



Planning forest management to reduce landslide risk along a railway line: a case study in Valle Camonica

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Railways operating in the mountainous landscape are crucial transport services both for citizens and for business. These transportation lines are often hit by soil mass failures (e.g., shallow landslides, debris flows and earthflows) that mobilize quantity of sediment and woody materials from the hillslopes. In this context, slope stability evaluation and slope stabilization are one of the major goals for the regional and local authorities. To reduce disasters and damages, geotechnical structures and bioengineering works are the most common solutions in the proximity of the infrastructures, whereas forest management plays a key role for the slope stabilization of the valley sides. Therefore, planning sustainable forestry operations remains the best effective strategy to prevent hydrogeological hazards and to promote natural and environmental benefits.

On this background, this work addresses to assess the vulnerability of the railway lines and to improve the protective effectiveness of forests both at the slope and regional scale, integrating the assessment of the landslide susceptibility and the evaluation of the possible direct and indirect risks. Direct damages are the costs of restoration and repair of the infrastructure, whereas indirect costs affect the society by interrupting utility service and by causing loss of local economy and tourism. Moreover, sustainable forest management provides additional benefits related to timber production and biological conservation.

The main purposes of this study are:

1. to provide the probability that landslides can cause damages to the infrastructure analysing the landslide susceptibility map and the sediment connectivity map, obtained adopting a physically-based spatially-distributed model, called PRobabilistic MUltidimensional shallow Landslide Analysis, PRIMULA;
2. to estimate the degree of loss to a specific section of the railroad at risk and to monetize it investigating the specified landslide magnitude and thereby the possible mobilised volume of sediment and woody materials that can reach the infrastructure;
3. to generate scenarios of forest management to maintain a healthy and balanced condition of forests optimizing the protective functions and the economic benefits.

This innovative approach has been tested on a section of railroad between Iseo Lake and Edolo via Valle Camonica, situated into the Central Italian Prealps, mostly covered by forests and prone to shallow landslides. The encouraging results show how the proposed procedure can be of interest for land planners as a tool to facilitate their work by identifying the highest vulnerable sites and to prepare adequate countermeasures to decrease the risk.