Geophysical Research Abstracts,
Vol. 10, EGU2008-A-11360, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-11360
EGU General Assembly 2008

Anticlockwise hysteresis behaviour in urban river fine sediment transport dynamics: a challenge for the first-flush model

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Urbanization is increasingly seen as a key environmental change which impacts on river systems. This paper focuses on storm-event suspended sediment and turbidity dynamics from the most urbanized catchment in the UK (River Tame, Birmingham). The study tests first-flush and hysteresis models, and integrates several hydrological and geomorphological approaches, including the use of two automatic water quality monitoring stations to detect downstream propagation and transformation of urban sediment fluxes, statistical analysis of sediment transport hysteresis, interdisciplinary conceptual modelling to help inform hydrological, geomorphological and biogenic impacts on sediment delivery, and anthropogenic tracers to confirm hydraulic links between urban road systems and river channels. 'First-flush' effects are rare in the River Tame system: sediment peaks generally follow the flow peak, and lengthy turbidity tails drive *anticlockwise* hysteresis. This suggests limited sediment exhaustion, delayed triggering of sediment supplies, and/or distal sources. A new Hysteresis Index developed by Lawler et al. (*Science Total Env*., 2006) allows storm-event responses to be assessed over longer timescales, down-basin, and between catchments, to assist process inference and intercomparability across different hydrological systems. Biological sediment stabilization effects are conceptualized within a BASS (Biofilm Adhesion of Sediment Supplies) model. Sediment concentration peaks were often as-

sociated with ammonia spikes, indicating transient but significant contributions from waste water sources: this has implications for the ‘geomorphological’ versus ‘human’ components of urban ‘sediment’ yield, and the hydrological processes of sediment delivery. These newly-identified prolonged sediment-flux impacts suggest that urban influences on river systems may be more significant than previously thought: this may challenge traditional assessment and mediation measures. Furthermore, small-scale headwater basins can provide early warning systems for sediment and sediment-associated pollution events propagating downstream.