Advanced Geomorphology in River Catchments – Reconstructing the fluvial activity of the Bergstraßenneckar

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Introduction & Methods

Organized by the European University Alliance (4EU+) cooperation programme, students and lecturers from the University of Milan, the Charles University Prague and Heidelberg University worked together in June 2022 in the field course "Advanced geomorphology - Application of geophysical, geodetic and sedimentological methods in river catchments" with the aim to reconstruct the fluvial activity of the Bergstraßenneckar (BSN), a former river channel of today's Neckar river in the eastern part of the northern Upper Rhine Graben in southwestern Germany (Fig. 1).

Different methods were used, ranging from percussion coring and soil moisture measurements to more technical instruments like the EM (electromagnetic induction) and ERT (electrical resistivity tomography). While the EM gives more insights about the upper soil layer up to a depth of around 2 m, the ERT device reached as deep as around 9 m with the Schlumberger configuration (Engel et al. 2022: 4). It measures the potential difference in electrical resistivity of soil components which results in a 2D profile indicating different sediments. Coring with the percussion corer (Fig. 4-5) with a core length of up to 5.3 m helped to observe the dynamic changes of fluvial activity in soil samples which were further interpreted and generalized with the results of the ERT.

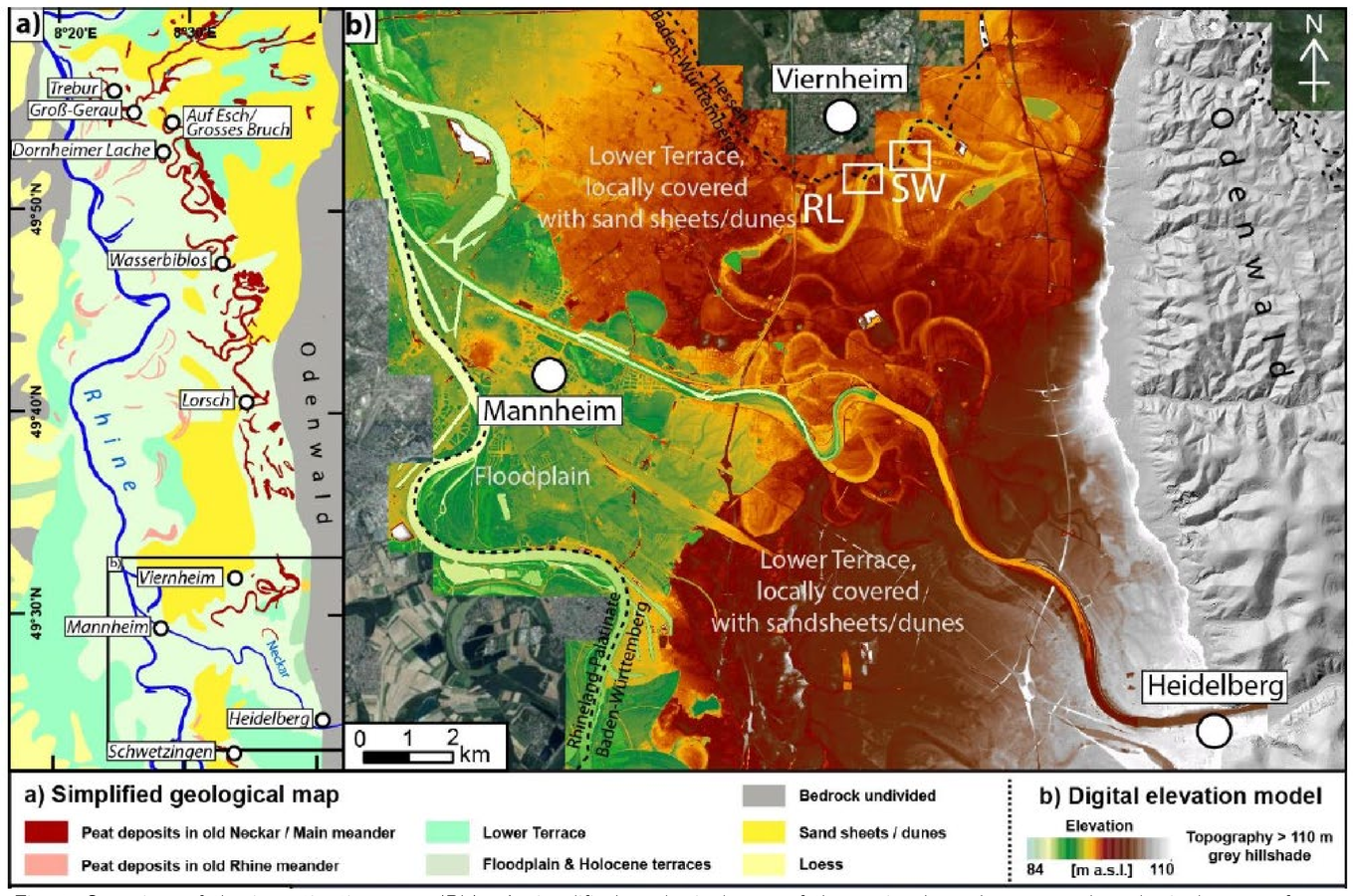
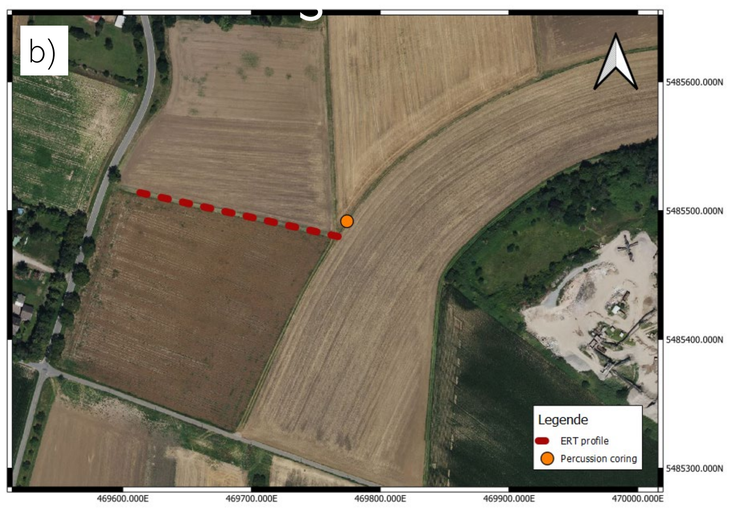


Fig. 1. Overview of the investigation area (RL). a) simplified geological map of the region based on several geological maps of Germany. b) high-resolution digital elevation model showing relief variations at 84-110 m above NHN. RL = Rindlache (Engel et al. 2022: 17).

Result

Fig. 2. Location of the borehole and ERT profile (a), image of the cores (b, own representation).



Coring

- The core was taken on a dirt road between two fields located at the outer part of the former riverbed of BSN (Fig. 2b)
- The coring was 5.30 meters deep, it is shown in figure 2a, most important parts are marked
- A) Upper part (19-100 cm): fine sand and silt, further down poorly sorted clay with silt and sand, containing shell fragments
- B) 145-162 cm: Peat with clay content containing fragments of roots
- C) 215-282 cm: well-sorted silty clay containing organic material, interrupted by thin layers of sand with episodic gravel
- D) 282-400 cm: coarse sand with well rounded granules, change in size with increasing depth and transition to sand gravel mixture with gravels up to a size of 5 cm

Electromagnetic resistivity tomography (ERT)

- The ERT profile was measured along a dirt road starting near the coring and reaching further out of the former riverbed up the slight slope of the north-western flank of the channel (Fig. 2).
- Lowest resistivity values are shown in the first part of the profile between 0 and 39 m from the starting point in the riverbed in approximate 1.35 to 3 m depth
- These values are overlain by very high resistivity values and stand in contrast to higher values in the central and upper part of the profile from 39 to 98 m (Fig. 3)

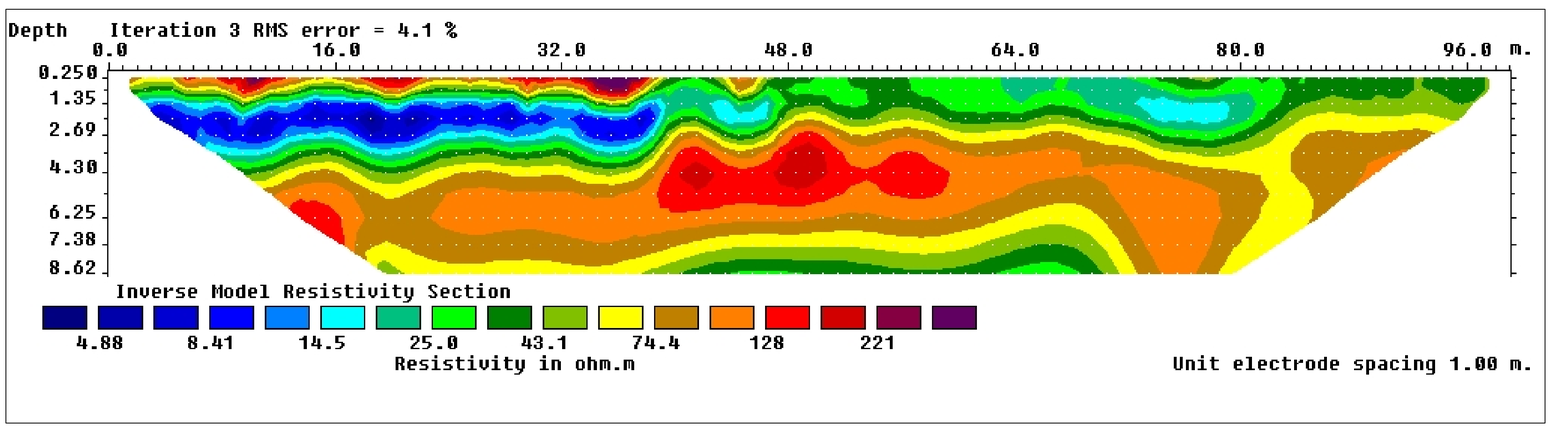


Fig. 3. Electromagnetic resistivity (own representation)

Discussion

- The basal part of the core consisting of well-rounded gravel and coarse sand, most likely represents the **bedload of the former active river** channel of BSN
- Fining-up of sediments in the overlaying part of the core and shift from sandy fluvial deposits to greyish mud layers indicates a **channel cutoff** and limnic deposition due to overbank flows
- Several **phases of temporal reactivation** (e.g. through flooding events) before entire abandonment are shown as thin layers of sand and small gravels within these deposits
- These changes in material lead to similar variations in conductivity which can be seen in the ERT profile showing lowest resistivity values in depths of about 1.90 to 2.85 m referring to the fine grained limnic deposits
- Exact timing of fluvial activity of southern BSN remains unknown due to missing radiocarbon ages, but presumably ends in Younger Dryas (Engel et al. 2022: 10).

Fig. 4-6. Impressions from field work (photos: Stefan Hecht)

Conclusion

The results of the coring and the ERT measurements showed a distinct former fluvial activity in the BSN. Different layers of sediments with variations in their conductivity hint towards a dynamic evolution with several phases of reactivation before entirely abandonment of the former river channel, approximately at the time of Younger Dryas. The field course gave a good insight in current scientific research and greatly supported the cooperation between the three universities.

Fig. 7. Participants of the 4EU+ field course (photo: Stefan Hecht)

Further reading: Engel, M./Henselowsky, F./Roth, F./Kadereit, A./Herzog, M./Hecht, S./Lindauer, S./Bubenzer, O./Schukraft, G. (2022): Fluvial activity of the Lateglacial to Holocene "Bergstraßenneckar" in the Upper Rhine Graben near Heidelberg, Germany – first results, E&G Quaternary Science Journal, 71, 213–226.

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