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Quantification of in-channel large wood recruitment through a 3-D probabilistic approach

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Large wood (LW) is a relevant factor in physical, chemical, environmental and biological aspects of low order mountain streams system. LW recruitment, in turn, is affected by many physical processes, such as debris flows, shallow landslides, bank erosion, snow- and wind throw, and increases the potential hazard for downstream human population and infrastructures during intense flood events. In spite of that, the LW recruitment quantification and the modelling of related processes are receiving attention only since few years ago, with particular reference to hillslope instabilities which are the dominant source of LW recruitment in mountainous terrains at regional scale. Actually, models based on the infinite slope approach, commonly adopted for slope stability analysis, can be used for estimating probable LW volume and for identifying the most hazardous areas of wood input, transport and deposition. Such models, however, generally request a robust calibration on landslide inventory and tend to overestimate unstable areas and then LW recruitment volumes.
On this background, this work proposes a new LW estimation procedure which combines the forest stand characteristics of the entire catchment and a three-dimensional probabilistic slope stability model. The slope stability model overcomes the limits of the infinite slope approach and considers the spatial variability and uncertainty of the model input parameters through a Monte Carlo analysis. The forest stands characteristics allow including the root reinforcement into the stability model as stochastic input parameter, and provide the necessary information to evaluate the forest wood volume prone to be recruited as LW and its position on the hillslopes.
The procedure was tested on a small mountainous headwater catchment in the Eastern Italian Alps, covered with pasture and coniferous forest and prone to shallow landslide and debris flow phenomena, especially during the late spring and the early autumn. The results showed how the proposed procedure is very promising. In fact, the estimated LW volume is comparable with the one measured by field surveys.
As the procedure used data commonly available, it is of great interest as a tool for forest planning and management, and to predict the effects of forest alterations, both of natural and of anthropic origin (e.g. diseases, fire, clear-cutting or clearing), as well as helping in-channel wood retention structures positioning.