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# Using backpack mobile laser scanning system for mapping large wood in a forested headwater stream of southwest Japan

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Understanding the dynamic of instream large wood (LW) is essential for reducing hydrogeomorphic hazards in populated mountainous catchments. Quantifying the spatiotemporal distribution of LW is generally the most demanding process for investigating LW dynamics in rivers. Over the last two decades, multiple airborne sensors have been applied for mapping LW in relatively large alluvial rivers. However, those existing approaches are not necessarily suitable for remotely sensing LW in forested headwater streams, mainly due to canopy obstruction, weak illumination, and operational difficulty. Therefore, we tested the applicability of a 5-kilogram commercial backpack mobile laser scanning system for detecting and quantifying LW in a forested headwater stream of southwest Japan. Extremely dense point clouds (~15000 pts/$m^2$) were continuously scanned within 150-meter reach of the 2nd-order stream (slope: 0.045) by a 6-minute walk following rainfall-triggered debris flows. Dimension and volume of LW measured from point clouds were compared to associated field and UAV photogrammetry-based mapping data. Based on a surface shape detection algorithm and subsequent manual filtering of falsely detected objects (e.g., riparian trees), 25 cylinders corresponding to 34.9 $m^3$ total volume were delineated from point clouds. While the UAV photogrammetry-based approach was able to quantify only 2.4% of total LW volume, 75.1% of LW volume was successfully reconstructed by backpack mobile laser scanning. The visibility of the UAV photogrammetry-based approach was substantially limited by the dense riparian vegetation of our study reach. However, underestimation of wood piece length and overestimation of wood piece diameter consistently occurred for both remote sensing approaches. Therefore, further efforts would be made to evaluate the sensitivity of individual parameters used in point cloud processing for LW detection and quantification. Considering the mobility of sensors and data availability of near-surface objects, our case study indicates that backpack mobile laser scanning potentially provides a powerful alternative for more continuous, efficient, and frequent LW mapping, particularly in forested headwater streams.