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Identifying object protection forest for natural hazards with the model Flow-py

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We present object protection forest maps for rockfall, shallow landslides and snow avalanches, which were generated within the Interreg Alpine Space project GreenRisk4ALPs with the runout model Flow-py. Six Alpine regions with varying sizes from 45 km2 to 2250 km2, and topographies, from steep valleys of Val Ferret in Italy to the German Alpine foothills in Oberammergau, were modeled.

The term direct object protection forest is used for forests that protect objects in developed areas against gravitational natural hazards. That is, a direct object protection forest can only be assigned, if an object is endangered and a direct link between the precise locations of the hazard process area and the object can be established. The two main protective effects forests can have against gravitational natural hazards are 1) to reduce the release probability, or 2) to reduce the magnitude of an event, the effectiveness of both is dependent on forest structure. In addition, the degree to which the forest reduces the energy (magnitude) of the hazard also depends on the speed of the mass. If the magnitude/speed of a hazard process is too high, the forest will be destroyed. The location of a forest therefore determines its protective effect in two ways. First, high elevations and steep terrain (over 45°) will produce a weaker structure and be less effective against gravitational natural hazards compared to lower elevation gentle sloped terrain. Second, the energy of the hazard will be lower closer to the hazard's release and runout areas than in the middle of the process path.

Based on these relationships, we generated two types of object protection forest maps:

(i) maps that highlight existing direct object protection forest

(ii) maps that show where direct object protection forests have or would have the highest potential to either reduce release probability or reduce the energy of the hazard

The Flow-py model was used to model the routing and stopping of the three hazards and to establish the link between endangered objects and the hazard process areas. Input data are digital elevation models (10 m resolution) and locations of release areas as well as a GIS layer containing locations and types of objects, which is required for a custom plugin. The Back-calculation plugin was used with the Flow-py model to identify areas on the terrain (release areas, transit paths and deposition areas) that are associated with endangered infrastructure. To obtain the first maps, the model outputs were overlaid with digital maps of existing forest areas to identify direct object protection forest. The second map was produced by using the same model outputs and digital terrain models to identify areas in the process paths where the modelled hazard energy was low and effective protection forest can grow.

The presented maps can help to support decisions and prioritize interventions in risk-based protection forest and ecosystem-based integral natural hazard risk management in the Alpine Space.