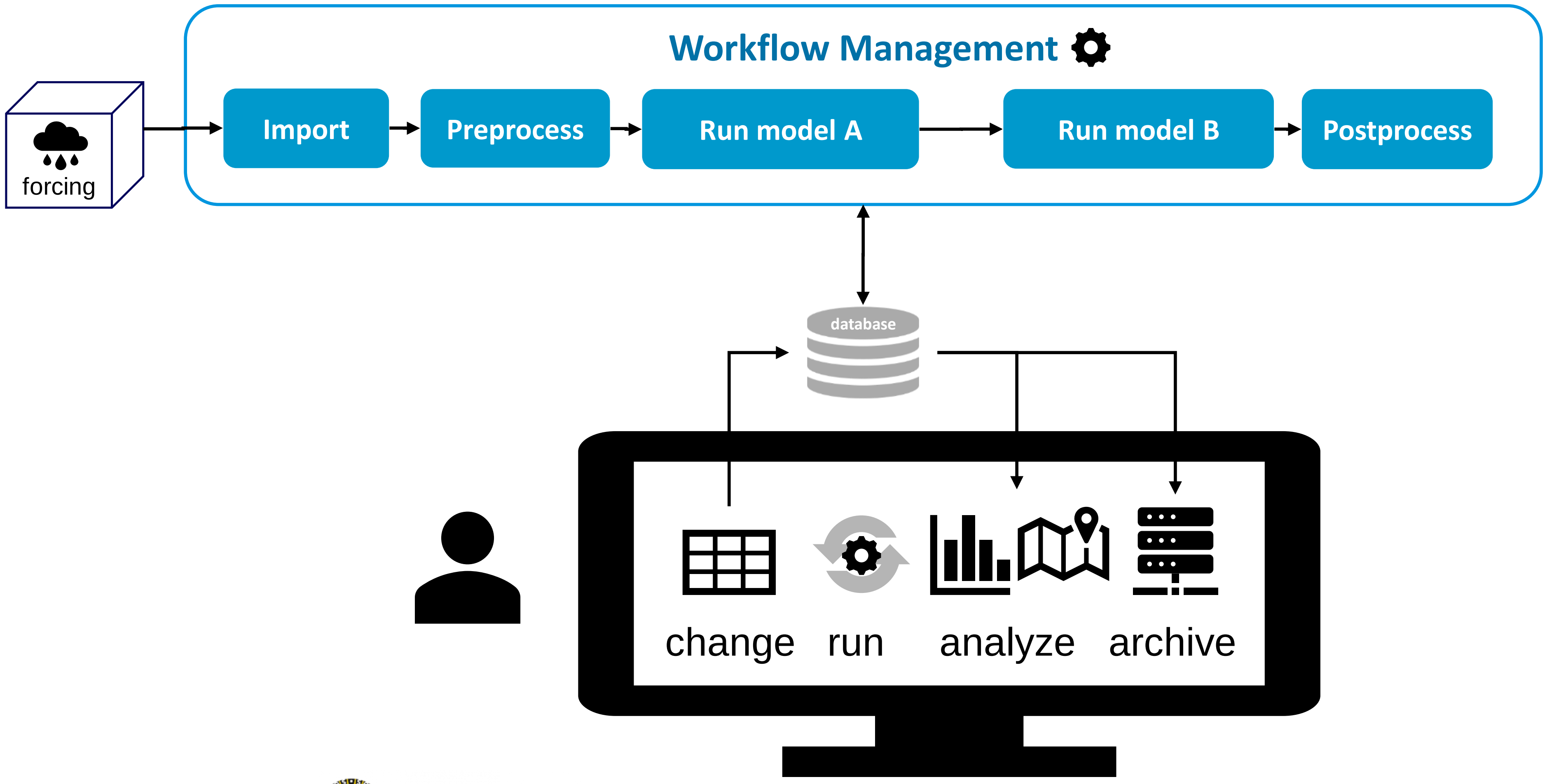
BlueEarth Engine

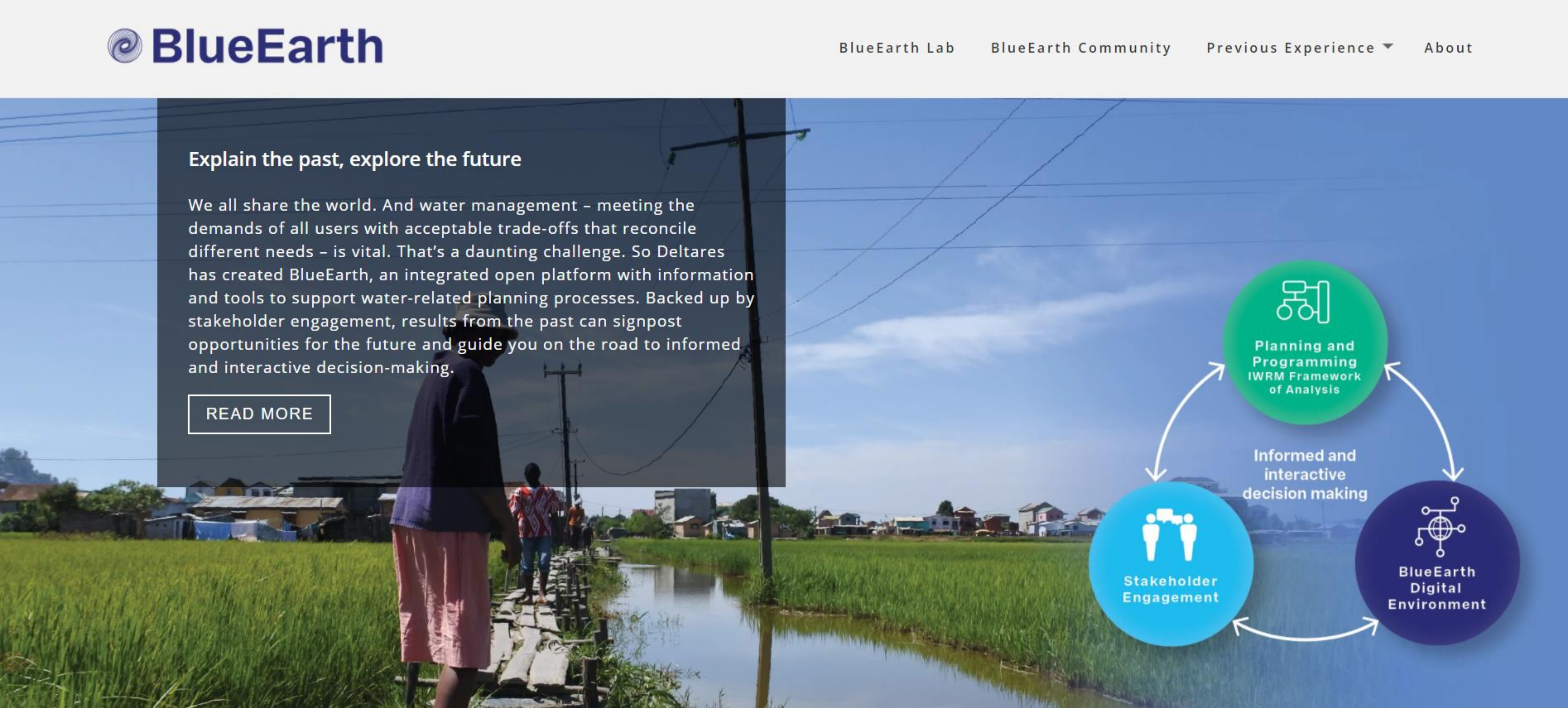
Data used:

msPAF is an indicator for toxicity from chemicals

Engine: Flexible, integrated modelling suite

BlueEarth Engine





blueearth.deltares.org

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