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Tracking the sediment plume from the 7th February 2021 Chamoli (Uttarakhand, India) hazard cascade

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The 7th February Chamoli hazard cascade originated from a 25 million m³ rock/ice avalanche slope failure that transformed into a destructive, far travelled debris flow / debris flood. There has been necessarily a significant science focus on the proximal and immediate part of the hazard cascade. Here we report on the larger spatial and temporal scale: the sediment plume that progressed over the following days and weeks along the Ganga (Ganges) River. At the time of submission this was still recognisable over 900 km from the landslide site and had passed through hydro and nuclear power schemes. Beyond the initial plume, which has implications for rapid sedimentation in hydropower schemes and water / aquatic habitat quality, the subsequent (or not) mobilisation of event sediments over future years is a possible medium term chronic-threat to some hydropower projects. We show spectral 'recipes' and semi-automated methods for tracking the mass movement sediment plume and quantifying celerity using Sentinel 2 imagery, infilled using high-temporal repeat optical imagery from Planet Labs. data. The plume averaged ~60 km/day and, as expected has begun to slow as the river gradient decreases, as well as becoming less distinctive as some sediment is deposited, and as other sediment-rich water joins the Ganga.

The tracking of sediment plumes from these hazard cascades can be extended over inventories of similar events using both Sentinel 2 and Landsat archives. Such approaches allow us to provide insight into the possibilities of automated detection of hazard cascade sediment plumes to identify previously unknown events from remote source regions, as plumes have a far larger spatial-temporal footprint than the initial event.