State-of-the-art on ecosystem-based solutions for disaster risk reduction:

a review on the use of protection forests for disaster risk reduction in mountain areas

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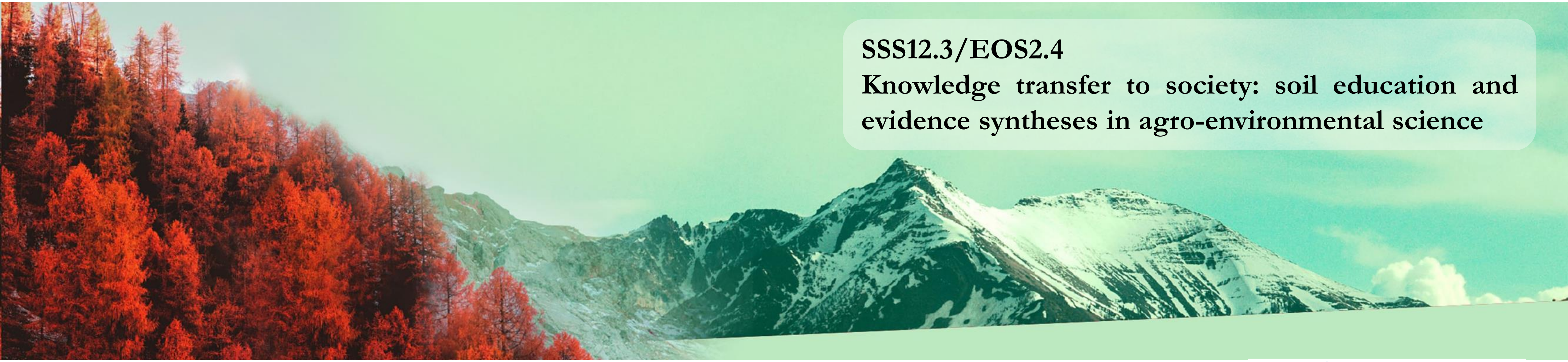
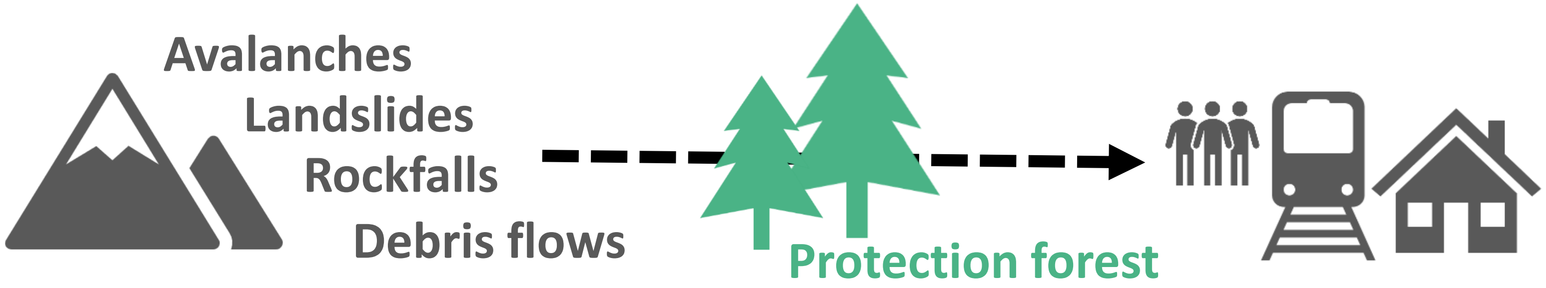


This research was conducted in the context of the GreenRisk4Alps project. GreenRisk4Alps has been financed by Interreg Alpine Space, one of the 15 transnational cooperation programmes covering the whole of the European Union (EU) in the framework of European Regional policy.

Introduction



Ecosystem-based disaster risk reduction (Eco-DRR) solutions act directly against the hazards, preventing them from happening or mitigating their impact in the runout zone

Objective: to analyse to what extent Eco-DRR measures (protection forests) have been studied in mountain environments, such as the Alps, comparing different gravity-driven natural hazards

To gain an insight on the general trend of publications in scientific literature on the topic

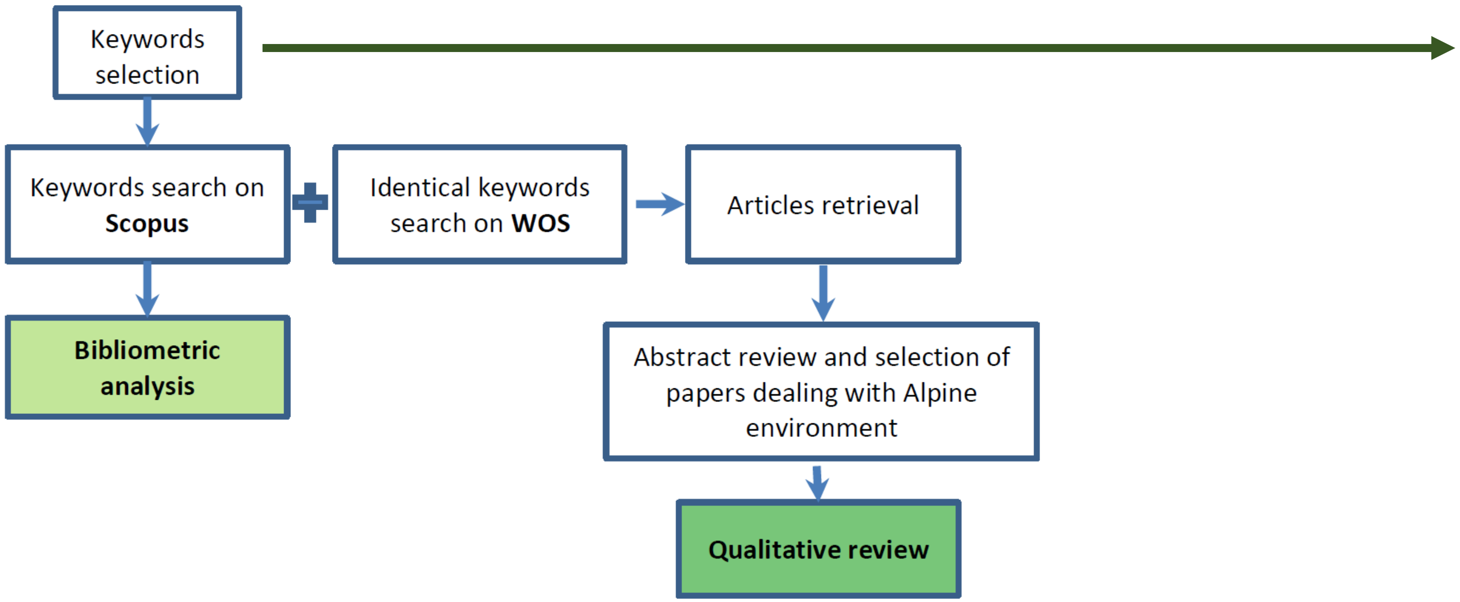
Bibliometric analysis

To analyse the studies available through a pre-defined set of questions in order to synthesize research topics, identify the strengths of the available studies, highlight research gaps

Qualitative literature review

Methodology

Poratelli et al., submitted



***Criteria used to review each publication*:**

1. Study areas and hazards analysed
2. Forest effectiveness
3. Forest disturbances and hazard interactions
4. Scenario development
5. Stakeholder involvement
6. Monetary evaluation

- **Three groups of search terms:**

	Topic Group	Search terms
1.	Gravity-induced natural hazards	Snow avalanche* Debris-flow* Rock fall* (or Rockfall*) Landslide*
2.	Risk management	Risk Exposure Vulnerability Hazard management Mitigation Disaster Risk Reduction (or DRR)
3.	Ecosystem-based solutions	Nature-based solution* Ecosystem-based approach* Ecosystem-based solution* ECO-DRR Protection forest Protect* function Protect* effect

Poratelli et al., submitted

Searched in:

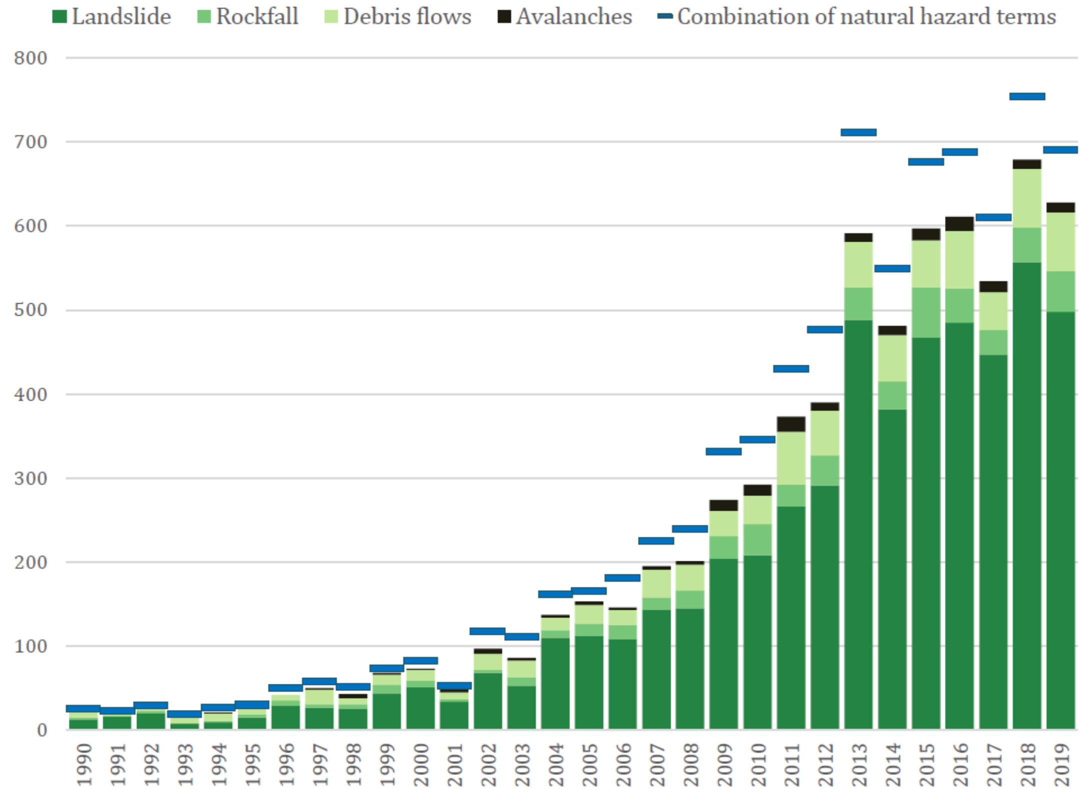
- Title, Abstract, Keywords
- Articles, reviews, book chapters and conference proceedings
- English language, 2020 excluded

Results

Bibliometric analysis

- First query: first two groups of search terms

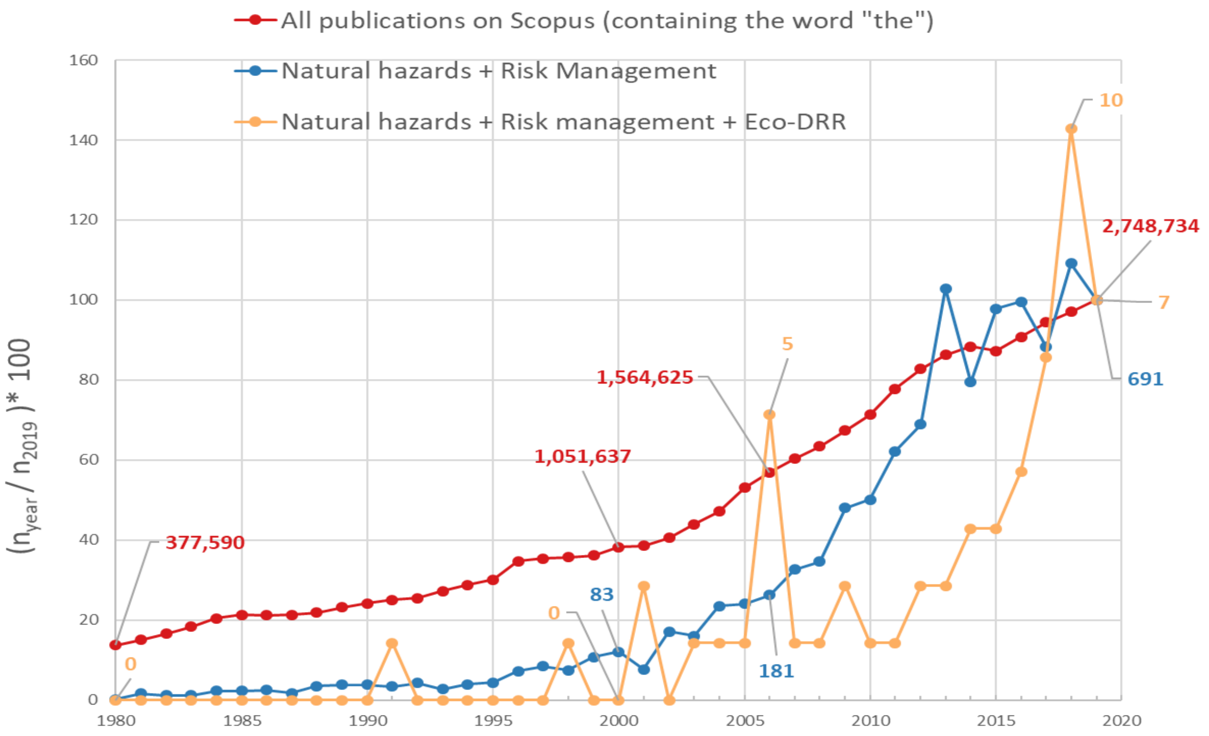
→ 8,146 publications



Number of publications indexed on Scopus each year (1990-2019), citing gravity induced natural hazards and risk management search terms *(Poratelli et al., submitted)*

- Second query: three groups of search terms

→ 55 of the 8,146 publications also included EbS terms



Percentage of publications in relation to the amount published in 2019 *(Poratelli et al., submitted)*

eurac research

European Geosciences Union

Interreg Alpine Space

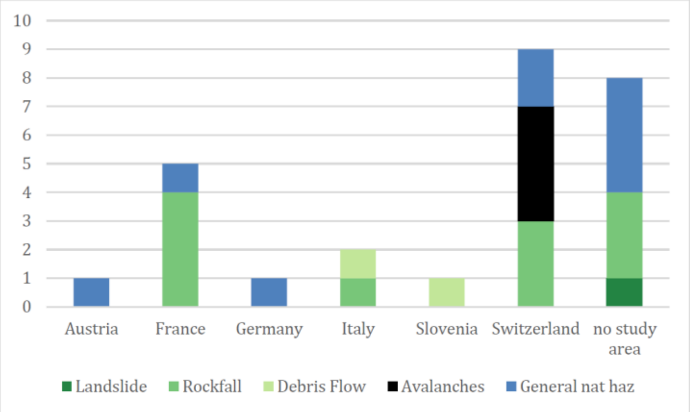
GREEN RISK 4 ALPS

Qualitative review

Results

Scopus Search: 55 publications + Web of Science Search: 8 other publications → 63 publications → ***Further selection:*** documents concerning the Alpine environment → 27 publications

1. Study areas and hazards analysed in the publications



Study areas and natural hazards focus of the selected publications *(Poratelli et al., submitted)*

2. Forest effectiveness

- **Uneven, multi-layered forest stands** provide the maximum effectiveness of protection from all the gravity-driven natural hazards considered [1,2,4,12–15];
- **Evergreen species** result more efficient for protection from avalanches [7]
- **Broadleaf coppices** result more efficient for rockfalls [10- 11]

3. Forest disturbances and hazard interactions

- The effects of fires, pests, animal browsing, windthrow or drought are addressed by eight publications [1,2, 4,5, 6, 10,17,18]
- Post disturbance management of protection forest influences the protection service (i.e. removing the dead wood after windthrow) [13,18]
- The cascade effects of damages caused by avalanches to the protection forest was analysed by [18]

(Poratelli et al., submitted)

Qualitative review

Results

Scopus Search: 55 publications + Web of Science Search: 8 other publications → 63 publications → ***Further selection:*** documents concerning the Alpine environment → 27 publications

4. Scenario development

- Three publications considered land use change scenarios [5,8,17]
- Differences in avalanche runout on a forested slope and on a slope lacking forest cover were analysed by [5, 8], [17] also considers rockfalls
- Differences in forest management after windthrow were also analysed, assessing the protective effect of snags and logs left on the ground [17]

5. Stakeholder involvement

- Four publications address this issue [1, 3, 9, 16]
- Stakeholders were involved in two studies to assess the demand for protection needed for the economic evaluation of the protection function [1, 3].

6. Monetary evaluation of protection effect

- Addressed by three publications[3,16,19],only one considering multiple hazards [16]
- Approaches adopted: replacement cost [3,16] and the avoided damages [19].
- The protection provided by the forest resulted to be more economically convenient than technical measures

(Poratelli et al., submitted)

Conclusions

Qualitative review

Eco-DRR is an emerging topic in literature. Results show a sharp increase in the number of publications on the topic from 1980 to 2019 compared to the overall number of papers published on Scopus, however…

Although the publications on the single topics of gravity-driven natural hazards and risk management have increased in the past decades, only few studies analyse ecosystem based measures, adopting a risk perspective, also considering the presence or value of the assets protected by the forest

….**Research gaps** (aspects addressed by few of the reviewed papers)

- The assessments of forest effectiveness in hazard mitigation are mostly hazard specific and do not compare or address multiple hazards
- Economic evaluations of the forest protection function rarely apply multiple approaches and rarely compare different protection options (i.e. protection forests vs technical measures)
- The studies show a lack of stakeholders involvement in assessments

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Thank you for your attention