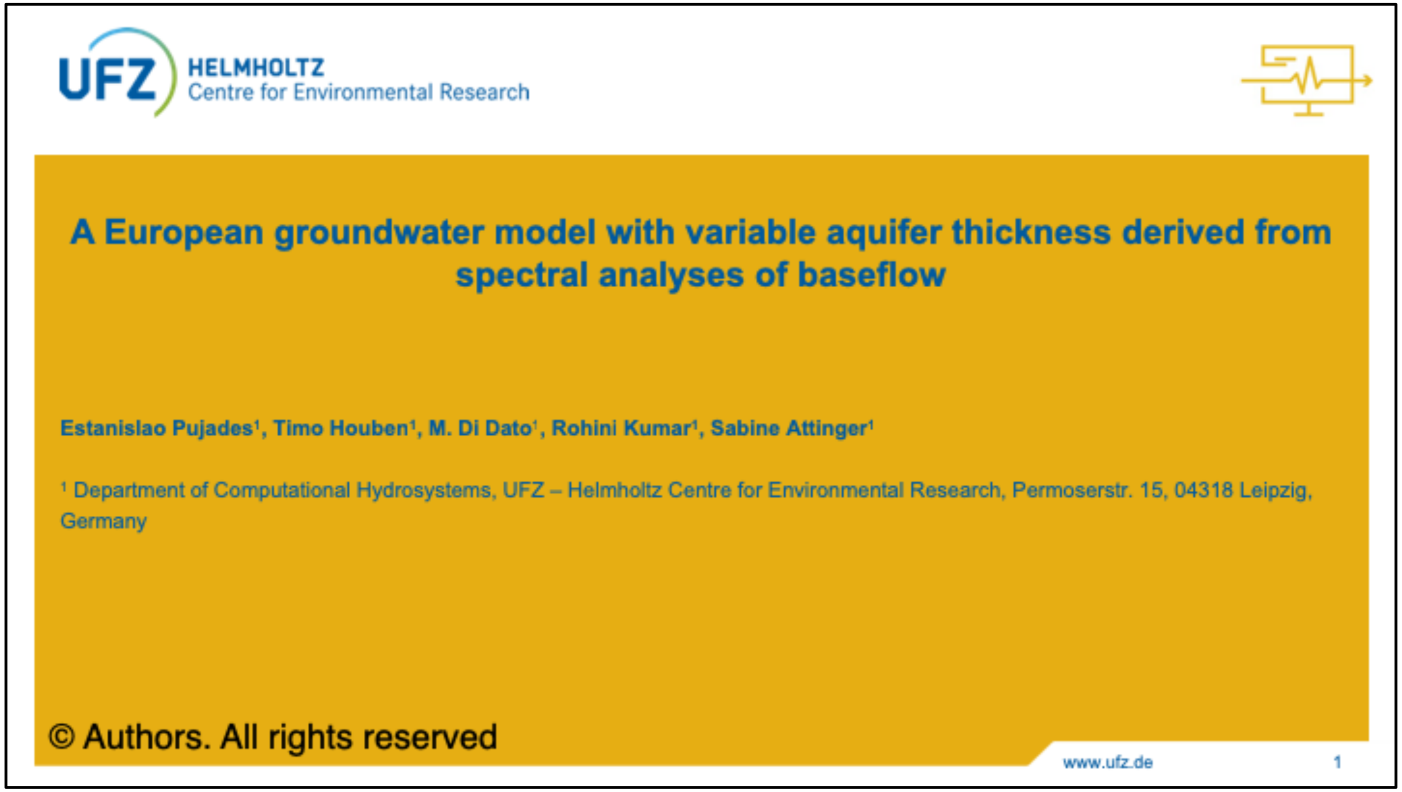


Notes

Here, we present a methodology for developing a groundwater model at the European scale.

Introduction and objectives

- Continental and and global numerical models are needed to predict the impacts of global changes (e.g., climate change) and design global water management strategies.
- Existing models have some limitations:
  - Results are only in steady state
  - Some assumptions are debatable (e.g., how thickness is calculated)
  - Accuracy: Large differences between computed and observed the piezometric head
- Objective: To develop a methodology to construct realistic and representative numerical models at the continental or global scales.

Notes

Numerical models at the continental and global scales are needed to predict impacts of global scale events, such as the climate change, and to design global water management strategies.

In the literature, there are some examples of groundwater models developed at the global scale. However, these models have some limitations. For example:

- Commonly, only the steady state is calculated
- The approaches to compute the thickness are debatable. Some of them derive the thickness by using the slope of the terrain.
- There are large differences between computed and observed piezometric heads.

Our objective is to develop a methodology to construct realistic and representative numerical models at the continental or global scales.

Main characteristics

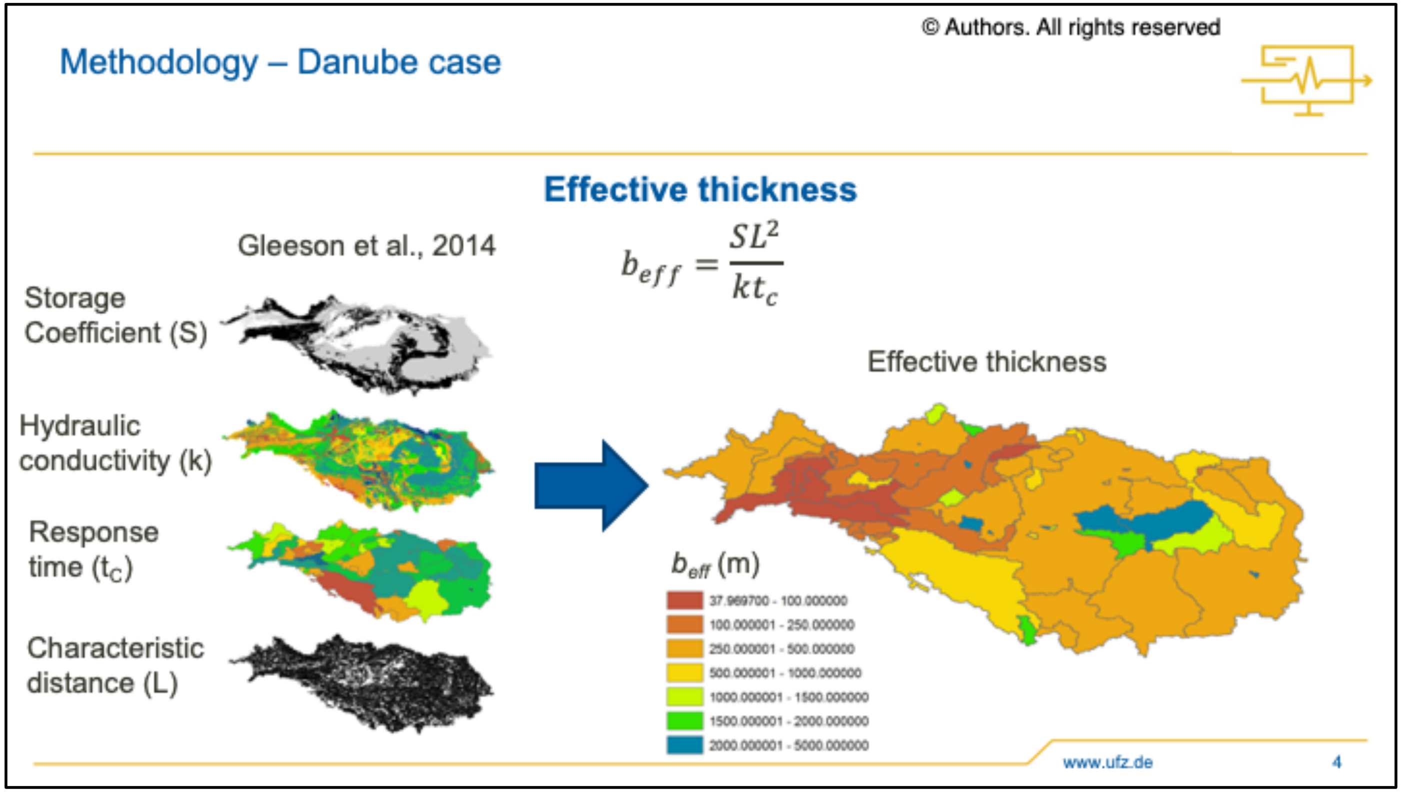
- Example: Danube basin
- Main characteristics:
  - 2D model
  - Spatial discretization: 500 m
  - Geometry:
    - Horizontal: Gleeson et al., 2014
    - Vertical: Thickness is implemented indirectly through the transmissivity. The effective thickness (b_{eff}) is computed using spectral analyses.

Notes

In this presentation we show how the proposed methodology was applied for developing the groundwater model of the the Danube basin.

The main characteristics of the model are:

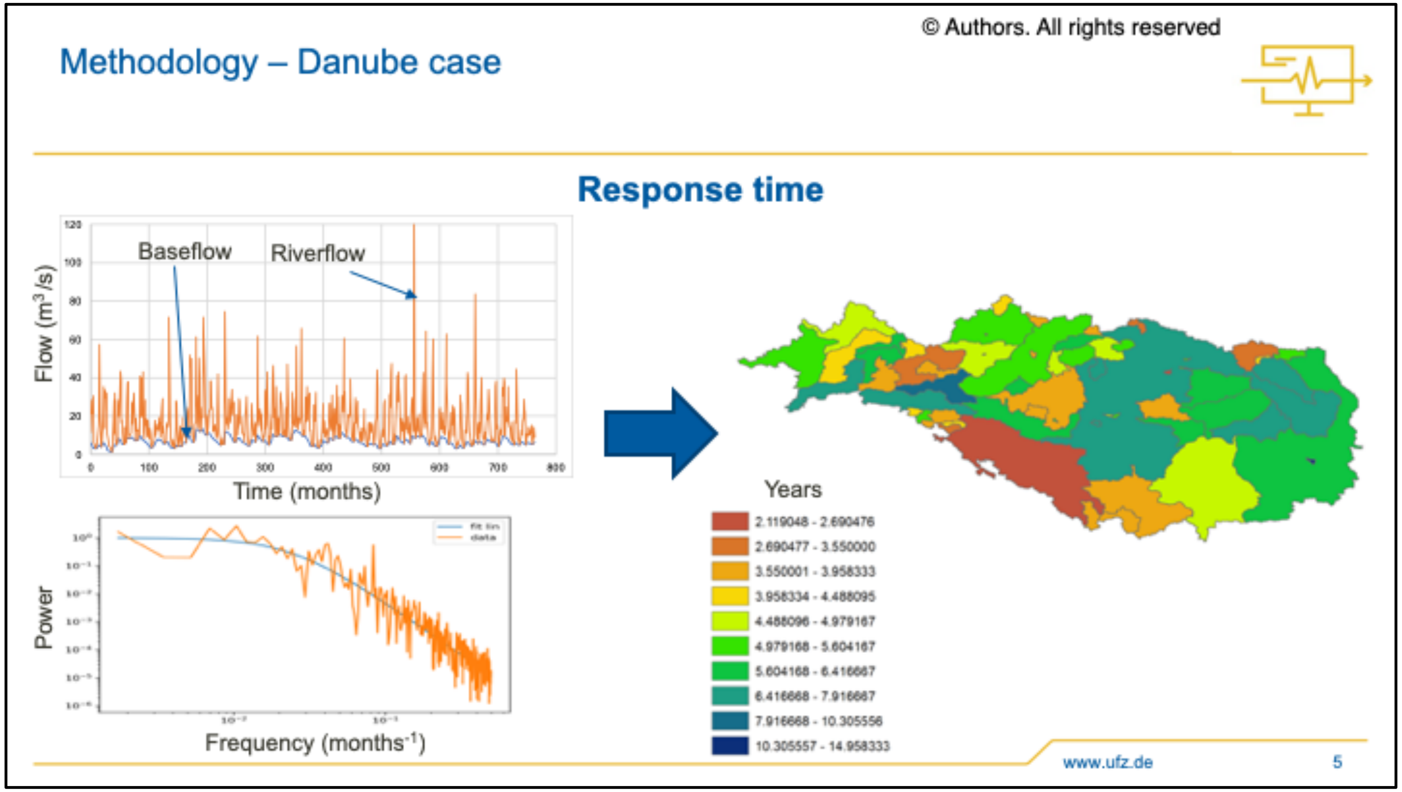
- 2D model
- The spatial resolution is 500 m.
- The horizontal geometry is defined according with Gleeson et al., 2014
- The vertical dimension is implemented indirectly through the transmissivity. The thickness is derived by spectral analyses of the baseflow.



Notes

On the top, there is the equation that we used to compute the effective thickness that depends on:

- The storage coefficient that is obtained from Gleeson et al., 2014
- The hydraulic conductivity that is also derived from Gleeson et al., 2014
- A characteristic distance, that in this case is the length of the aquifer. This distance is derived from the river network.
- The response time that is the needed time to reach steady state conditions after a hydraulic perturbation. This time is calculated from spectral analyses of baseflow. The computed time is the mean response time of the whole catchment located upstream of a gauge station.

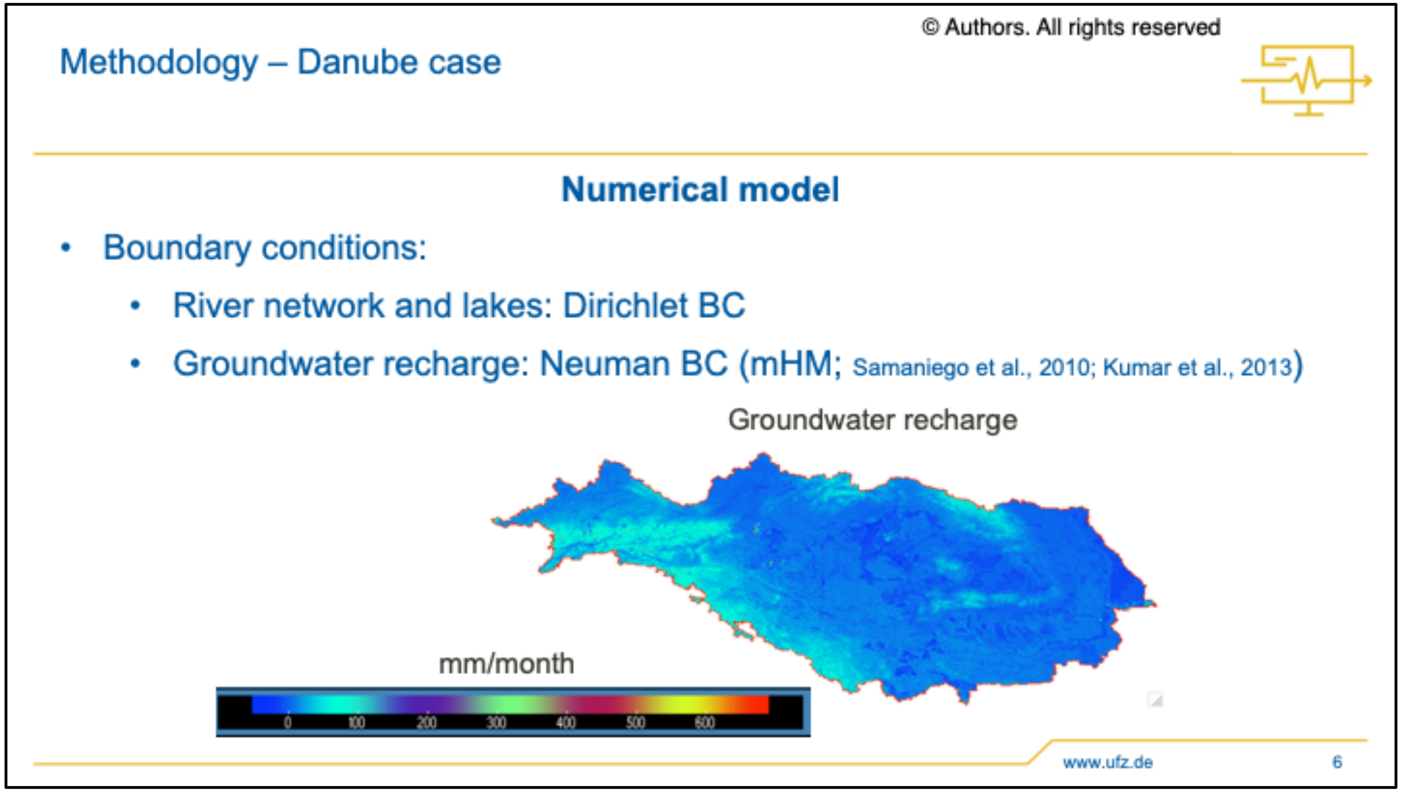


Notes

The response time is calculated following the next steps:

1. Selection of gauge stations: gauge stations must have discharge data during a long period of time.
2. Baseflow is computed from discharge data applying the Lyne-Hollick filter. The upper left figure shows the river discharge and the computed baseflow for one gauge station.
3. The power spectrum of the baseflow is computed and the inflection time is identified (lower left figure). At low frequencies the power spectrum is constant and after a certain frequency the power spectrum starts to decrease. The inflection point allows deriving the response time. This response time is representative of materials located upstream the gauge station.

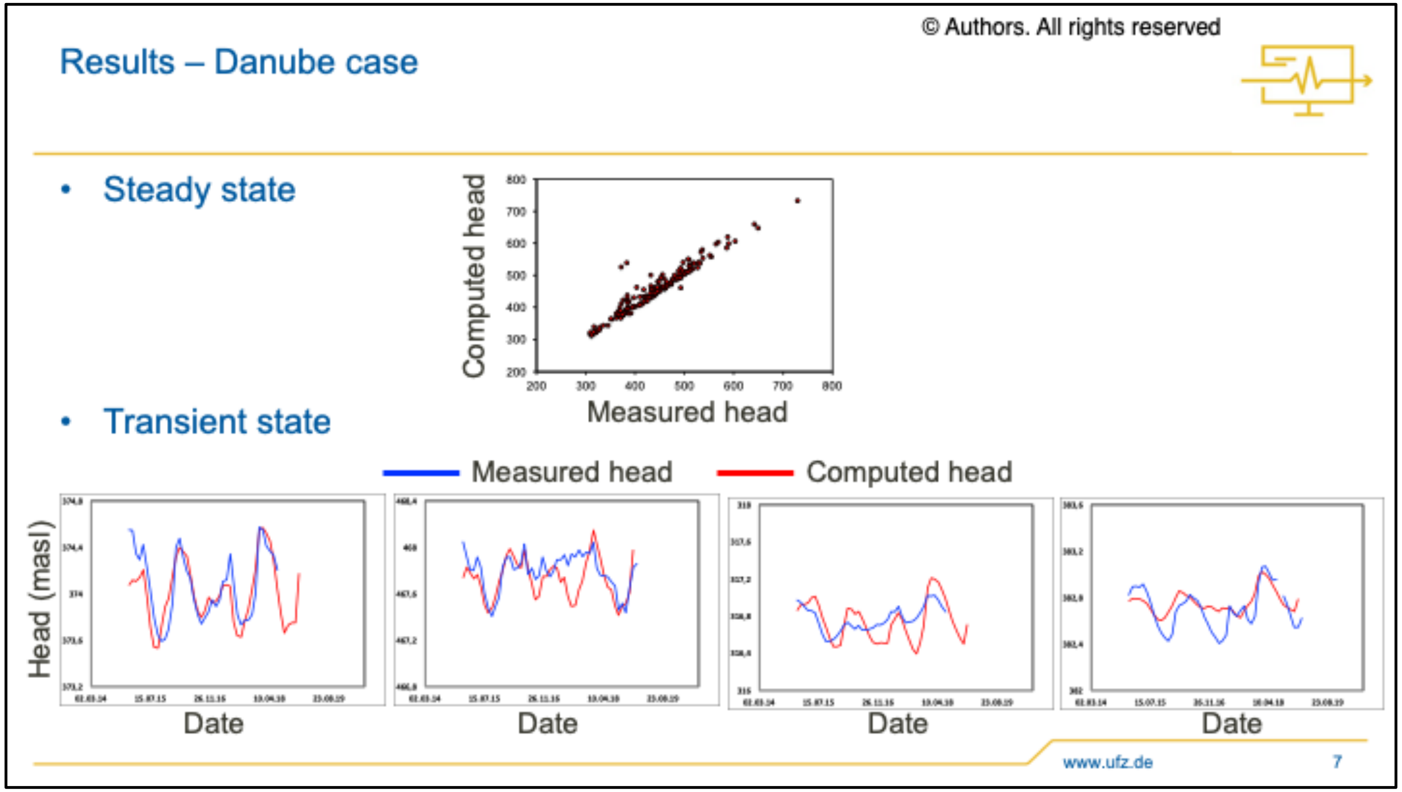
On the right you can see the response times calculated for different sub-basins.



Notes

The adopted boundary conditions are:

- Surface water bodies like rivers and lakes are simulated by prescribing the head according with the surface elevation.
- Groundwater recharge is implemented by prescribing the flow at the top of the model. Groundwater recharge is computed with the mesoscale hydrologic model (mHM).
- No-flow is considered at the boundaries of the basin.



Notes

Once the model is constructed, steady and transient state simulations are carried out and the results are compared with observations to validate the model.

On the top, you can see the comparison between computed and measured piezometric heads in steady state.

On the bottom you can see the comparison at four observation points between 2015 and 2018.

Steady and transient state results are acceptable. Therefore, we can conclude that our approach is useful to built realistic numerical models.

Conclusions

- The methodology is relatively easy to apply and allows obtaining realistic results.
- The approach has proved its usefulness at large scale.
- The thickness is computed in an innovative way. It depends on the hydrogeological behaviour of the basin.
- The European model will allow reproducing the piezometric head at steady and transient states. Thus, it will be useful for predicting the consequences of events occurred at the continental scale.

Notes

To conclude:

- The proposed methodology is easy to apply.
- It allows constructing models at large scale and obtaining realistic results
- The thickness is computed in an innovative way. Its value depends on the hydrogeological behavior of the basin. This approach is different from previous ones were the thickness depends on topographic characteristics.
- The European model developed by using this approach will be useful to estimate the groundwater response to events occurred at the continental scale

Questions?