Estimation of rockfall frequency from simulated trajectories and observed tree impacts

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Estimation of Rockfall Frequency From Simulated Trajectories and Observed Tree Impacts

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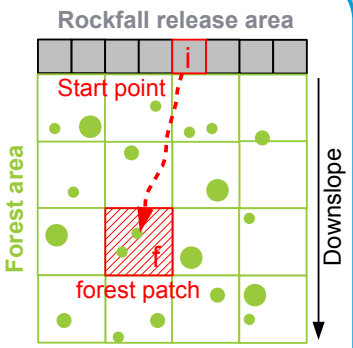
Recently, major advances have been made regarding rockfall propagation simulations in forested slopes and the mapping of past events from dendrochronological data. How to combine these data to map the spatial distribution of rockfall frequency ?

Methods

Conceptual framework:
- forest area divided in Nf forest patches.
- rockfall release area with Ns start points.

The number of impacts in a given forest patch f during the time lapse T is :

$$Impacts(f) = T \times \sum_{i=1}^{N_s} \left(p_{start}(i) \times p_{propagation}(i, f) \right)$$



Conceptual scheme

The matrix formulation for the whole forest is:

$$\underset{1\times N_f}{Impact} = T \times \underset{1\times N_s}{Pstart} \times \underset{N_s\times N_f}{Ppropagation}$$

$Ppropagation$ is estimated with numerical simulations (RockyFor3D model). Inputs:
- Terrain. DTM, roughness and soil type.
- Rockfall. Block shape, size and density.
- Forest stand. Tree positions and diameters.
- Start zones are mapped with a slope criterion.

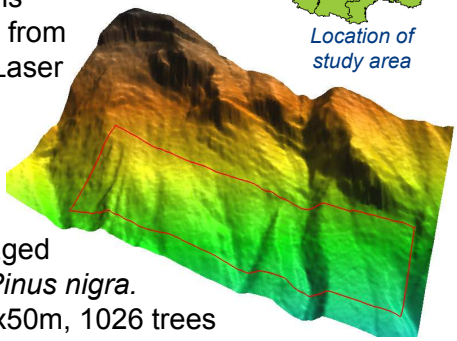
$Impact$ is observed on the field (number of scars on trees for each forest patch).

Material

The study area is located in Valdrôme (French Alps).

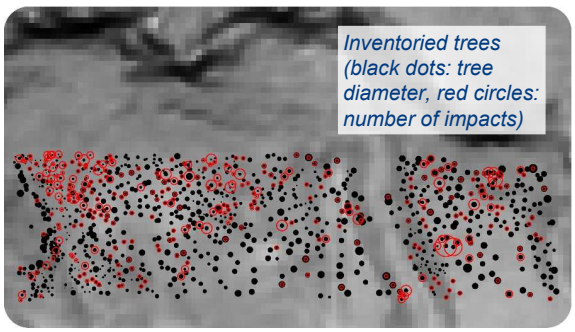
Location of study area

The DTM is computed from Airborne Laser Scanning data.

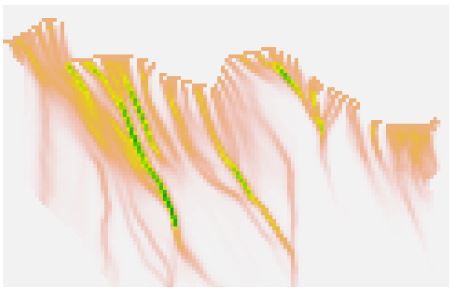


ALS DTM and inventory boundary

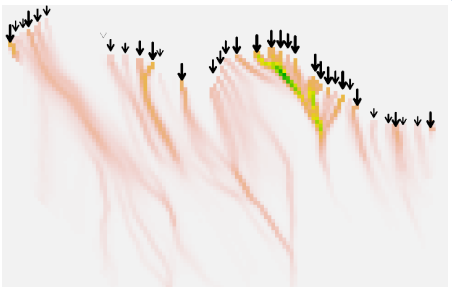
Forest is an even-aged stand of *Pinus nigra*. On 200mx50m, 1026 trees are mapped and the number of visible impacts is recorded.



Results



The system could be solved for $Pstart$ in the Valdrôme case study. It turns out that the release frequency is not homogeneous along the cliff.



Number of rockfalls assuming a uniform release probability along the cliff (left) and using the estimated release probability $Pstart$ (right)

This framework theoretically allows the mapping of the spatial distribution of rockfall release area. However, it relies on numerous assumptions and its robustness has to be assessed with additional field data or simulated scenarios.

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