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Impact of global change on the protective effect of forests in mountain areas

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Forests in mountain regions provide an indispensable ecosystem service by protecting people and infrastructure against natural hazards. Thanks to this Nature-based Solution (NbS), costs of engineered technical protection measures can be reduced or even avoided. Numerous studies have proven the high effectiveness of forests in mitigating the negative impacts of natural hazards. However, open questions remain about the long-term and sustainable provision of protective service by mountain forests, which are expected to be increasingly affected by global change. Natural forest dynamics and disturbances can result in temporary or irreversible loss of protective effects of forests, potentially accelerated by climate change. At the same time, rising temperatures and more frequent and severe droughts will lead to shifts in tree species distribution and forest composition, which may in turn impact their protective effect depending on the type of natural hazard. Furthermore, socio-economic changes, such as land-use change or the expansion of settlements, may affect the protective function of forests. The uncertainties related to these changes pose great challenges for the quantification and sustainable management of this key ecosystem service in mountain areas. To improve our understanding of the various effects global change has on protective forests, we summarized current knowledge based on a quantitative review. We conducted a systematic literature search using predefined terms in different databases. We focused on forests in mountain regions protecting against gravitational hazards (i.e., snow avalanches, landslides, rockfall, torrential floods and debris flow). This resulted in 70 peer-reviewed articles, books or book chapters that we systematically assessed. Most studies focused on anthropogenic forest change (i.e., management, de-/afforestation), followed by natural disturbances, whereas climatically induced changes (e.g., clearly linked to drought or rising temperatures) were less often addressed in the literature. The analyzed studies mainly examined the protection against floods, followed by avalanches, landslides and rockfall. Preliminary results indicate that global change had a predominantly negative impact on the protective effect of forests in mountain areas. In a next step, the types of impacts and potential interacting and compound effects will be analyzed in more detail.