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Monitoring and modelling morphological change in fluvial systems

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In the last decade, technological innovations and new applications of existing techniques have led to advances in mapping and modelling morphological change in fluvial systems, and offer great potential for new levels of analysis and identification of patterns and causal linkages. Key advances include the resolution of environmental change records and dating control, geomorphological flood histories, remote sensing and physical and numerical modelling approaches. This paper focuses on developments in topographic data acquisition, including airborne remote sensing, digital photogrammetry, differential GPS, and laser profiling (e.g. LiDAR) technologies, that allow rapid acquisition of high resolution and high precision topographic data sets over large spatial areas. These developments have offered new opportunities for investigating spatial and temporal patterns of morphological change in fluvial systems, and have contributed to significant revitalization in three key areas: (1) morphometric estimates of sediment transport and sediment budgeting; (2) boundary conditions for numerical models, including computational fluid dynamics and cellular modelling; (3) fully three dimensional characterisation of morphology that is independent of flow stage.

The potential is clear, however, there remain a number of significant challenges relating to quality control and the effects of error on specific applications and morphologies. This paper presents results from three investigations, representing field and laboratory analyses of gravel bed river morphology at a range of spatial scales and for different applications:

- Project 1 (with Langham & Brasington) - monitoring and modelling morphological change in a large gravel bed river, using ground-based GPS survey and digital photogrammetry derived from airborne imagery. Key issues highlighted:

defining a statistical level of detection of change for intercomparison of surfaces derived from both approaches, and assessing the sensitvity of the annual sediment budget.

- Project 2 (with Rollinson and McLelland) - mechanisms of for infiltration of fine sediment into gravel bed rivers, focusing on the link between bed configuration and sediment deposition. This work uses flume experiments, and laser bed scanning to examine changes in bed texture. Key issues highlighted: sources of error, validation of laser and traverse system, and empirical and modelling approaches to correction.
- Project 3 (with Yorke) - late Quaternary deglaciation and fluvial system reponse. This field-based catchment scale investigation of deglacial landform-sediment assemblages, utilises high resolution DEMs overlain with photomosaics (derived from aerial imagery) to visualise and better map Quaternary landforms. Key issues: georeferencing, mosaicking of multiple images, deriving ground control and check point elevations.

These case studies highlight the strengths and weakness of specific technologies and approaches to analysis of channel and floodplain morphology and change, and key areas that remain to be fully resolved. In particular, the critical need to define a specific threshold level of detection associated with each acquisition method, and for different fluvial settings (e.g. bar surface, sub-aqueous zone) is emphasised.