EGU22-1395, updated on 08 Aug 2022
https://doi.org/10.5194/egusphere-egu22-1395
EGU General Assembly 2022

Network-scale analysis of sedimentary hotspots in dynamic, seismically-active steepland rivers

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Seismic shaking in mountain environments introduces the potential for complex fluvial response from a multitude of landslide sources. Stream networks may be impacted in multiple branches, introducing the possibility of interacting sedimentary ‘pulses’ moving through the system. Large quantities of mobile sediment added to the stream network from multiple sources during and after a co-seismic event can overload susceptible river reaches, causing changes in sediment transport and storage. Although past research works have addressed dynamic sediment movement in river networks and identification of sedimentary hotspots, the physiographic factors (*e.g.* canyons, bends, fans, slope change) that prompt such change remain unexplored. The catchment settings and reach sequences that contribute most to delay/acceleration of the sediment in the active mountain environments are investigated in order to improve hazard assessment in susceptible terrain. In this work, we employ the one-dimensional River Network Bed-Material Sediment model (Czuba & Foufoula-Georgiou, 2014) to explore the landscape factors that may lead to hotspot behaviour for the very coarse sand fraction (2mm), followed by multi-criteria analysis of four basic stream network parameters: slope, sinuosity, channel confinement and tributary influence. Patterns of network topology associated with delay and accumulation of river sediment in the model were systematically identified in 75,400 stream links from 16 major drainages (135 to 6425 km^2) of New Zealand’s upper South Island, as assessed by sediment travel time and the cluster persistence index (CPI). Catchment size determines the number of sediment sources, and thus ultimately the magnitude of the sedimentary hotspots i.e., bigger catchments can accommodate more landslides which increases the sediment input, along with the chances of sediment accumulation at susceptible locations. Multi-criteria analysis of the top 10 reaches with highest CPI values in each catchment (160 sites, total), showed that about 30% of the hotspots occurred in partly-confined valley settings with gentle slope (<0.02m/m), moderate sinuosity (1-1.1), downstream from the confluence of two or more tributaries. This combination emerged as the most likely setting for the occurrence of sedimentary hotspots in active mountain river networks. This approach may provide a simple means to map out susceptible sites based upon reach characteristics, which will not only contribute to improved catchment hazard assessment but may also help to augment more sophisticated models of catchment response to co-seismic landslide events.