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The influence of vegetation on flood change

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Floods represent one of the most prevalent natural hazards in Europe, despite being an integral part of the river dynamics. It has been suggested that changes in climate and land use might lead to an altered magnitude and frequency of flood events. However, the mechanisms underlying such changes in flood generation still need to be elucidated. In this study, we develop a conceptual framework to start disentangling the complexity of key processes potentially involved. Firstly, two contrasting flood regime states are defined (e.g. higher or lower flood risk). Secondly, a feedback loop stabilizing the system in one of the two states is constructed. Thirdly, the mechanisms inducing a switch between the two states are outlined. Two main types of switches are considered; a single switch in the flood regime state (for example due to a drastic change in catchment characteristic), and recurring switches between the two states (for example due to an oscillation in climate circulation).
By specifically focusing on the role of vegetation, we conceive several physically meaningful examples following the general recipe described above. The type and internal characteristics of catchment vegetation is generally thought to influence flood generation by three main sets of mechanisms. These are i) changing the percentage of intercepted rainfall, ii) influencing water infiltration into the soil and iii) affecting the soil moisture via transpiration. Therefore, we concentrate on plant characteristics such as the leaf area index, rooting depth, root-to-shoot allocation patterns, and xylem and gas exchange parameters. We then use these variables to construct feedback loops between the vegetation and its environment and examine the potential to increase or decrease flood risk.
In the current study, our main focus is on processes occurring over a longer timescale with three aspects of plant-environment interaction that are of particular interest. Namely, i) the ability of plants to acclimate to a changing environment by adjusting their morphology and physiology, ii) the effects of past events (e.g. drought, extreme temperatures) on the current ecosystem functioning and iii) the influences of vegetation on soil structure and chemistry. This novel approach is potentially useful in flood hydrology, since it features a greater level of biological detail than typically considered. However, the scarcity of long term biological data related to the aforementioned processes still remains a challenge.