Early historic topography of the Lower Rhine valley and upper delta

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Introduction

Reconstruction of past topography in a palaeo-DEM is useful for a range of geological, geomorphological and archaeological applications. We developed a workflow (Fig. 2) for constructing palaeo-DEMs of large areas at high resolution, and applied this workflow to a region with a long history of human interference in the landscape. The results (Fig. 6) indicate major changes in floodplain connectivity.

Objectives

- Develop a workflow for palaeo-DEM construction.
- Reconstruct the circa 1000 CE topography of the Lower Rhine river valley and the upper part of the Waal-Nederrijn-IJssel delta.

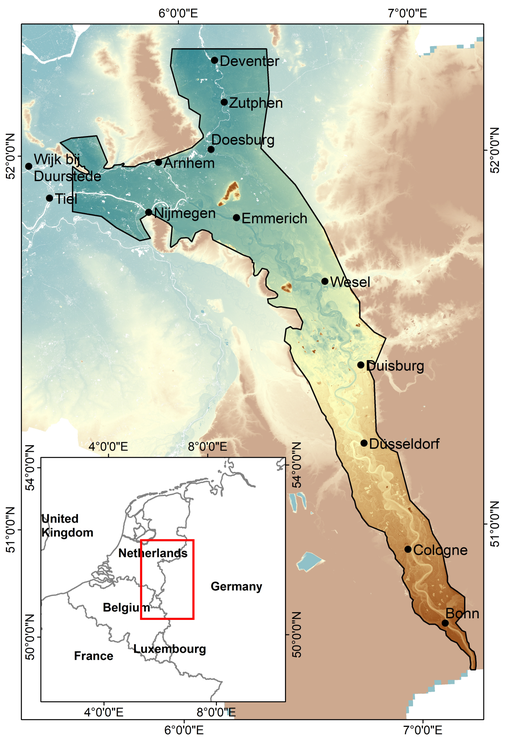


Fig. 1. LiDAR DEM with study area.

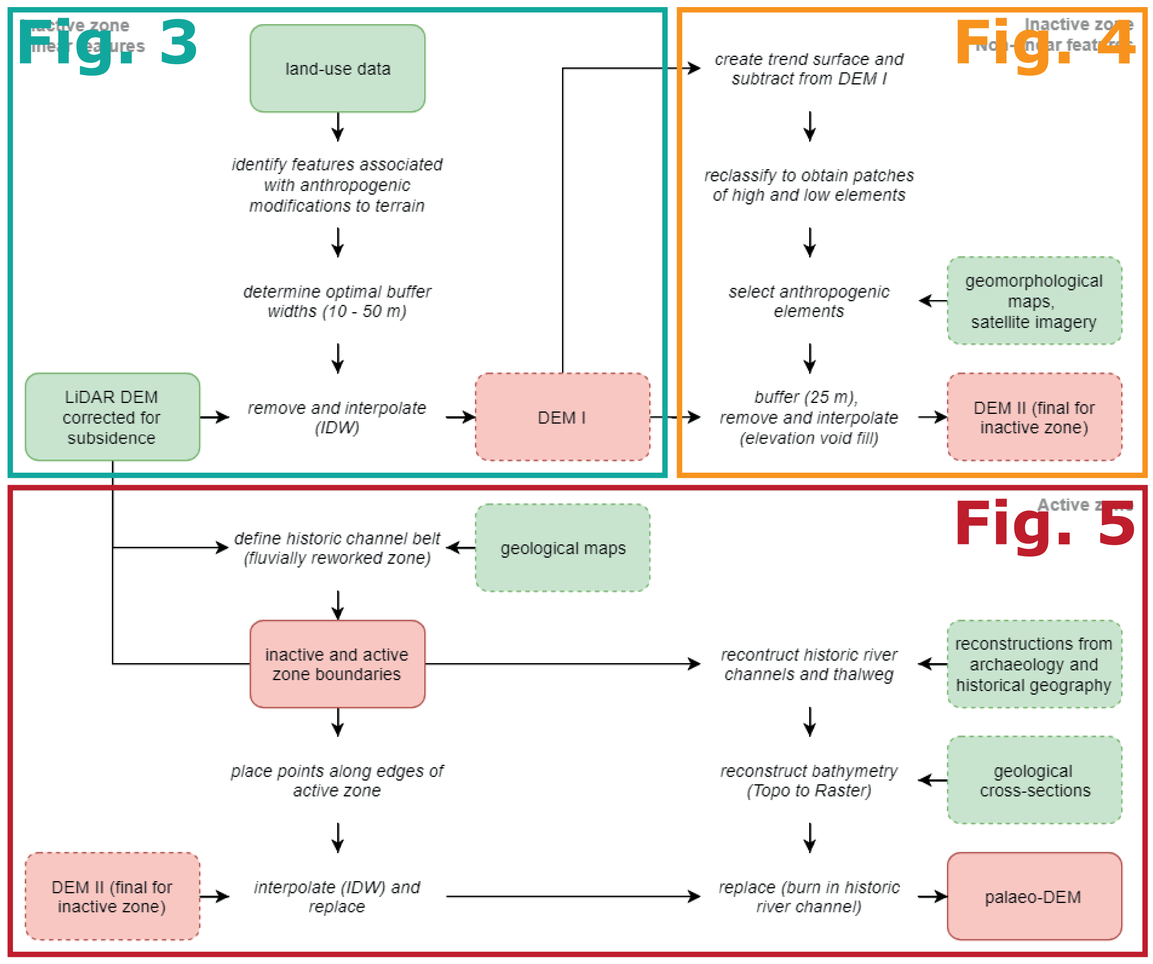


Fig. 2. Workflow developed in this study and applied to the study area.

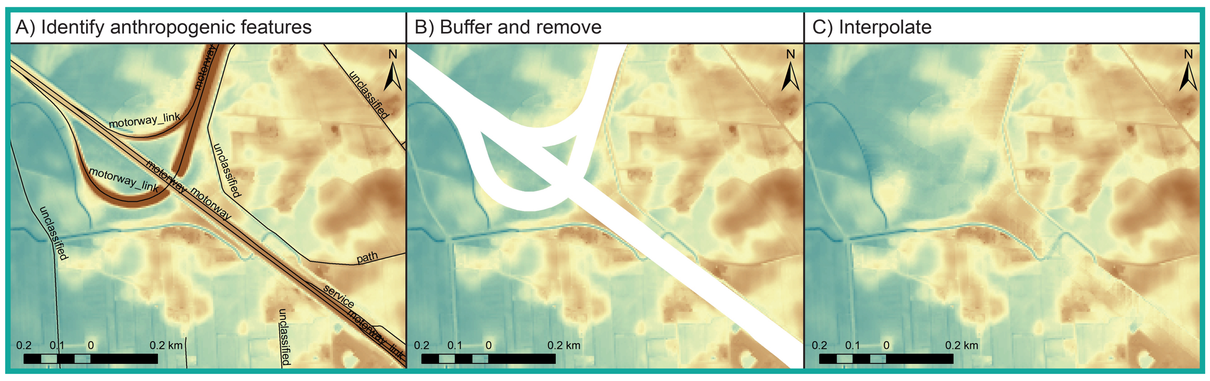


Fig. 3. Automated removal of highway taluds from DEM using OpenStreetMap vector data.

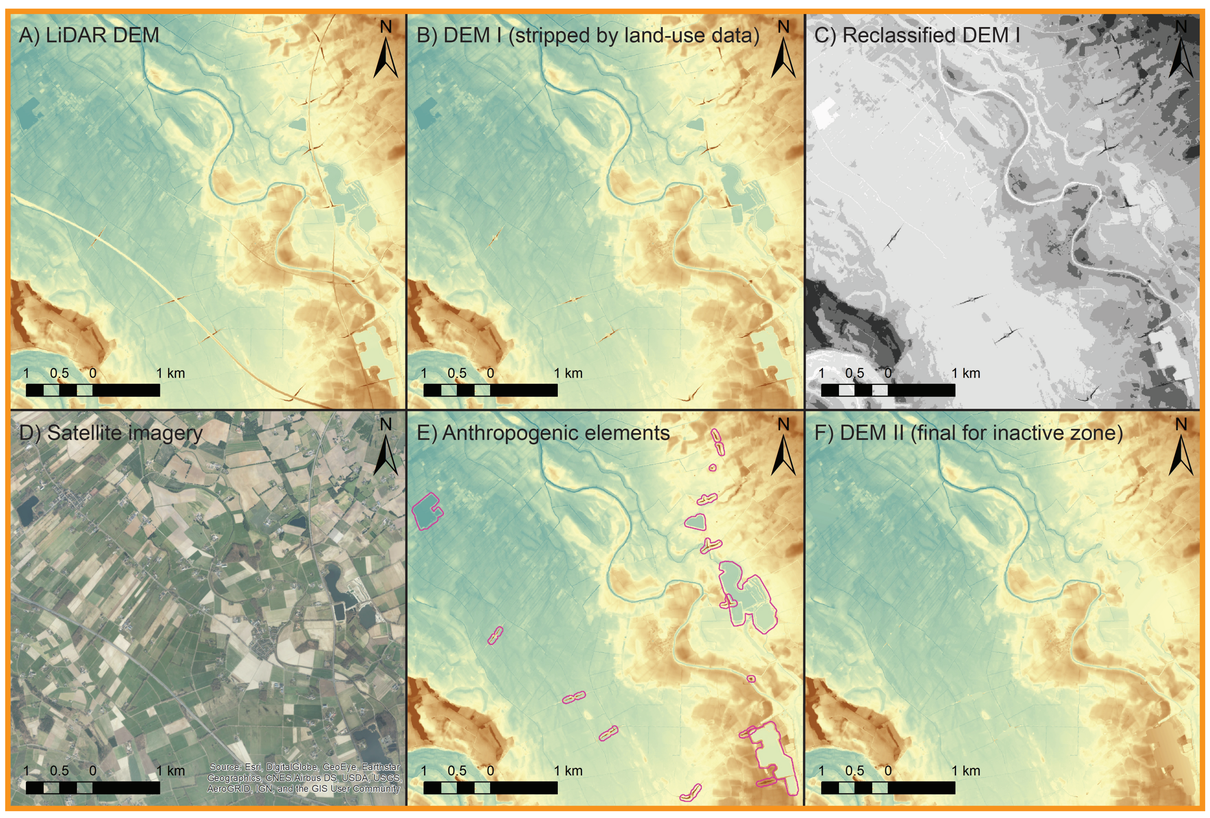
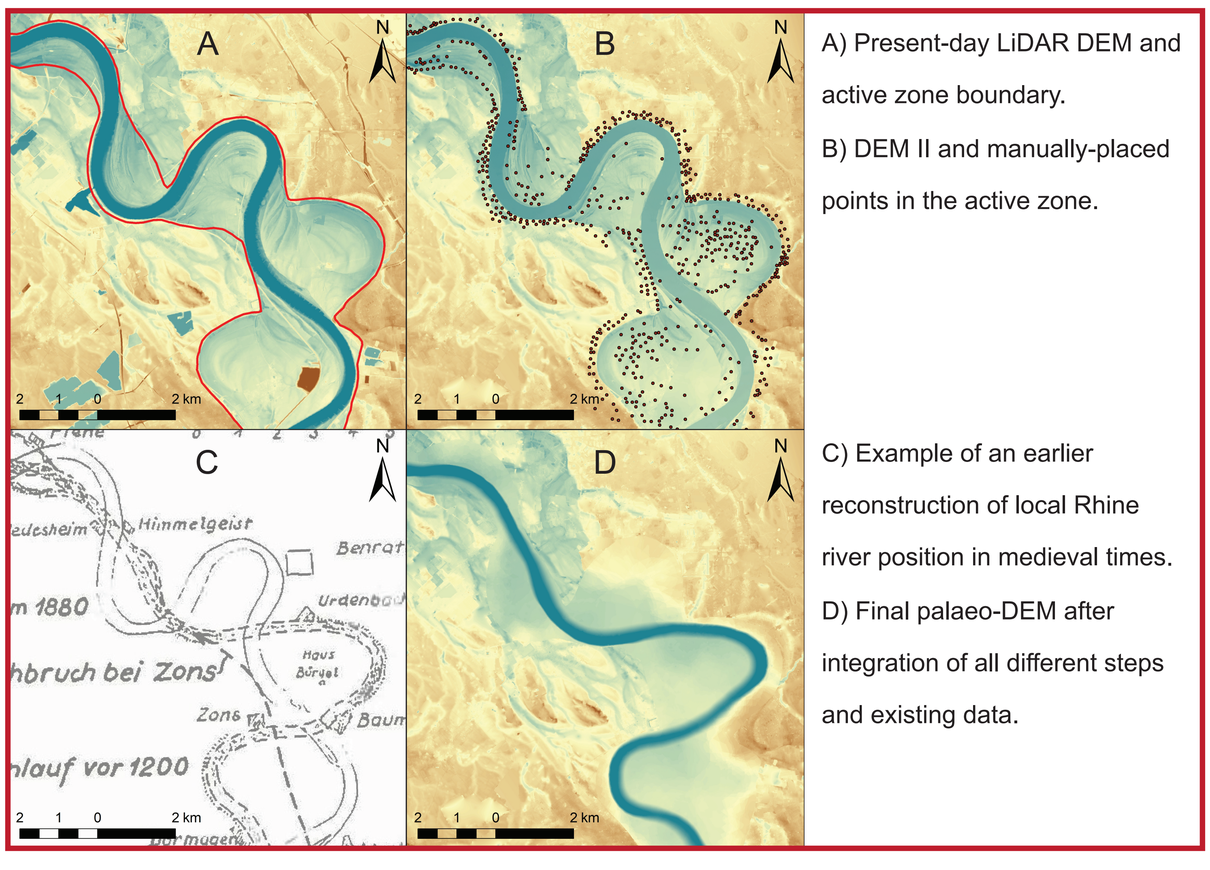


Fig. 4. Removal of remaining anthropogenic elements using a detrended and reclassified DEM.



A) Present-day LiDAR DEM and active zone boundary.

B) DEM II and manually-placed points in the active zone.

C) Example of an earlier reconstruction of local Rhine river position in medieval times.

D) Final palaeo-DEM after integration of all different steps and existing data.

Fig. 5. Reconstruction of floodplain topography in the fluvially-reworked area.

Present-day DEM:

- LiDAR DEM of ground surface.
- Anthropogenic modifications to the terrain include dikes, infrastructure embankments, dump sites, raised grounds for building, pits, quarries, harbours.
- River training.

Palaeo-DEM:

- LiDAR DEM adjusted by alternating automated and manual steps listed in workflow.
- Natural state of floodplain, no compartmentalization.
- Medieval river position.

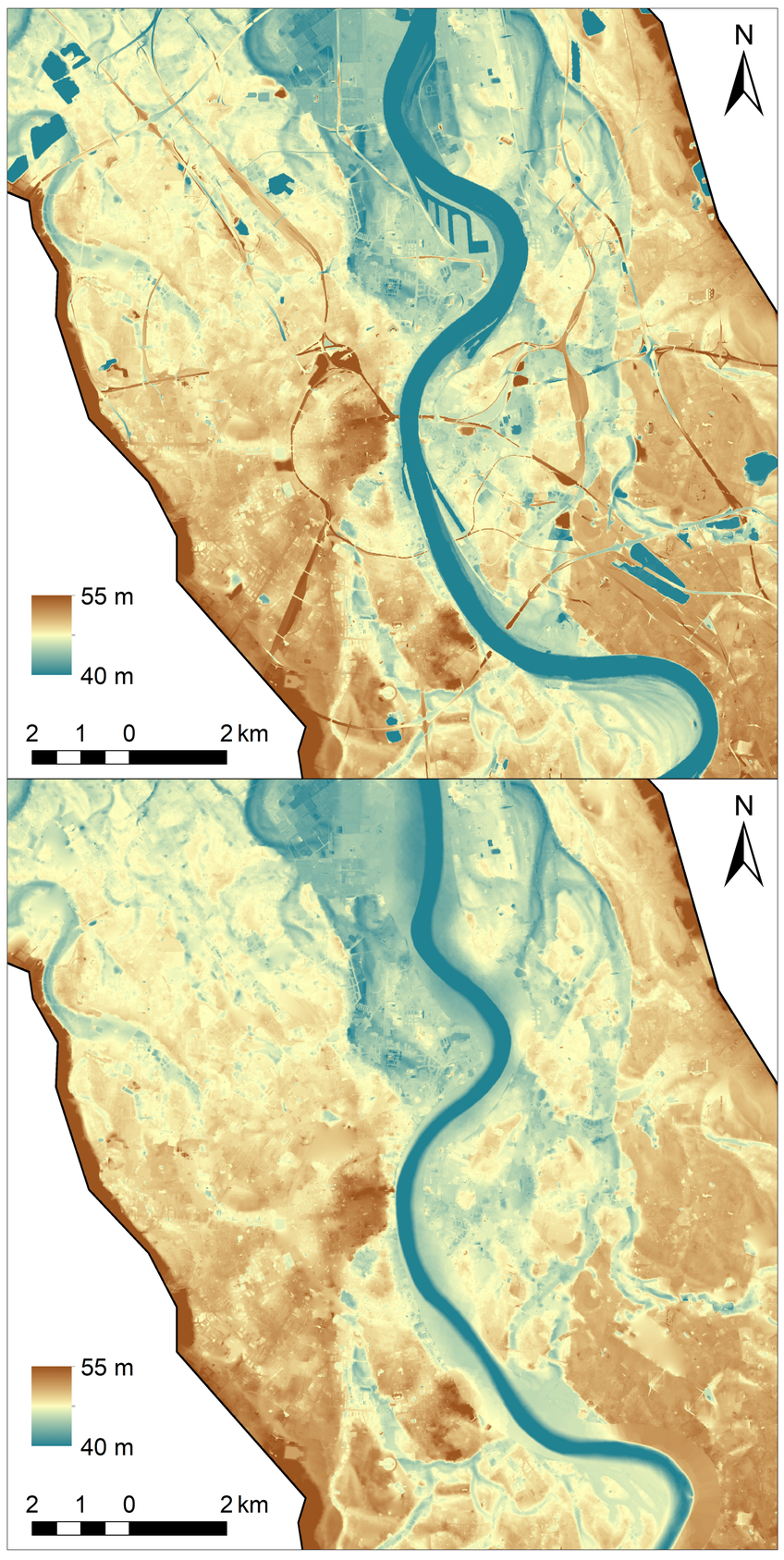


Fig. 6. Close-up of study area around Cologne before and after workflow application.

Future work

The workflow developed here is widely applicable to lowland areas at different spatial scales. The resulting palaeo-DEM is currently being applied in a hydraulic model study in order to identify late Holocene to historic flooding patterns and quantify the magnitudes of the largest historic floods of the Rhine river.