

EGU2020-19353

<https://doi.org/10.5194/egusphere-egu2020-19353>

EGU General Assembly 2020

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## Regional scale mapping of rockfall-protection forest efficiency

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In mountainous areas, rockfall phenomena cause damages and safety problems in residential areas and along transportation facilities. Forests that lay upslope the elements at risk can mitigate rockfall hazard by reducing the kinetic energy of blocks and the probability of impact. Nevertheless, the effects of rockfall protection forests is usually quantified only at local scale.

In order to assess the forest efficiency for different combinations of forest (tree size, forest density, forest position, forest length), morphological (slope gradient) and lithological (expected block volume) conditions, we performed a large set of parametric simulations by using the HY-STONE rockfall simulator (Crosta et al, 2004) with a tree impact algorithm that allows calculating the probability of impact, the loss of energy and the lateral deviation of the trajectories based on forest density, tree size and block volume. For each simulation, we therefore quantified the forest efficiency by using a new energy-based efficiency index (EEI) that measure the reduction of rockfall kinetic energy along the forest.

The results of the parametric simulations show that the block volume, the slope inclination, the tree size, and the forest density are, in decreasing order of relevance, the most sensitive parameters for rockfall efficiency. Due to its importance, the volume of blocks associated to different lithologies found in Central Italian Alps have been analysed through a statistical analysis of talus deposits. This allowed to obtain volume frequency distributions for the different lithologies, and the associated percentiles of expected block volume.

Starting from the parametric simulations, we developed a multiple linear regression that allows to predict an EEI index value (efficiency of protection forest) as a function of forest, morphological and lithological parameters. This regression function has been eventually applied to all the protection forest of Central Italian Alps, providing regional scale maps of rockfall-protection forest efficiency for different block volume percentiles.

Crosta, G. B., and F. Agliardi. (2004) Parametric evaluation of 3D dispersion of rockfall trajectories." *Natural Hazards and Earth System Science* 4.4: 583-598.

**How to cite:** Sala, G., Lanfranconi, C., Frattini, P., and Crosta, G. B.: Regional scale mapping of

rockfall-protection forest efficiency, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-19353, <https://doi.org/10.5194/egusphere-egu2020-19353>, 2020