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Controls on reach-scale geomorphological and sedimentary impacts of the November 2009 flood, River Derwent, Cumbria, UK

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Between November 18th and 20th 2009, Cumbria, NW England was hit by an exceptional precipitation event producing an unprecedented total of 372 mm of rainfall. Between November 19 and 20 alone, 313 mm of rain fell at Seathwaithe. This was equivalent to a month's precipitation and set a new UK record. The flood was the biggest event recorded in this region and had major consequences for population and infrastructure over a large area, as well as involving loss of human life. Due to its system-wide impact, the November 2009 flooding in Cumbria presented an unparalleled opportunity to gain insight into the controls on, and impact of, an extreme flood. Ground-based mapping and sedimentological work was undertaken immediately after the flood as part of a UK Natural Environment Research Council (NERC) Urgency project along with the acquisition of aerial photography, LiDAR and TLS data. This paper presents an overview of the main erosional and depositional impacts within the Papcastle and Camerton reaches of the River Derwent.

Erosional impacts include: channel margin erosion, linear scours into vegetated surfaces and overbank deposits, headward migrating cataracts, scour around obstacles such as bridge piers and large woody debris, and waning stage chute channel development and bar surface winnowing. Depositional impacts include: large-scale, metre-thick high-relief amplitude overbank gravel/cobble bars, overbank gravel sheets, scour-hollow fills and sand sheets supporting ripple and dune fields as well as silt drapes.

Channel widening and avulsion was facilitated by a two-phase process of elongate scour hollow development during high flow stages followed by the headward migration of step-like cataracts on the waning flow stage. Overbank scour is thought to be developed from furrows (tool marks) gouged by the roots and branches of flood transported trees. Extensive gravel and cobble sheets were deposited on top of vegetated surfaces immediately downstream of confined reaches where stream powers were sufficiently high to entrain coarse-grained sediment from the river bed and banks.

The erosional and depositional impact of this flood can be attributed to the exceedence of local thresholds for erosion and hillslope coupling combined with sufficiently high stream powers and flow stages to distribute sediment widely across large areas of the vegetated river corridor. Distinctive erosional and depositional impacts during the November 2009, River Derwent floods provide a model for identifying the occurrence of similarly high magnitude floods with this and other river systems.