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Predicting sensitive reaches during an extreme event in the headwaters of the Ganga River Basin, NW Himalaya

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Extreme flood events are an architect of abrupt, large and uncommon series of geomorphic processes. In spite of low frequency, extreme flood events can carry out maximum geomorphic work, i.e. erosion, deposition, and transportation of sediments. The extreme flood events play a vital role in the development and modification of the landscape in a mountainous terrain. Therefore, it is important to quantify the role of extreme flood events (i.e. surface processes acting during the extreme flood events) in landscape evolution/modification in a mountainous terrain.In the last decade, Northwestern Himalaya has witnessed several high magnitude flood events. Between 15th – 17th June 2017, several extreme floods occurred in the upper Ganga River basin (i.e. upstream of Devprayag) and affected different valleys of the basin. The dynamic change in the landscape during this event raised an important question - “Can we predict those reaches which are more prone to landscape modification during extreme flood events in mountainous or bedrock river?”.
In this study, we use normalized steepness variability of a river profile to predict the geomorphic changes in different reaches of the upper Ganga River basin. We focused our analysis on the Higher Himalayan segment of the Ganga basin. The rivers are analyzed for variation in their steepness along the length, and segments susceptible to landscape modification showed either erosion or deposition during the extreme event. The results also indicate that maximum landscape change occurs by the debris flow along the main channel except in few parts where it is due to the unstable hillslopes. Our results predict that the area between Hanuman Chatti and Govind Ghat in the Alaknanda River, Kedarnath and Sonprayag in the Mandakini River, and the Asiganaga valley in the Bhagirathi River are highly sensitive reaches, susceptible to changes during an extreme event.

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