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Numerical evaluation of the forest protective role against rockfall after a windthrow: the case study of the Mt. Pore (North-Eastern Italy)

Francesco Bettella (1), Paola Bolzon (1), Emanuele Lingua (1), Marco Piras (2), and Frédéric Berger (3)

(1) Department of Land, Environment, Agriculture and Forestry (TESAF), University of Padova, Legnaro (Padova), Italy (francesco.bettella@unipd.it), (2) Department of Environment, Land and Infrastructure Engineering (DIATI), Politecnico di Torino, Torino, Italy (marco.piras@polito.it), (3) IRSTEA, National Research Institute of Science and Technology for Environment and Agriculture, Mountain Ecosystems Research Unit, St-Martin d'Hères, France (frederic.berger@irstea.fr)

Protection forests effectively preserve people and infrastructures against natural hazards such as rockfall, snow avalanches, landslides, debris flows, soil erosion and floods. Consequently, a reduction of this protective effect due to changes in forest structure can drastically increase the degree of risk related to these phenomena. The Vaia winter storm (29-30 October 2018) affected 41000 ha of forest in North-Eastern Italy, with an amount of windthrow timber volume of $8.6 \bullet 10^6$ m^3, compromising the protective function of a large portion of the forests. The aim of this study is to evaluate changes in the protective effect against rockfall of a forest located on the southern slope of the Mt. Pore after the damages of the Vaia winter storm. Three scenarios have been considered: 1) forest before the windstorm (condition at summer 2018), 2) uncleared windthrow (current status after the windstorm), and 3) cleared windthrow (removal of all fallen dead stems). Rockfall numerical simulations have been pursued considering these three scenarios using the 3D rockfall trajectory model Rockyfor3D. The protective effect of the forest in the three scenarios has been evaluated using the model outputs to calculate quantitative indicators at the distance of the infrastructures at risk. Field surveys and a UAV survey carried out during summer 2018 allowed the collection and the spatialization of the model input parameters, including the forest characteristics before the wind storm. Furthermore, after event on-site investigations allowed the estimation of the windthrow damages and the calibration of the model parameters in the second and third scenarios. Modelling results show that the great amount of dead stems lying on the ground after windthrow (second scenario) can provide protection against rockfall comparable to the living forest (first scenario) in the short period. Effectively, even though the forest and the elements on the ground are not able to stop all the boulders, they can significantly decrease the kinetic energy of the boulders, reducing the speed and rebound height, and decreasing the magnitude of the phenomenon. On the other hand, clearing the windthrow (scenario 3) increase the rockfall risk, especially for the infrastructures at higher distances from the rock cliff. Finally, field surveys supported by remote sensing surveys are revealed essential in order to achieve simulations adherent to reality.