A geophysical study of palaeochannels on the Somerset Levels coastal plain and wetland to explore river landscape evolution and the implications for flood risk.

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Background

The way we manage floods is changing. From traditional hard engineering to soft nature-based measures, flood risk management could benefit from an understanding of the natural processes and features preserved within palaeochannels, which have otherwise been hidden by a legacy of engineering and land management on the river and floodplain. This study presents field tests of geophysical surveying methods on palaeochannels to explore their uses for understanding river landscape evolution and palaeohydrology.

Aims and Objectives

Aim: Characterise the palaeohydrology and long-term development of river systems in the Somerset Levels.

Objectives:

- Identify and map palaeoriver systems
- Produce two-dimensional models of cross sections from ancient river systems, revealing their anatomy and evidence of dynamic processes.
- Reconstruct geomorphology and palaeohydrology to create reference points of rivers existing under different degrees of human and natural conditions

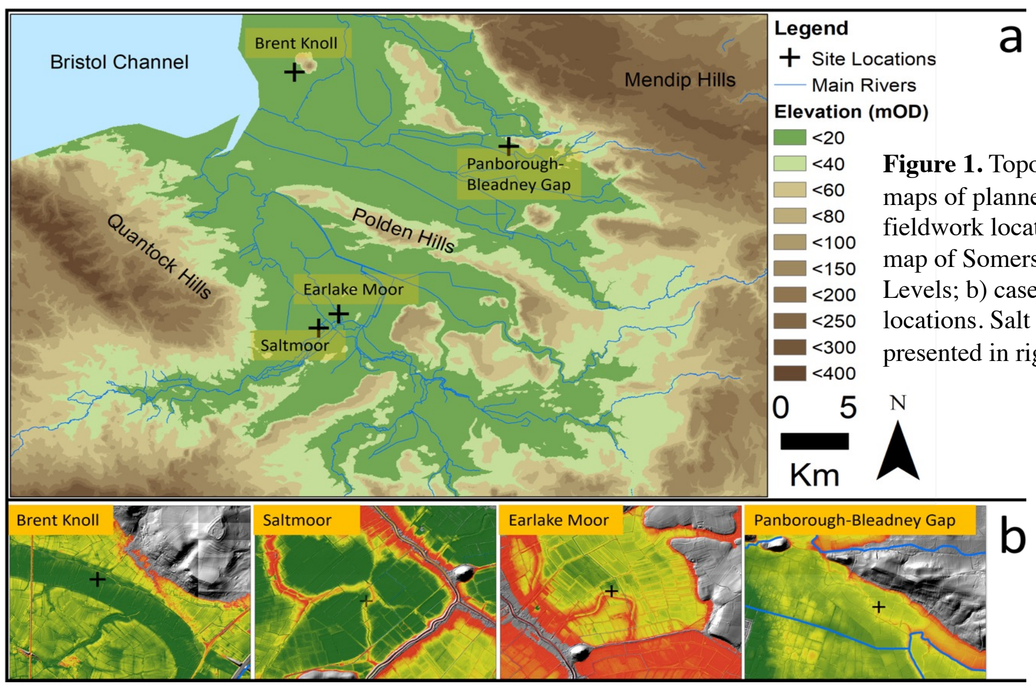
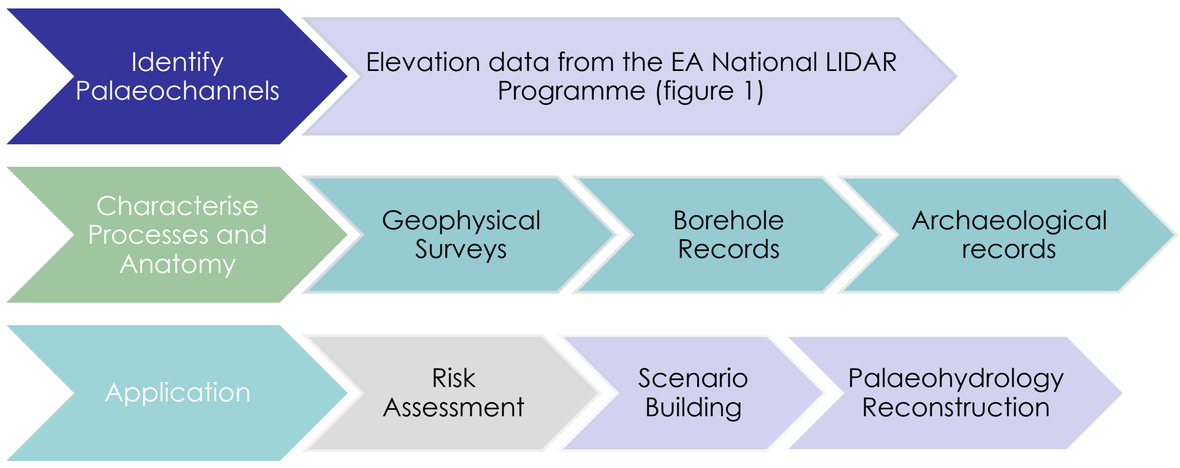


Figure 1. Topographic maps of planned fieldwork locations: a) map of Somerset Levels; b) case study locations. Salt moor presented in right panel

Methodology

This project will integrate multi-dimensional datasets to map and characterise the geomorphology of ancient river systems, capitalising on indicators of sedimentation and erosion. Two-dimensional geophysical profiles are supported by topographical LIDAR datasets, subsurface borehole records, and contextual archaeological studies (figure 2). River palaeohydrology will be examined using published discharge equations and channel dimensions derived from the geophysical surveys.



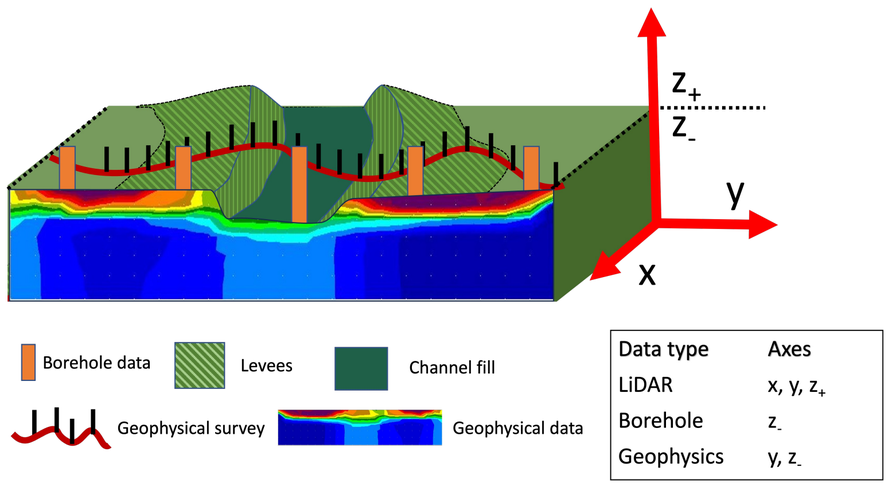


Figure 2. Schematic diagram of data contributions in three dimensions. LIDAR data connects palaeochannels sites to large-scale geographic settings as well as providing elevation data. Geophysical and borehole data investigate subsurface.

Case study: Saltmoor

Saltmoor is a low-lying area of farmland in the floodplain of the confluence of two major rivers near their tidal extent. The palaeochannel was part of the former drainage system which was artificially rerouted to open land up for agriculture. The sediment is dominated by silt, clay, and peat.

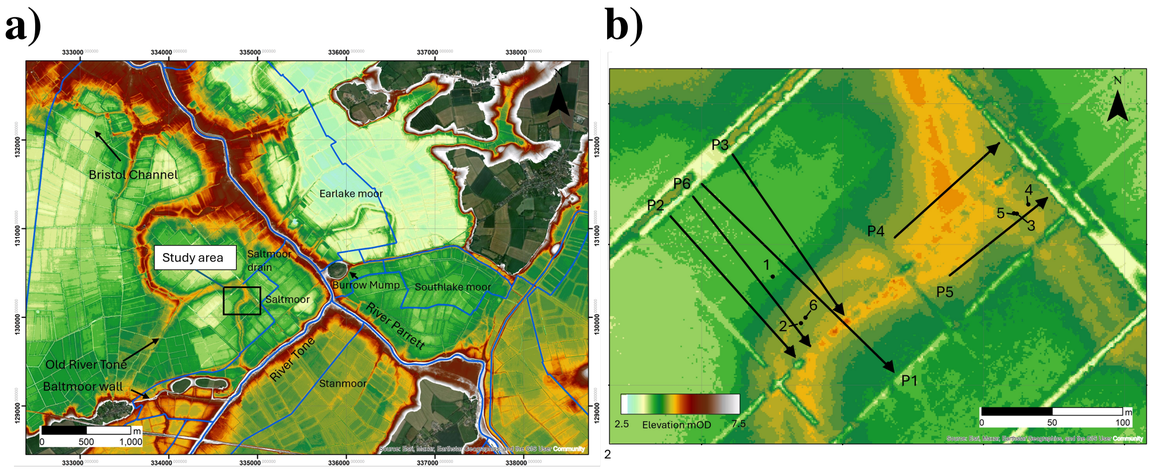


Figure 3. Topographic maps of case study area: a) Burrowbridge showing palaeochannels amongst modern river systems; b) map showing case study map of Saltmoor with profiles and borehole locations marked.

Geophysics involves applying a force to the ground and measuring the responding energy yields models of the subsurface. Surveying profile lines were designed perpendicular to the channel axis as derived from LiDAR imagery and positioned to intersect secondary sediment coring data (figure 2).

A combination of different methods reduces uncertainty[1] by targeting multiple geophysical qualities in the ground material. The following methods are non-invasive, quick-to-use, and (mostly) inexpensive, creating two-dimensional images that can be used to interpolate between coring data: a) ground penetrating radar (GPR); b) electrical resistivity (ERT); c) seismic refraction tomography (figure 3).

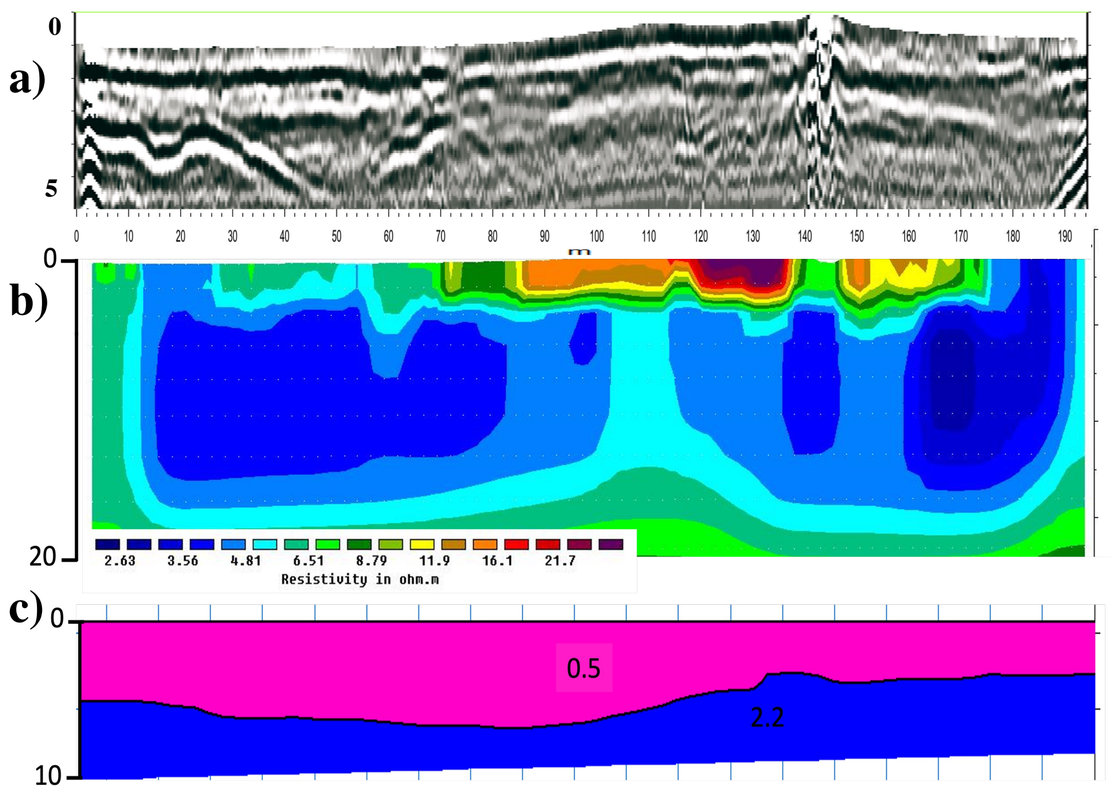


Figure 3. Results of geophysical surveys from profile 1 (figure 2). Together the profiles reveal the scale and architecture of a channel belt that likely formed as a result of an avulsion following the well-documented diversion of the river Tone in the 14th Century[2]. a) GPR profiles demonstrating dielectric contrasts between peat and overlying silt and clay sediments. b) ERT image of the channel fill, banks and overbank deposits. c) Seismic velocity (km/s) layers indicating interface of increasing velocity.

Outcomes

This thesis will integrate sediment, topographic, and geophysical data to produce baseline geomorphological models that can be used to improve modern river management, especially regarding recent trends towards natural flood management that require natural targets. Geometric parameters derived from the geophysical profiles are used within Manning's hydraulic equation to estimate the palaeodischarge at each site.

Other case studies

The methodology has been applied to four different sites, representing a different period of human and natural history. The ability to resolve geomorphological features and geometric parameters using the geophysical surveying methods will be compared across sites. The results will be contextualized within frameworks for managing flood risk and river management, particularly within river restoration and natural flood management

[1] Schrott, L. & Sass, O. (2008) Application of field geophysics in geomorphology: Advances and limitations exemplified by case studies. Geomorphology (93) pp. 55-73.
[2] Williams, M. (1970). The Draining of the Somerset Levels.