EGU22-10675
https://doi.org/10.5194/egusphere-egu22-10675
EGU General Assembly 2022

Response of a small mountain river to a sediment pulse tracked using sub-canopy UAV surveys

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Remotely piloted aircrafts (UAVs) and Structure-from-Motion photogrammetry (SfM) have become a widely used approach for producing high-resolution topographical measurements of river systems. This approach has the benefit of capturing data over large spatial scales while requiring little time in the field. In small, forested rivers, the dense canopy has hindered the use of remote sensing techniques, limiting topographic data collection to more time-consuming and lower-resolution methods. This complicates monitoring the response of these systems to individual floods, as in many situations there is not enough time to complete more time-consuming surveys between events.

In this study, we pilot the use of sub-canopy UAV surveys (flown at 1-3 m altitude) to monitor the response of a small mountain stream (1-3 m wide) in British Columbia to a sediment pulse generated by the removal of an upstream culvert. Using eleven surveys flown over a three-year period, we track the downstream propagation of the pulse and the subsequent responses in bed topography and roughness along the 240 m reach. We observe a “build-and-carve” response of the channel, where some channel segments aggrade during the first floods after pulse generation, whereas others undergo little morphologic activity. In subsequent floods, these aggradational segments rework through the carving of well-defined channels that release this aggraded sediment downstream. These “build-and-carve” segments serve as temporary storage reservoirs that caused the pulse to fragment as it progressed downstream. The locations of these storage reservoirs were set by the initial channel morphology and the movement of in-stream wood and debris. This study highlights the importance of temporary sediment storage reservoirs for fluvial morphodynamics and provides some insights and suggestions for the future monitoring of forested river systems using sub-canopy drone surveys.