Protective Functions of Forests - a Scientific Introduction

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Forests make a considerable contribution to protection against natural hazards.
Protective effect

Protective forests represent an essential factor in the risk reduction of natural hazard processes over long periods of time on large potential natural hazard disposition areas. A direct protective effect of forests is given when people, human settlements or installations as well as cultivated soils are endangered by natural hazards (object protection forests).

An indirect protective effect of the forest against natural hazards refers to the preservation of the forest site itself (site protection forest). By counteracting soil erosion, improving the hydrological and climatic conditions at the site and maintaining ecosystem services, the disposition for natural hazard processes...
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Protective forests reducing risk from natural hazards, like:

- flood events often with high sediment transport rates
- mass movements like debris floods or debris flows.
- rock-fall events.
- avalanches, ...
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The effects of forest cover on torrential hazards (Sebald et al., 2019)

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The effects of canopy disturbance on torrential hazards (Sebald et al., 2019)

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- Disturbances significantly influenced occurrence and frequency of torrential hazards,
- Higher occurrence of debris flows with regular, large forest disturbances.

![Diagram showing the effects of various factors on debris flow and flood occurrence and frequency.](image-url)
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Future protective effect

- Research on future climate conditions expect an increase of the global average surface temperature of 3-5°C by 2100, compared to the first decade of the 20th century.
- Regarding the expected climate change impacts on forests, major threats to desired forest structures are natural disturbances like wildfire, wind, and insects’ outbreaks.
- This raises several open questions for a sustainable and improved hazard management in protective forests.
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Cumulative area and number of afforestation sites at the timberline, conducted by the Forest technical Service for Torrent and Avalanche Control between 1945 and 2017 in Austria. The arrows refer to important research and test sites with respect to the establishment of forest in high elevations; with FBVA I/II (Hampel et al., 1961, 1963) laying the foundation for the wind-snow ecogram and Z.FW 137/6 (Schönenberger, 1986) introducing cluster afforestation and Stillberg referring to the test site in Davos, Switzerland from which important conclusion were drawn (e.g. Barbeito et al., 2012).

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Impact of canopy disturbances on future protective effect. PROTECTED (ACRP)

- Change in peak discharge relative to the peak discharge without disturbances stratified by management and no management for 50, 100, 150 and 200 years after simulation begin. The symbol is located at the median, while the lower and upper end of the bar represent the 25. and 75. percentile estimated from 20 repetitions. The lower panel shows the disturbed area relative to the total forested area for each year.
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- Potentially mobilized volumes for 50, 100, 150 and 200 year after simulation start, under consideration of managed forest landscapes based on a historical scenario and four climate projections - with (filled) and without (hollow) disturbances.
Summary

Protective Forests are in permanent interaction with:

- Soil and terrestrial ecosystems
- Water-atmosphere-environment
- Habitat and landscape
- Demands on renewable primary raw materials and resource-oriented technologies
- Demands on social dynamics
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Conclusio

- The impact of global environmental changes on protective forests requires an adaptation of the current state of knowledge.
- Protective forests are an integral part of alpine ecosystems and provide more than just regulatory ecosystem services.
- In the sense of a sustainable strategy in dealing with forests, their protective function should also be discussed and analysed in the context of supporting, provisioning and cultural services.
Challenges to be posed to science:

- How much natural resources are needed to ensure sustainable protection against natural hazard processes such as snow / avalanches, rockfalls, erosion / landslides and torrent processes?
- What is the impact of land use and land use change in the "ecosystem" torrential catchment?
- What is the effect of global warming on afforestation campaigns or natural regeneration at high-elevation?
- How does climate change indirectly alter the protective effect of forests due to a climate-induced increase in forest disturbances like wildfire, wind and insects outbreaks?
- What strategies are needed to maintain or improve the water or soil balance in the sense of the supportive ecosystem service of a torrential catchment?
- What direct role does a forest play in hazard assessment and planning of measures against torrential processes?
- How can we sustainably manage natural resources and habitat development? Which combinations of technical and natural based measures support the reduction of the occurrence of torrential processes?
Thank you for your attention!
References I


