Where the Big Scrub met the Big Swamp.
Using LIDAR to predict Holocene archaeological site stratigraphy at palaeo estuarine margins: a case study from coastal NSW.

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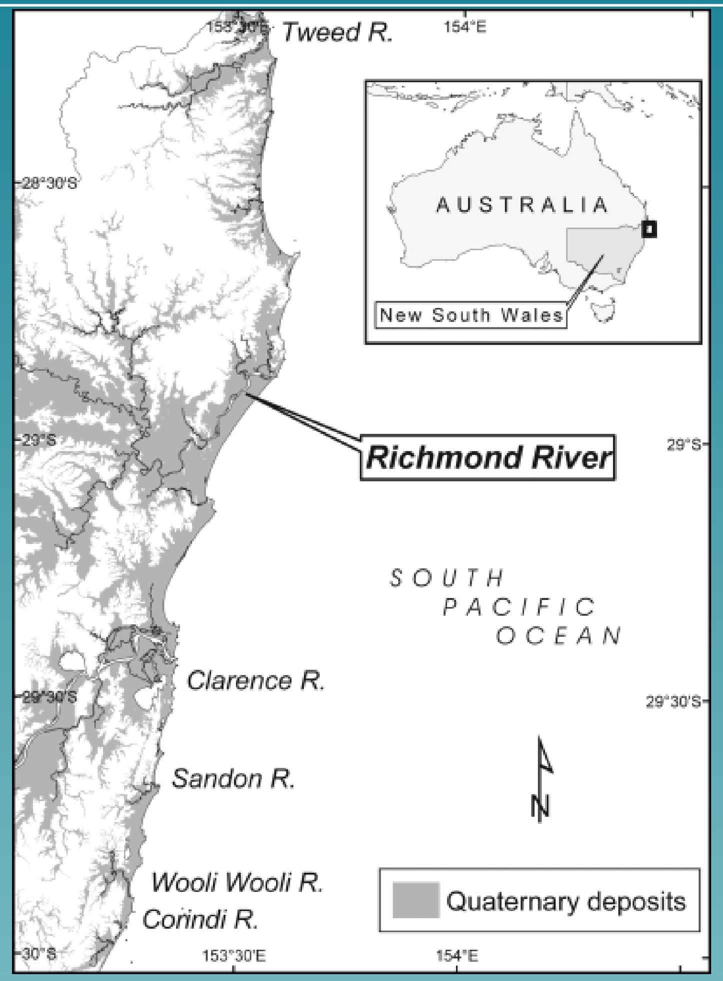

Quaternary deposit map (Hasimoto *et al.* 2006 Figure 1)

Introduction

• The Richmond River floodplain is one of the largest sediment infilled valleys on the eastern seaboard of Australia, with a catchment of c. 6900 km². The lower reaches of the floodplain are microtidal, but gradients are so low along the lower river tract is brackish estuarine 40km upstream of the river mouth for parts of the years. Wet season floods can flush out the system rendering all parts of the river fresh.

• In the Holocene transgression estuarine and mangrove sedimentation accumulated on buried Pleistocene land surfaces at -2 to -4m AHD with mangrove mapped in areas 40-55km upstream of the river mouth.

• This research examines LiDAR data as a precurser to exploring the potential for developing subsurface predictive modelling of archaeology potential a) below the floodplain and b) at floodplain margins.

The Big Swamp story – Australian Archaeology

• In Australia, direct archaeological assessment and mitigation of subsurface deposits or near surface deposits of floodplain wetlands is infrequent, and rarely involves excavations in waterlogged sediments, or attempts at predictive deposit modelling to target and then assess archaeology stratified on former landsurfaces (soils) buried by Holocene alluvium.

• More commonly, palaeoenvironmental investigations of Holocene wetland stratigraphy focus on the calibration of archaeological change on adjacent dry land sites and land surfaces (eg see Stevenson et al 2016), and/or detecting fire history as a proxy of human actions by First Peoples on landsurfaces adjacent to swamps.

• “Big Swamp” floodplain ecological changes, forced by Holocene sea level transgressive flooding of valley floors, is a key driver of the change seen in the archaeological record from the tropics to southern temperate coasts of Australia (eg see Ditchfield et al 2018).

Study Area

• The Richmond River Estuary and Lower Floodplain is the largest of several bedrock-bound embayments along the Northern NSW coast. These embayments filled with unconsolidated sediments of Pleistocene to Holocene age during late Pleistocene high sea level stands. Successive global high levels triggered beach barrier and back barrier shallow lagoonal sedimentation, and associated flood deltaic, estuarine and mangrove sedimentation. The model of deltaic, estuarine and then later stage alluvial accretion in the lower floodplains of estuaries, developed by Roy (1984, 1993, 1998) has provided the foundation for increasingly sophisticated modelling and mapping of Quaternary coastal deposits and landforms for the eastern coast of Australia, especially New South Wales (Hashimoto 2005; Hashimoto and Troedson 2008).

References:

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• Rapinel S., Hubert-Moy L. and Clement, B. 2015. Combined use of LiDAR data and multispectral earth observation imagery for wetland habitat mapping

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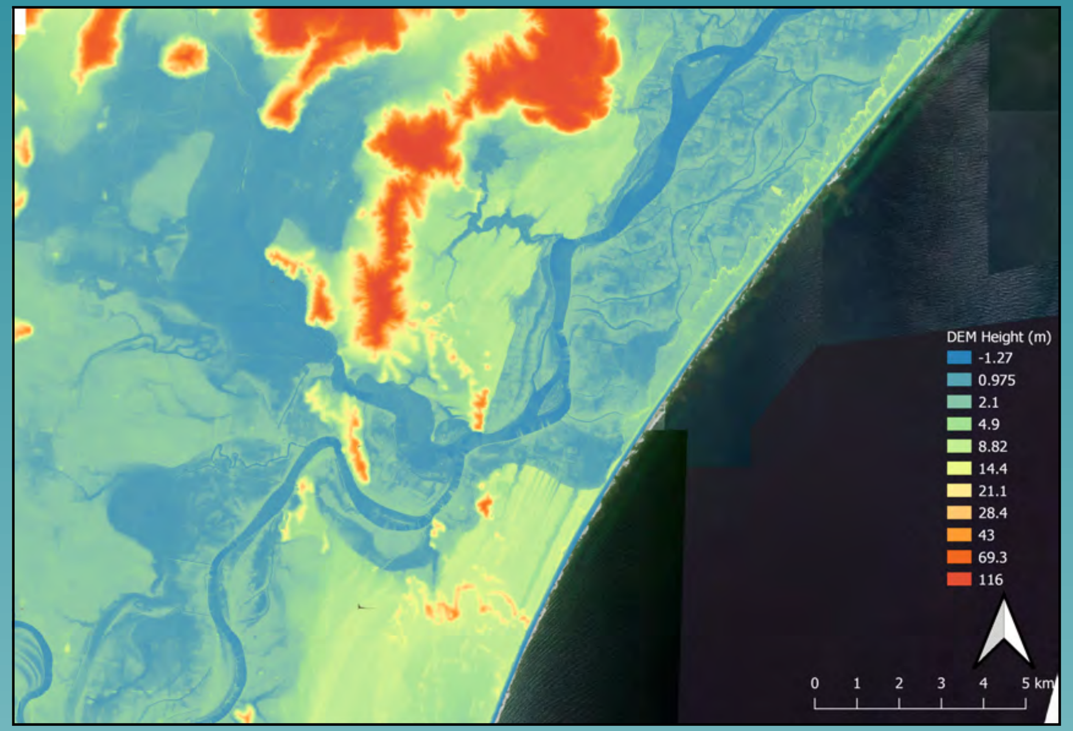
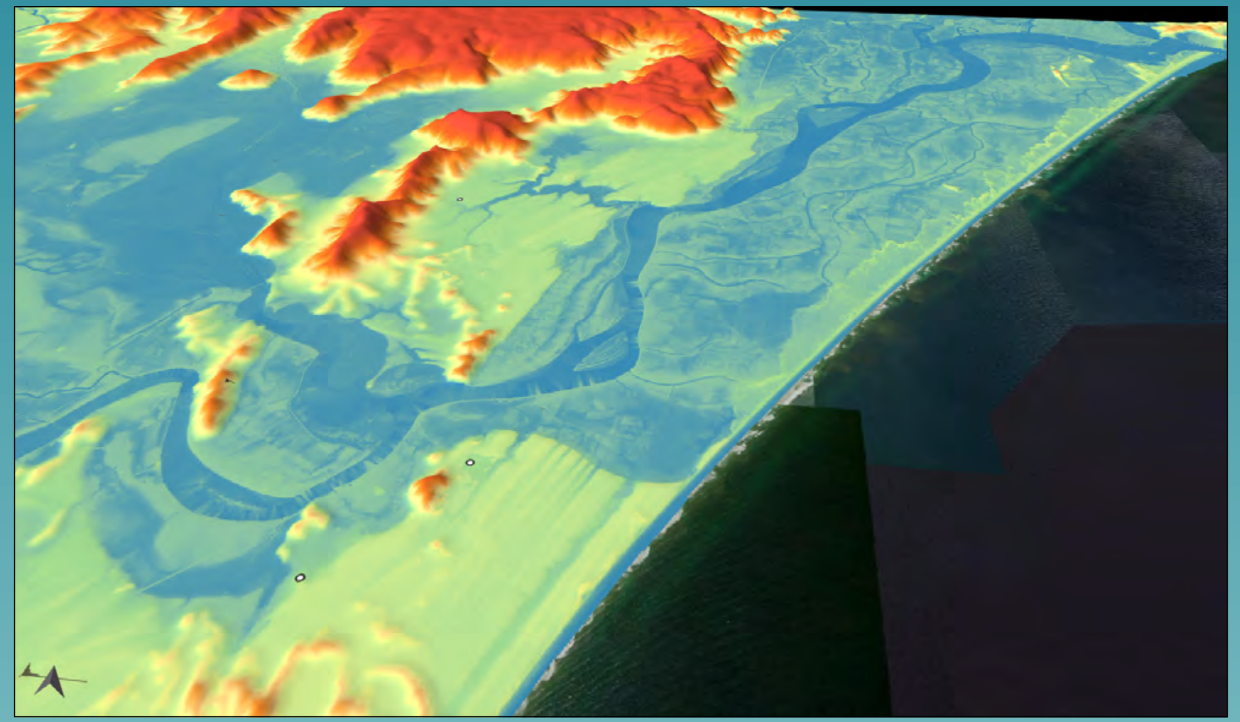
Methodology

The digital elevation model (DEM) dataset was acquired through pubically available datasets derived from LiDAR surveys collected by Geoscience Australia between 2001 and 2015. The 1 metre resolution LiDAR-derived DEMS have been compiled and reseamples to 5 metres dataset. This dataset has then been processed in QGIS 3.10 to separate the distinctions in elevation data into singleband pseudocolour with distinctions between gradients on a continous colour spectrum. Areas represented on the blue-green are close to sea-level whilst those in yellow-red areas are in higher altitudes. This DEM was then processed using QGIS 3D map viewer into a 3D model reconstruction of the landscape.

Satelite imagery of study area

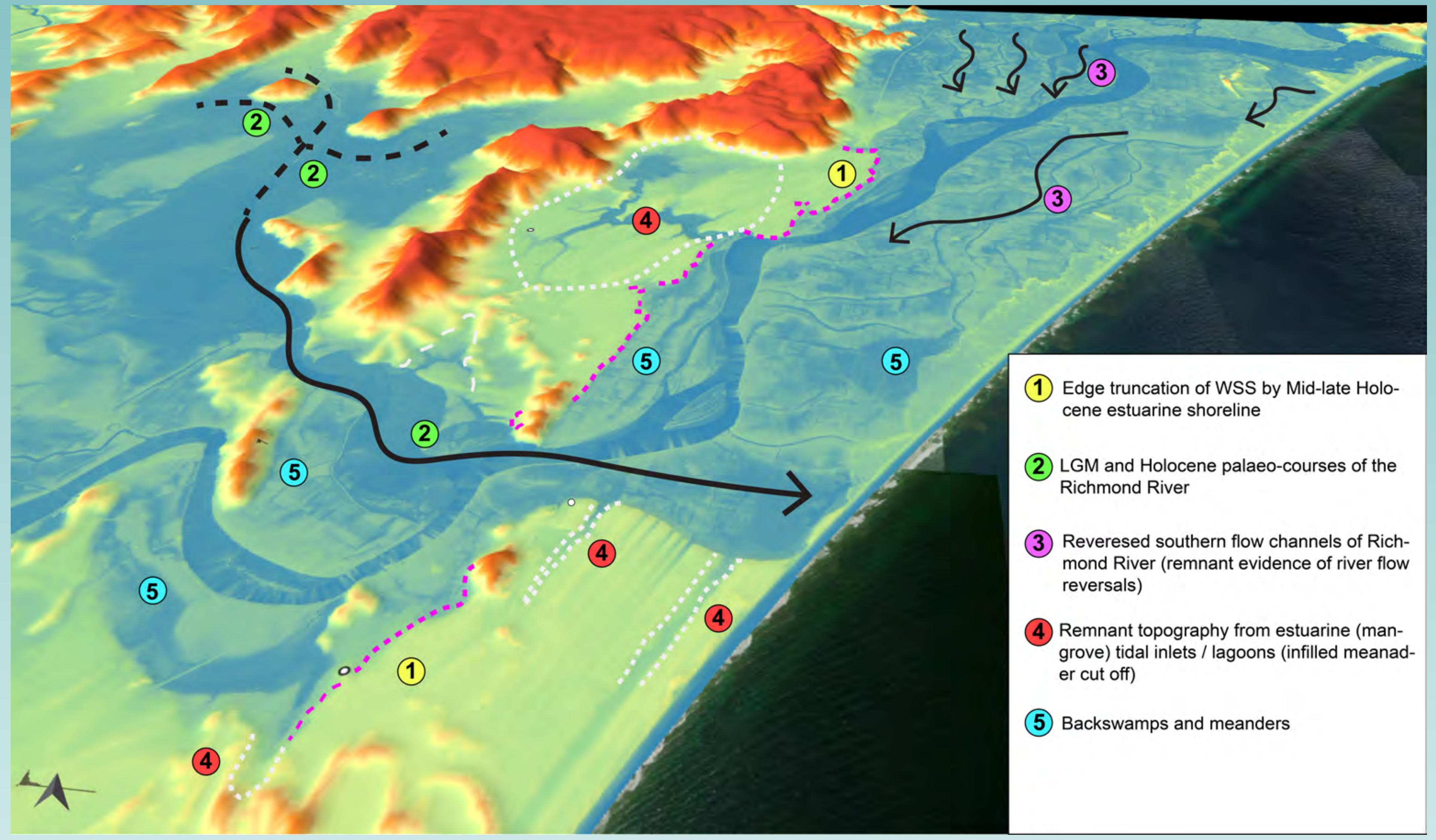


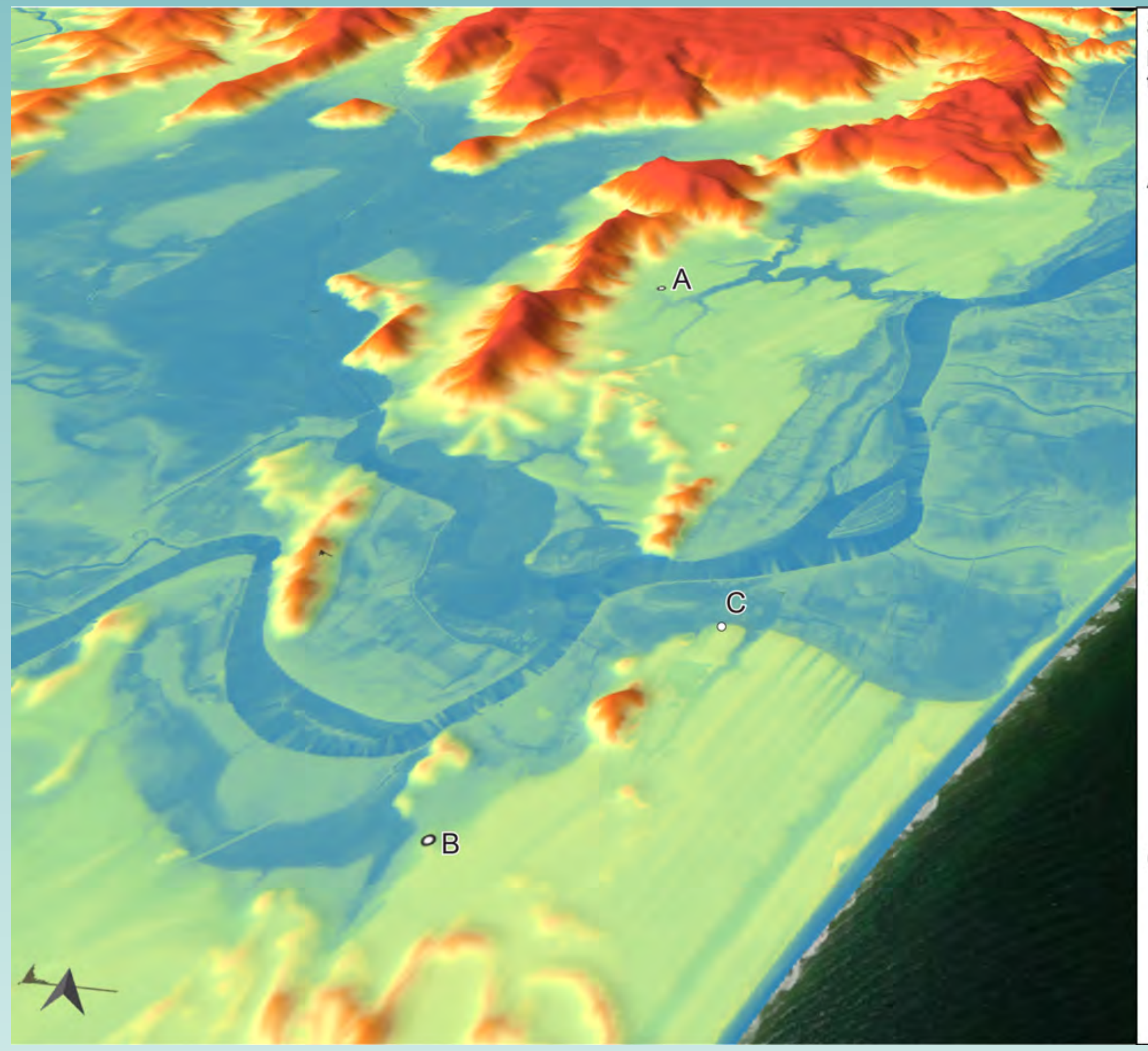
Lidar image in singleband pseudocolour


3D representation of the landform using the DEM model dataset. Note the elevation of the hill terrains have been exaggerated for distinction between elevated hills and surrounding mountain ranges.

The Woodburn Sand Sheet (WSS) is a residual flat landform, deposited during the last interglacial high sea level (Marine Isotope Stage 5) when sea levels were at least 5-7m higher than present. Well sorted sands infilled the embayment, palaeo-estuary and shorefaces during MIS Stage 5, to depths down to >15-20m AHD with a top surface to the WSS at >5m AHD.

Global sea level has not attained heights of +5-7m AHD since, so the WSS has become a residual flat terrain form bounding large areas of the lower estuary. The initial extent of the WSS has been dissected by river channel incisions, terrace formation and reworking by multiple river channel course changes





Selected locations reveal Lidar landform evolution model predicts stratigraphy (and subsurface archaeological potential):

A- Wave washed bench (on coffee rock) on former mangrove upper tidal limit

B- Palaeo-shoreline and beach sequence at base of slope

C- Truncated shoreline + eroded lower slope with Mid-Holocene onlap at base

Data examined are from what is essentially the swathe margins of the Woodburn Sand Sheet as it meets prehistoric wetlands (now drained) that existed in the pre-European landscape, and areas of former intertidal wetlands dating from the mid to late Holocene.

LIDAR is detecting subtle elevation differences in the essentially flat and now drained floodplain landscapes. These micro- elevation differences connect and create pattern of predictive archaeological value. The LIDAR imagery removes the modern land use veneer across former wetlands revealing:

• Connectivity in (now drained) meandering palaeochannel systems
• Predictable departure points, off marginally higher ground (access/egress points) into wetland resource areas
• Larger “top estuary” former swamplands, not clearly visible in Google Earth or contour mapping on 1:50,000 sheets. Detection here probably reflects 20th century surface elevation change progressively resulting from 19th-20th century drainage. Compaction/oxidation effects from drainage are acting to produce surface micro-relief which are products of a) past terrain and b) responses of deposits which infill past terrain to European drainage.

Conclusion

The ability of LiDAR to image subtle (very low gradient and low relief) floodplain landforms and reveal evolutionary “phasing” in the late Holocene flood plain was unexpected, as was the apparent successful linkage between “phased” floodplain landform inference to predicting sub-surface deposits. This pilot study suggests:

• High value in using LiDAR to plan coring and subsurface investigations for archaeological or palaeo-environmental investigations across floodplain margins.
• Scope for predicting buried landscape surfaces (with likely in situ archaeology) at floodplain margins
• High archaeological value in using a “phased landform model” identifying target areas as a precursor for high resolution drone based LiDAR or LiDAR survey coupled with high resolution earth observation spectral imaging (as used in habitat surveys eg see Rapinel et al 2015).