G E U S

MODELING OF THE GEOLOGICAL EVOLUTION OF THE RED RIVER DELTA, VIETNAM

IN THE CONTEXT OF ARSENIC CONTAMINATION OF AQUIFERS

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Early Career Hydrogeologists' Network
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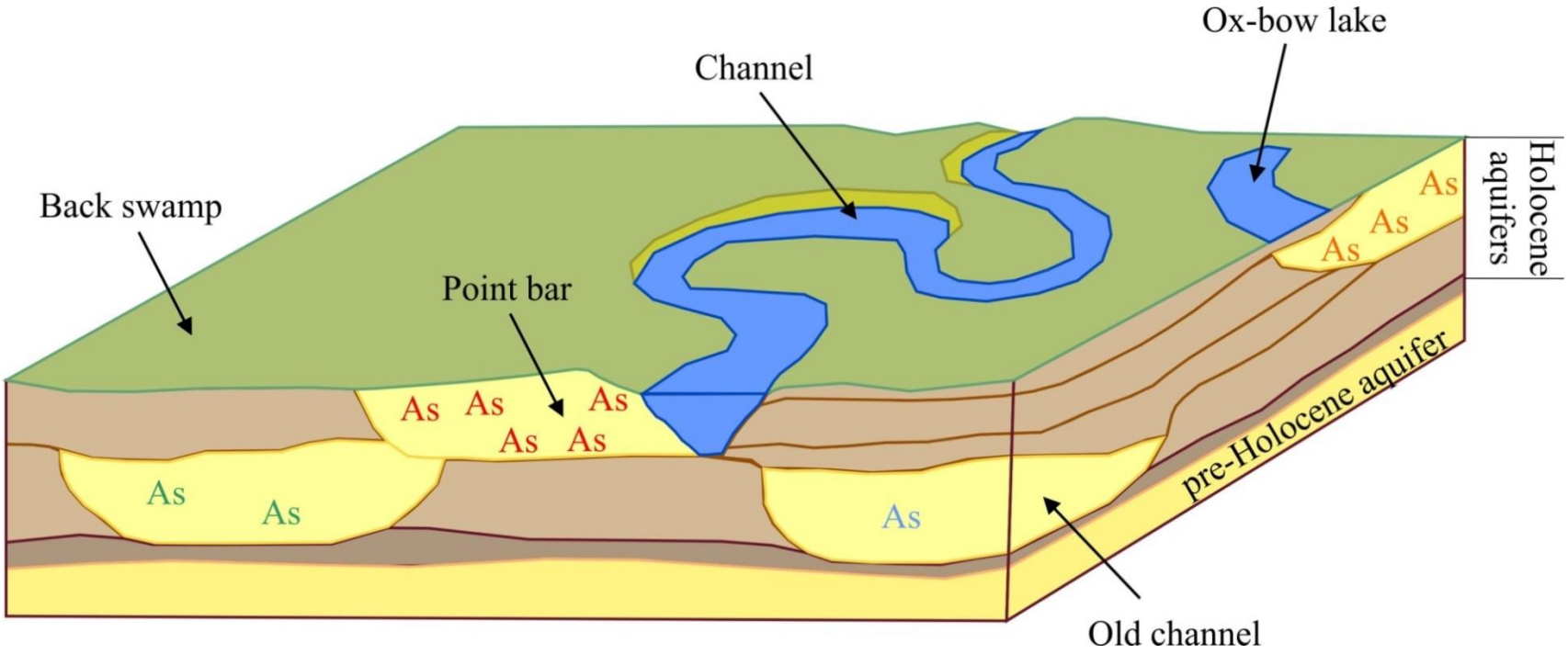
43rd IAH congress

MOTIVATION

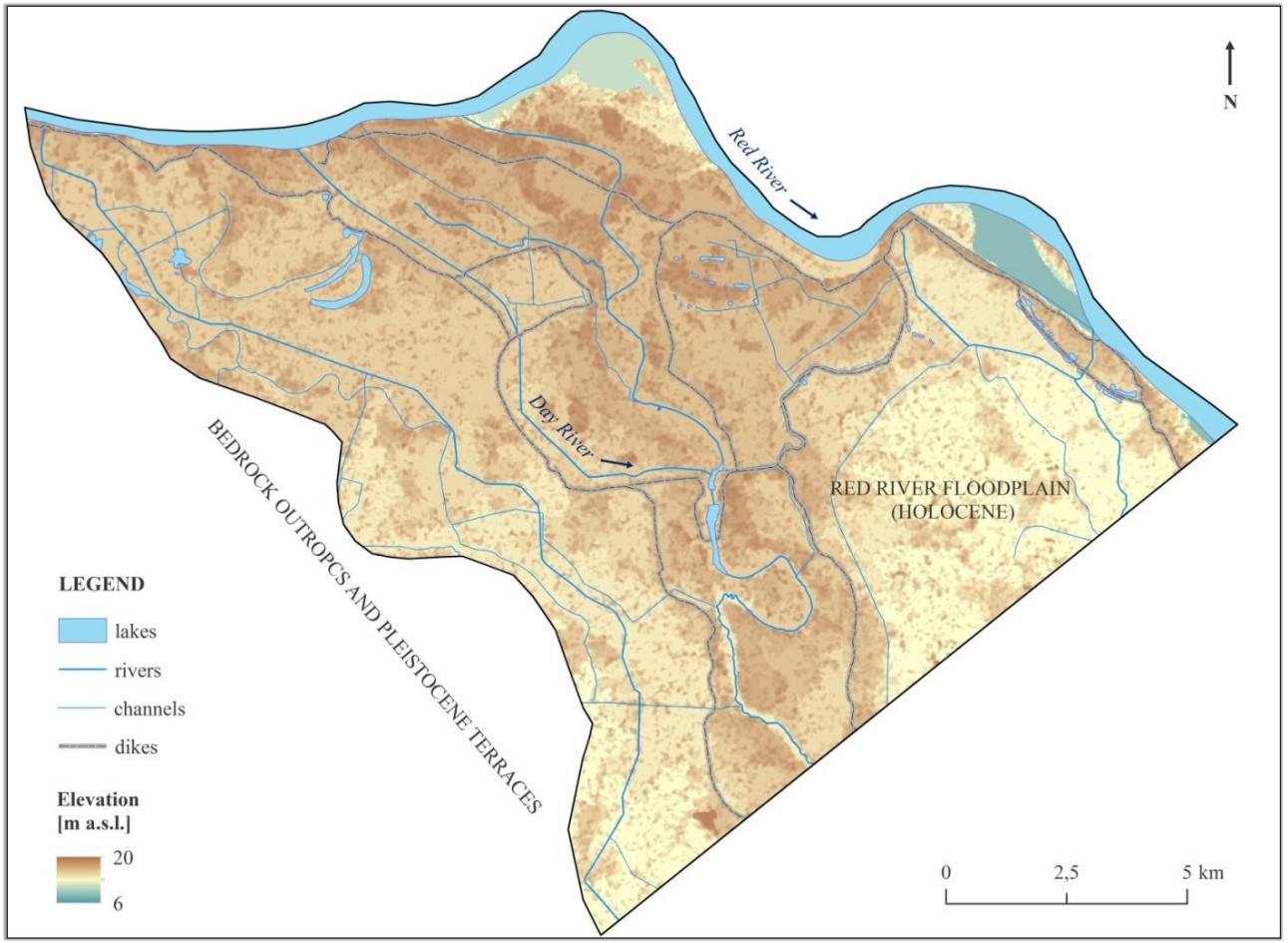
- Contamination of aquifers by **geogenic arsenic (As)** is a widespread problem in **SE Asia**.
- **As concentration** in groundwater **decrease with increasing sediment age.**



OBJECTIVES

- to develop the **geological model for complex meandering river system**
- to check how the **sedimentary evolution** of the aquifer and **recent flow paths** modify the **spatial distribution of As**.

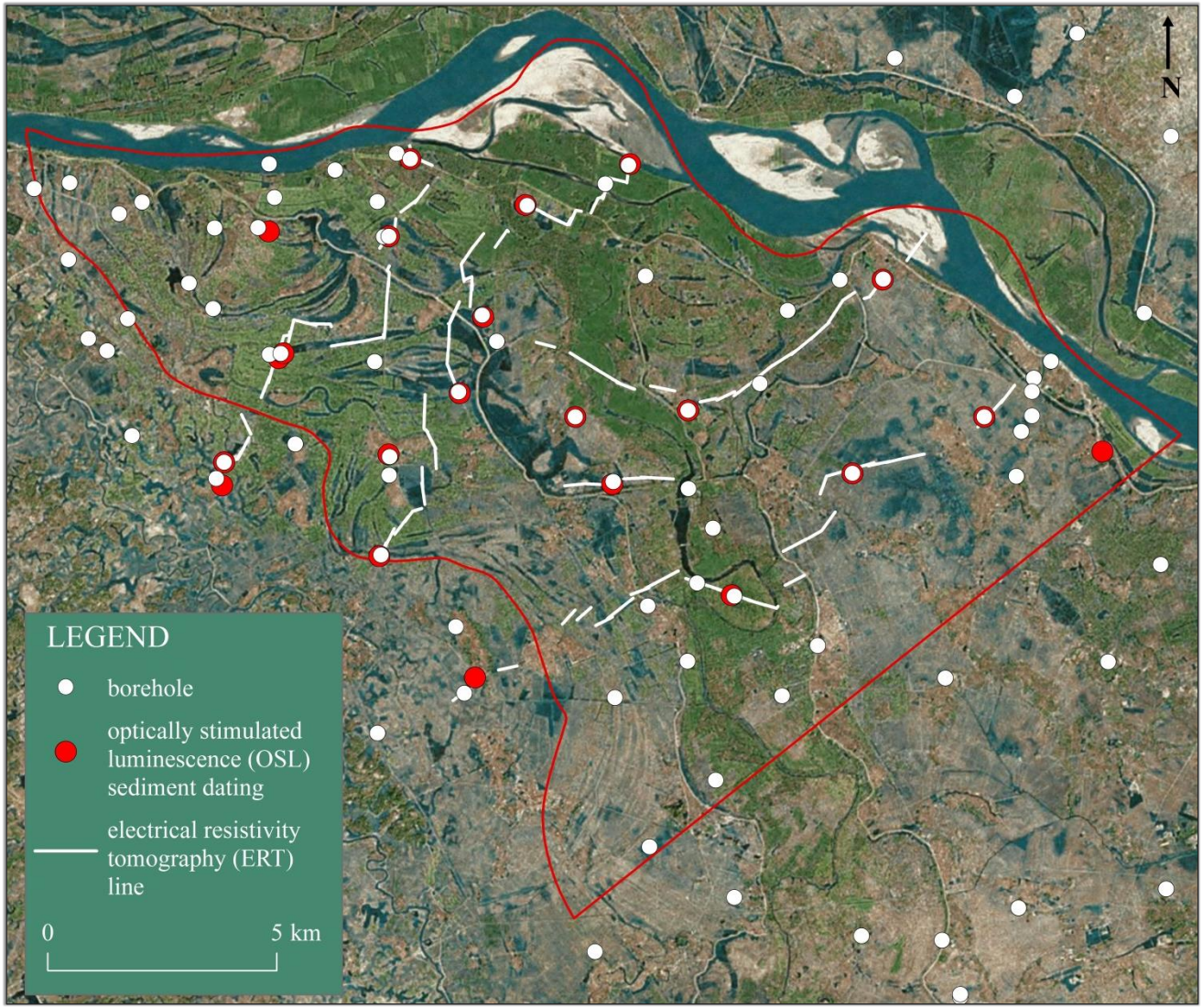
STUDY AREA



- Uppermost part of the **Red River delta**.

- Migration of the river limited ca. **1 kyr ago** due to the **dikes construction**.
- Natural **geomorphology disturbed**.

METHODS



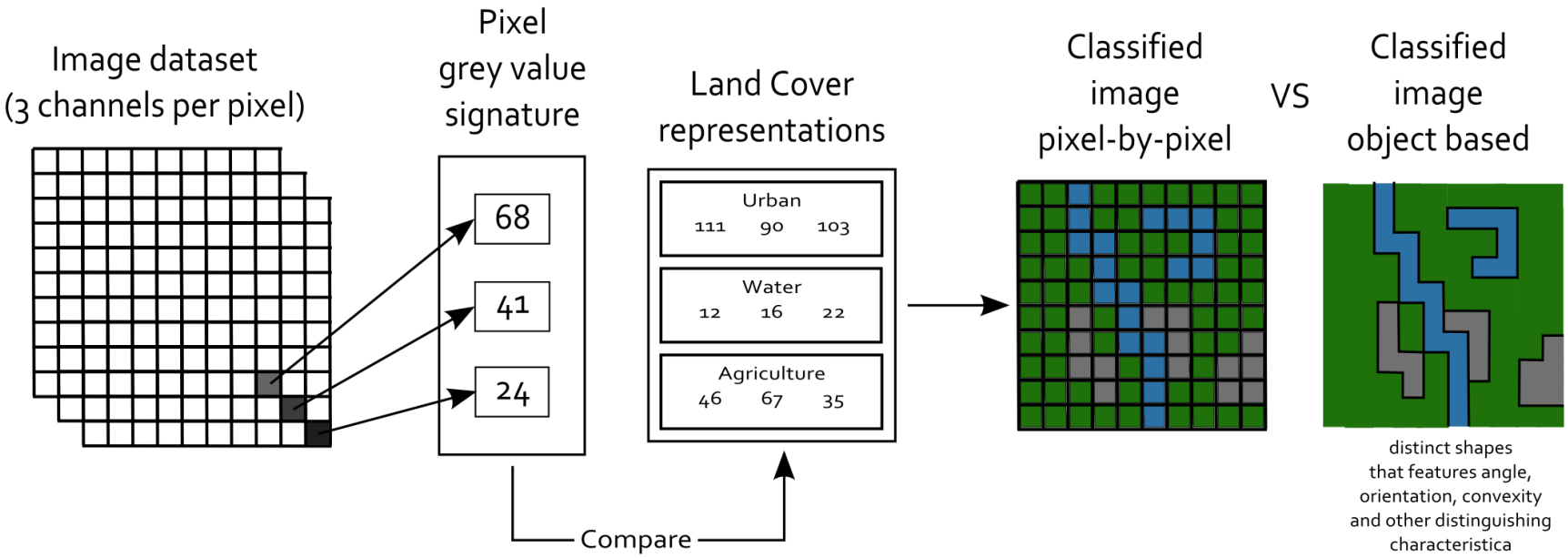
- remote sensing (OBIA)
- ground truth observations

- ERT survey

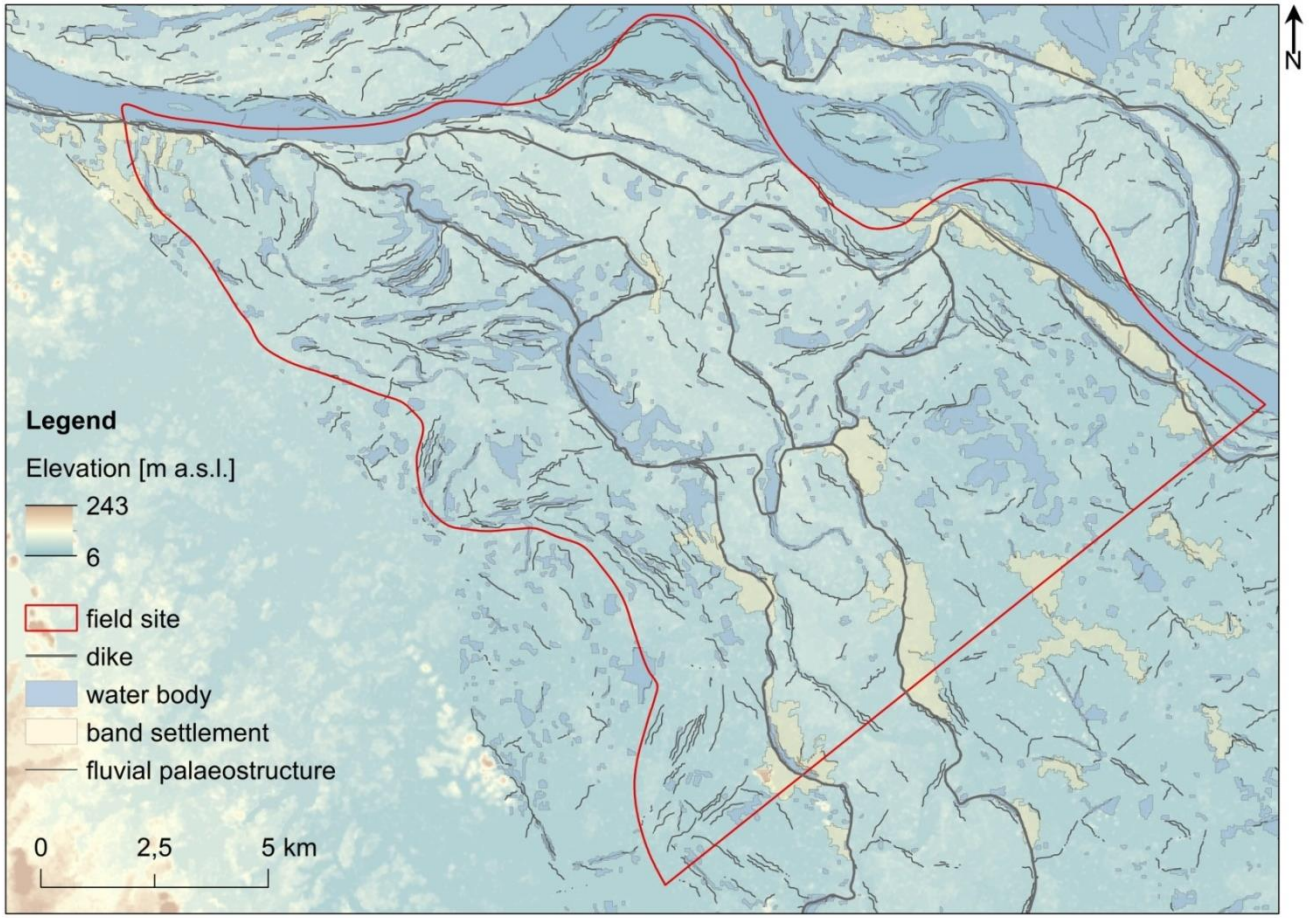
- borehole geological data
- gamma-logging

- OSL dating

OBJECT BASED IMAGE ANALYSIS (OBIA)



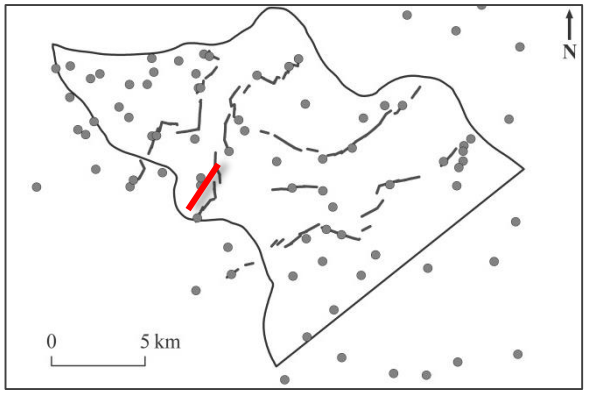
RECONSTRUCTION OF THE FLOODPLAIN EVOLUTION
OBJECT BASED IMAGE ANALYSIS

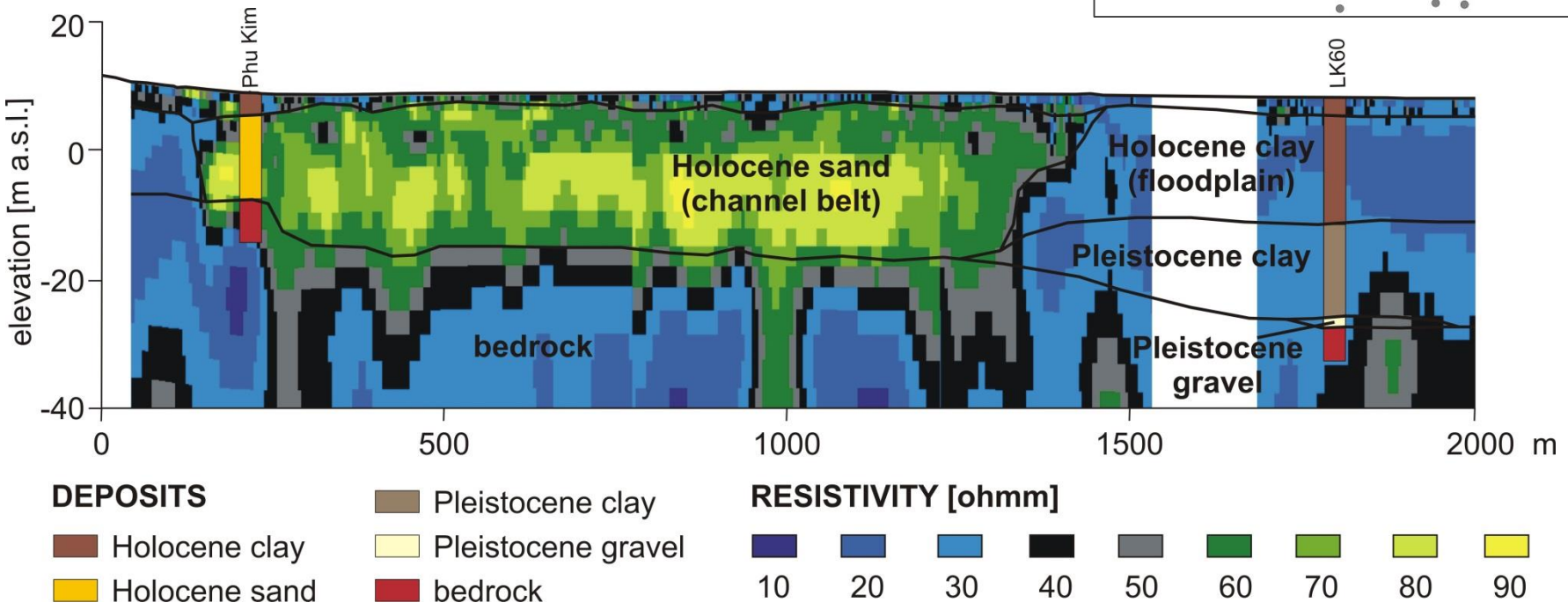


- **Fluvial palaeostructures**, **river courses** and **avulsions,** shallow **clay/sand distribution.**
- ~~Channel geometry, connection between aquifers.~~
- Aerial, surface data.

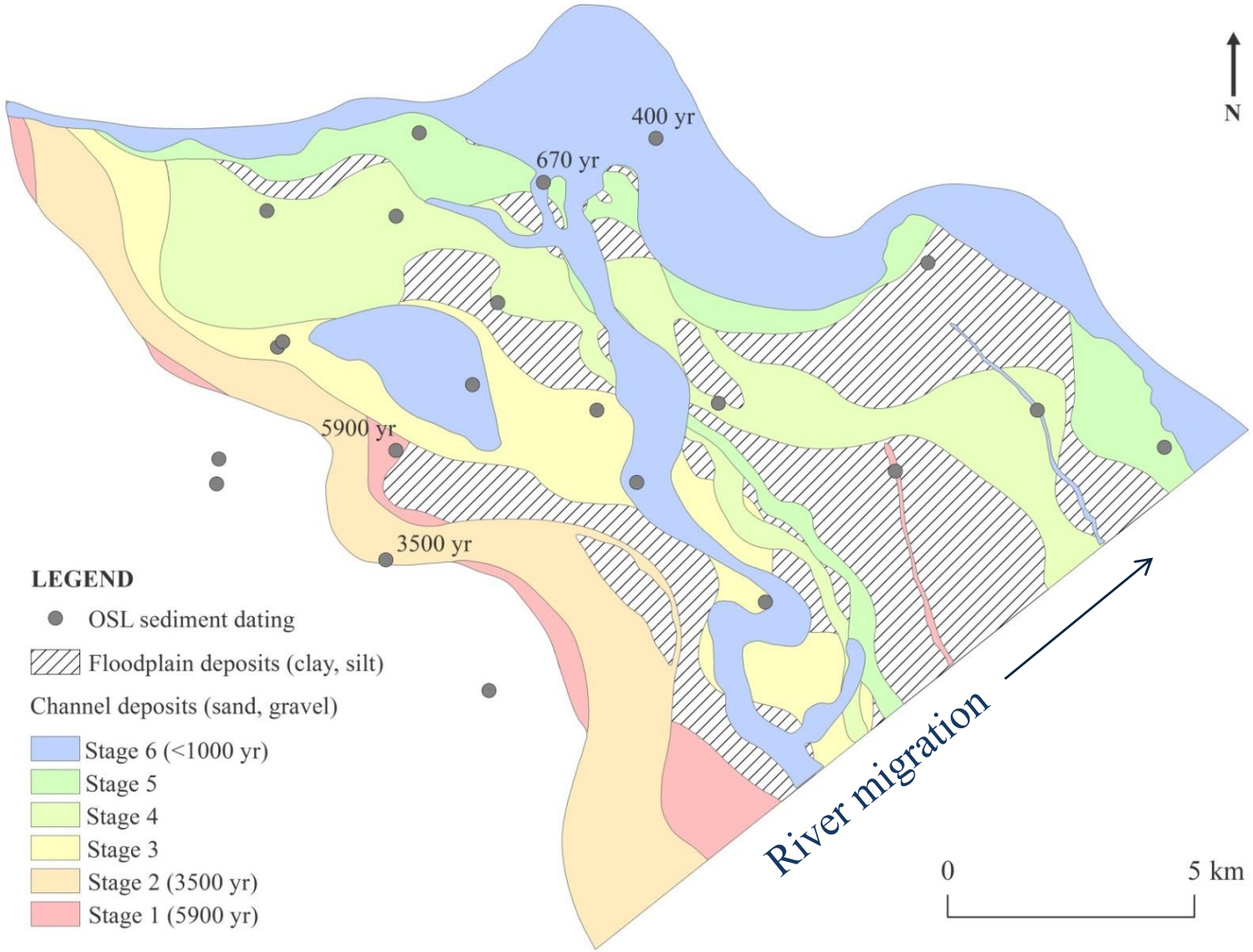
RECONSTRUCTION OF THE FLOODPLAIN EVOLUTION
GEOLOGICAL DATA

- **Channel geometry, contact between aquifers, regional geological conditions.**
- ~~River courses, avulsions, detailed local geology.~~
- Subsurface linear and point data.





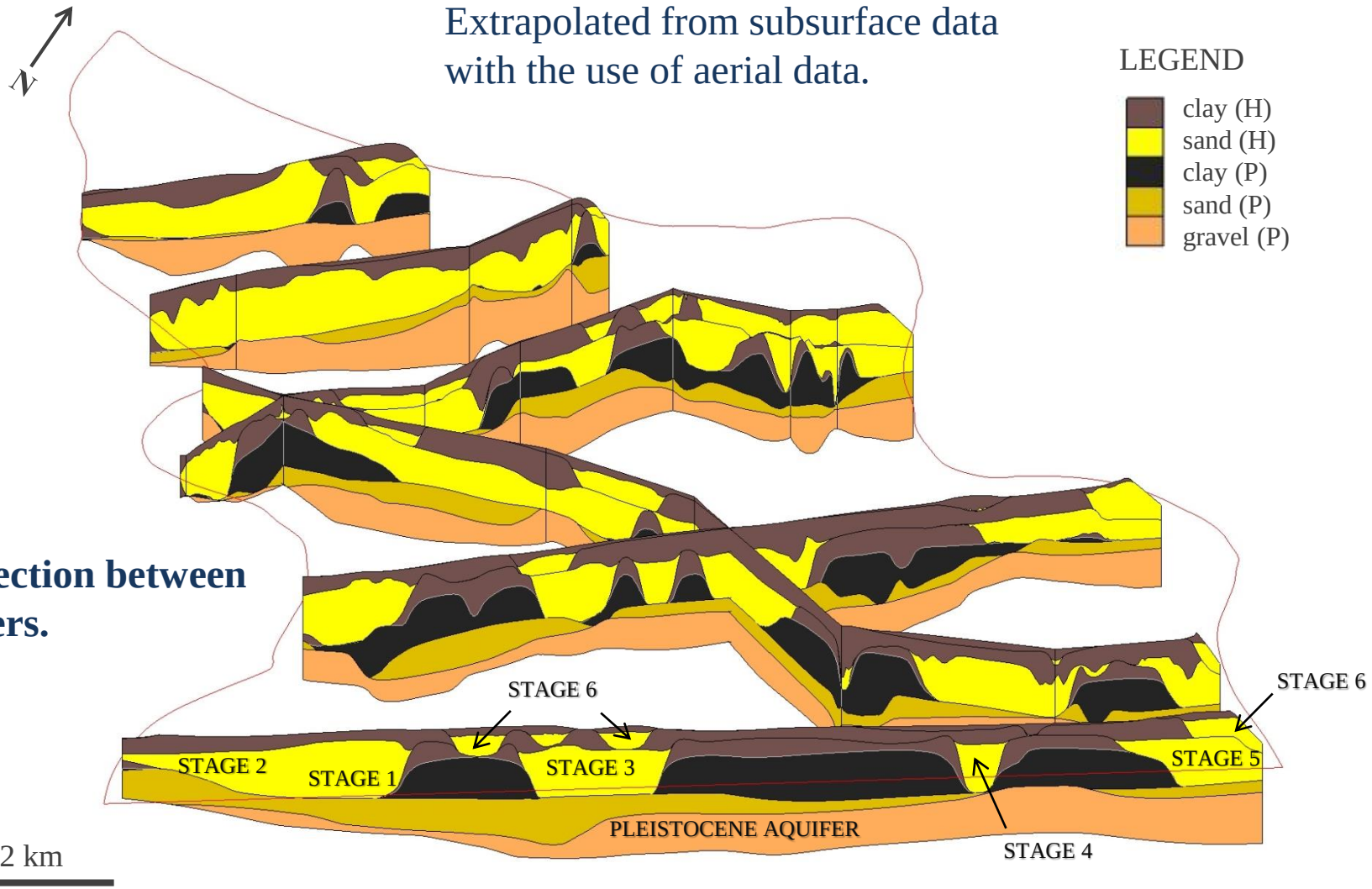
RED RIVER FLOODPLAIN EVOLUTION – 2D



- **Point bar** deposition – approx. **100 years**.
- **River avulsions** – scale of **thousands years**.

RED RIVER FLOODPLAIN EVOLUTION – 3D

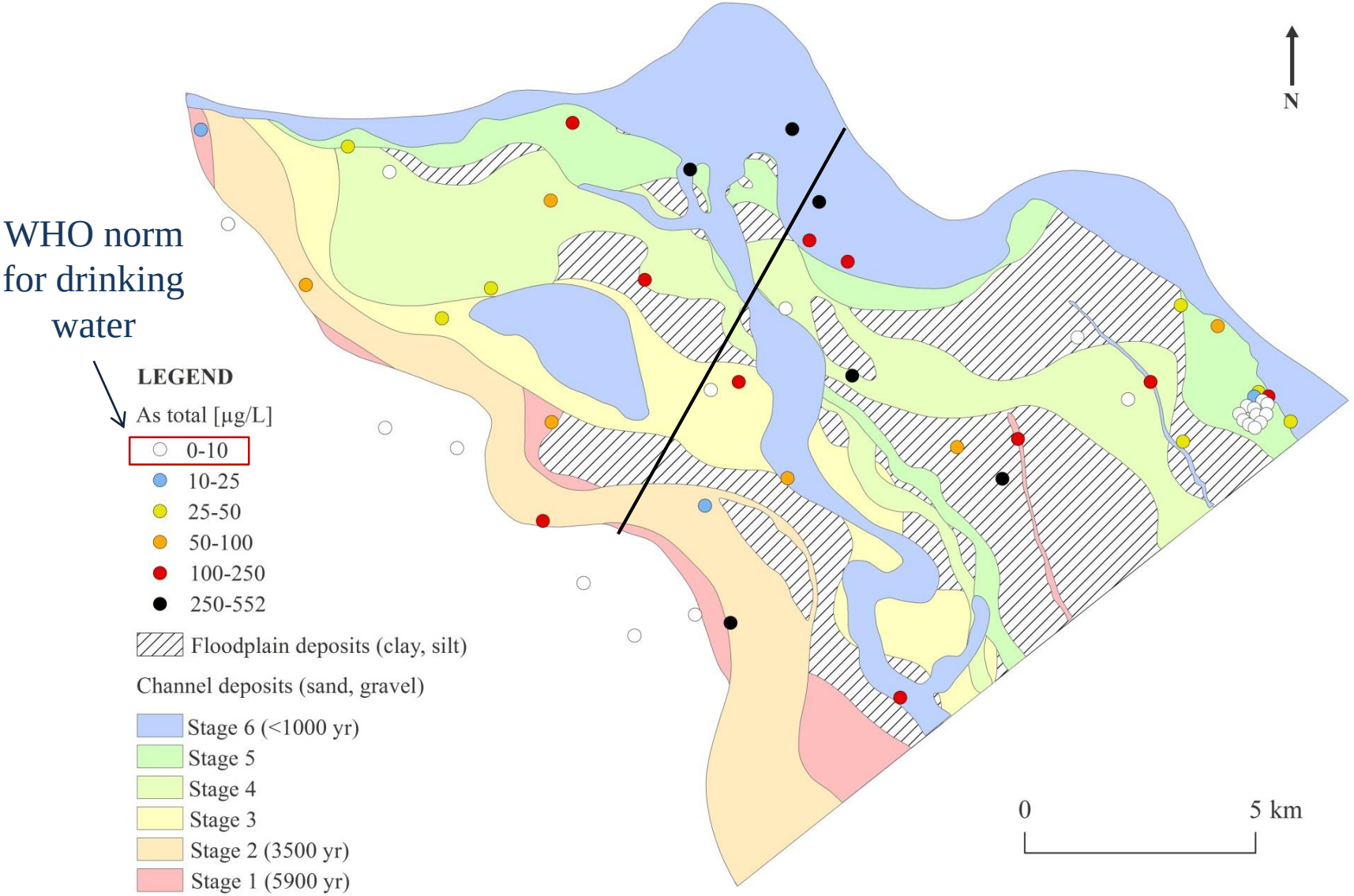
Extrapolated from subsurface data with the use of aerial data.



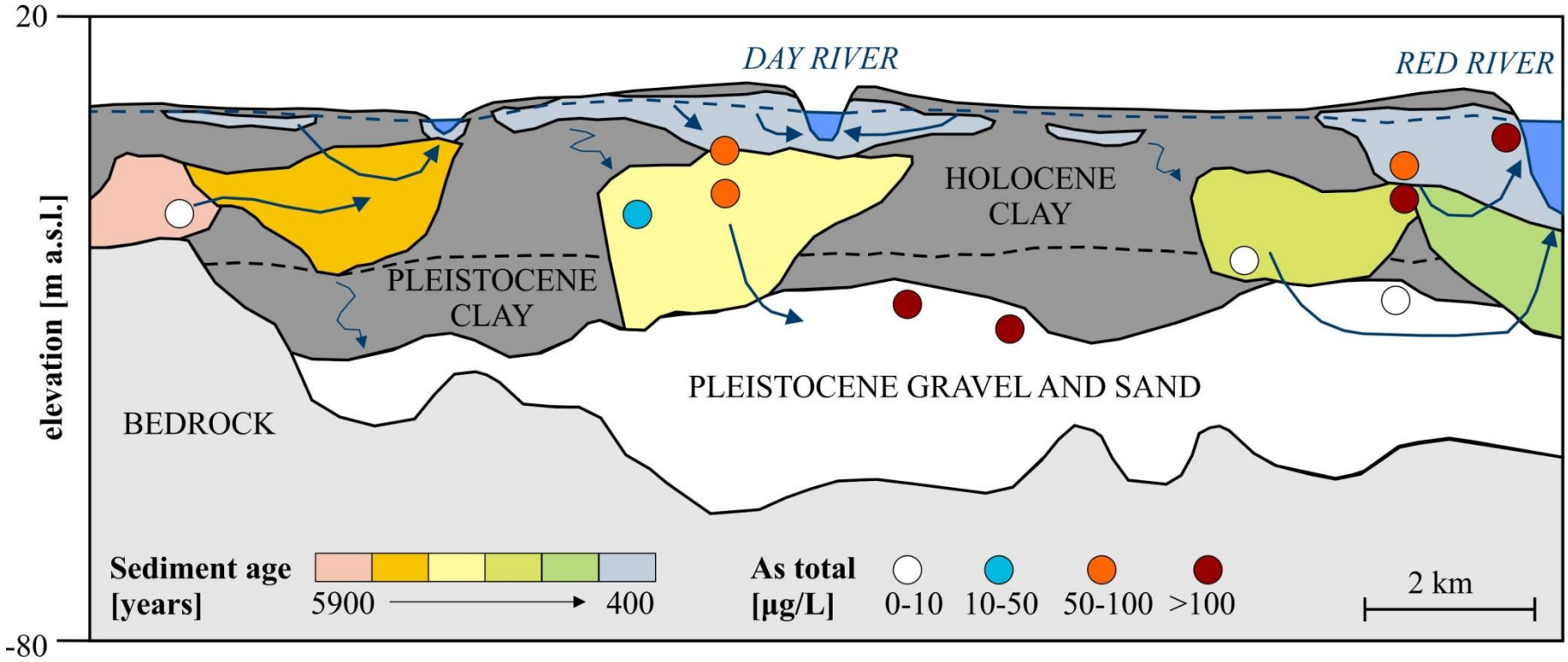
Connection between aquifers.

SEDIMENT AGE VS ARSENIC DISTRIBUTION

WHO norm for drinking water

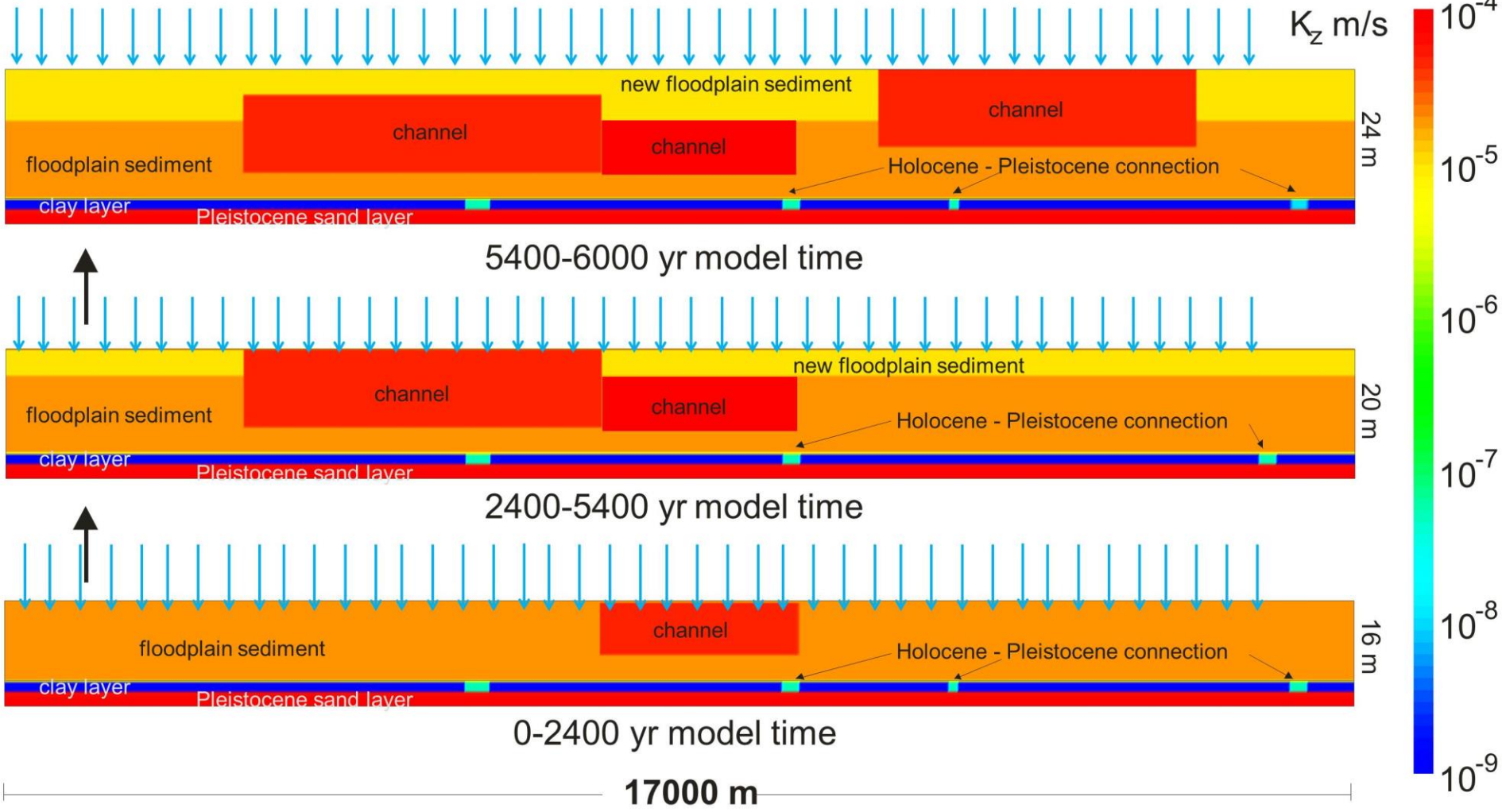


SEDIMENT AGE VS ARSENIC DISTRIBUTION



- Intense **erosional processes** lead to the local **hydraulic connection** between different Holocene river channel belts and Pleistocene aquifer.
- **Groundwater with high As concentration flows from the recent river sediments towards the older buried river channel belts and Pleistocene aquifer**.

NEXT STEP…
TIME STEP MODEL OF **GEOLOGY**, FLOW AND TRANSPORT



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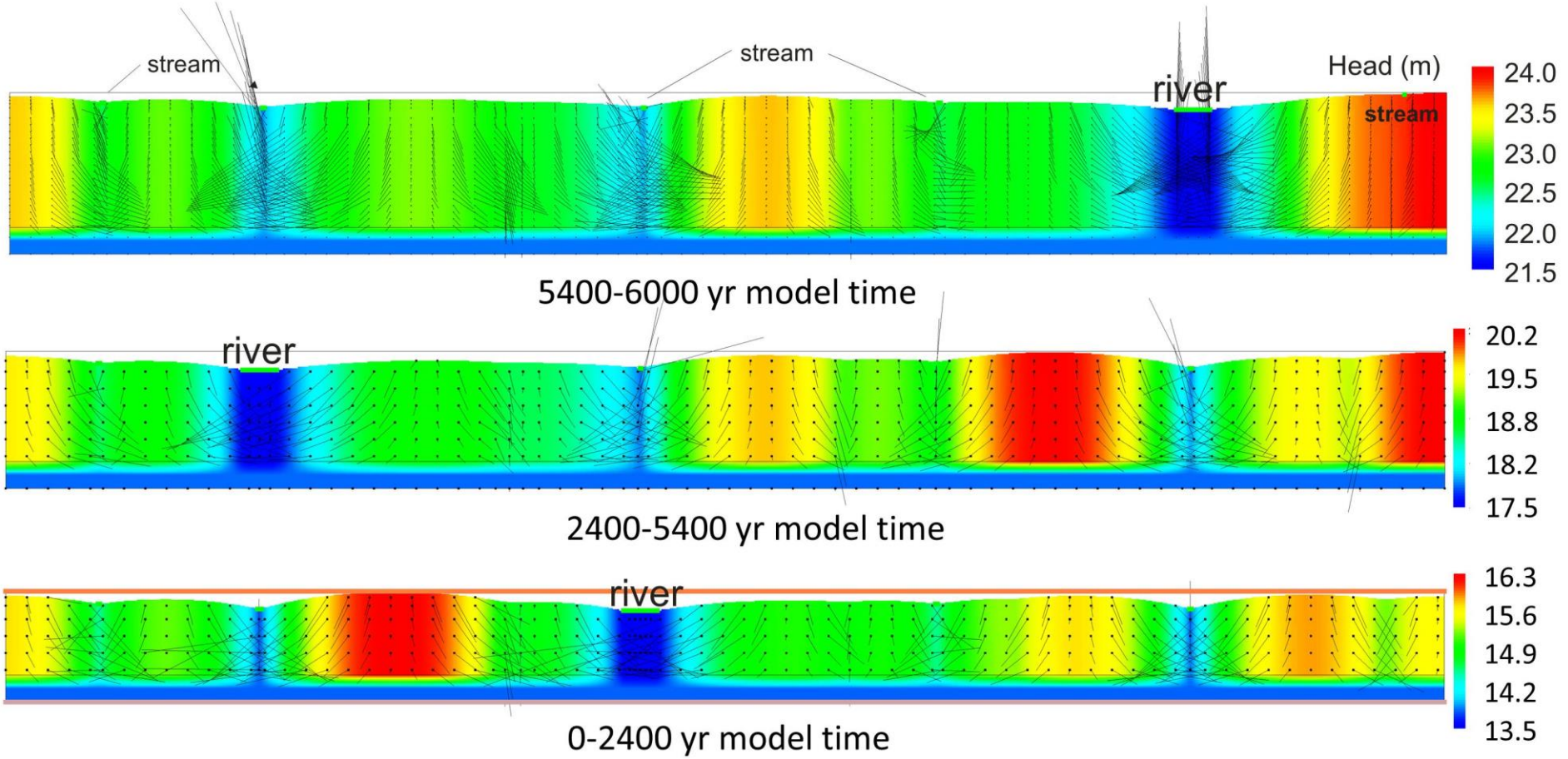
TIME STEP MODEL OF GEOLOGY, **FLOW** AND TRANSPORT



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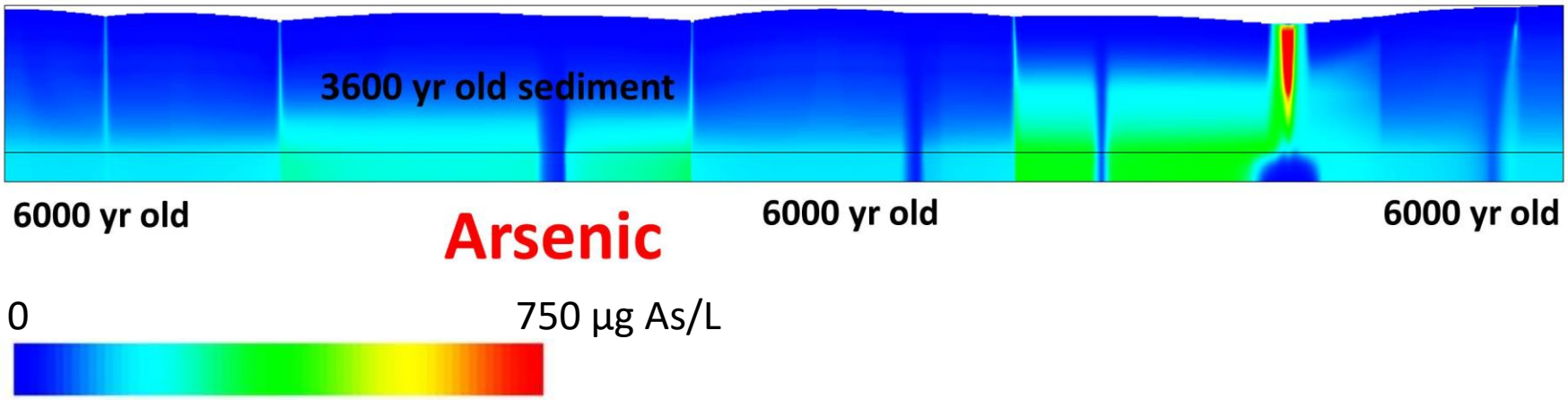
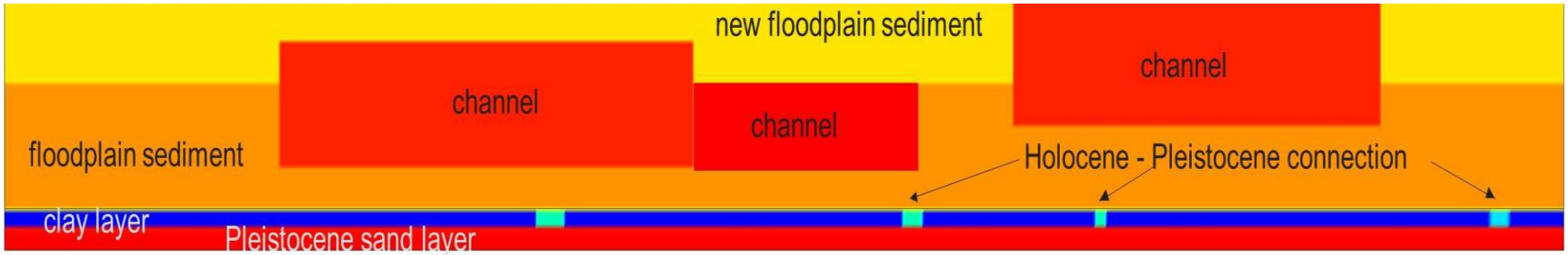
TIME STEP MODEL OF GEOLOGY, FLOW AND **TRANSPORT**





CONCLUSIONS

- **Joint analysis of geophysical**, **borehole** and **remote sensing data (OBIA)** is an invaluable tool for a development of the **3D geological models of the complex meandering river systems**.

- Previously described **pattern of groundwater arsenic concentration decreasing with increasing sediment age** [Postma et al., 2012] is **modified by the groundwater flow paths**. Shallow groundwater carrying high arsenic concentration flows through the hydraulic windows towards the older burried channel belt deposits and Pleistocene aquifer.

Postma D., Larsen F., Thai N.T., Trang P.T.K., Jakobsen R., Nhan P.Q., Long T.V., Viet P.H., Murray A.S. (2012): Groundwater arsenic concentrations in Vietnam controlled by sediment age. Nature Geosci., 5: 656-661.

THANK YOU FOR THE ATTENTION