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Land-use/cover change (LUCC) and erosion risks

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Traditional farming in the Alps - preserving biodiversity and protection against natural hazards risk - is pressurized by socio-economic conditions and hardly profitable. Resulting extensive LUCC alters vegetation composition and plant diversity in alpine landscapes (Tasser & Tappeiner, 2002).
Topography in mountainous landscape fosters erosion by snow gliding in winter and surface runoff in summer. Research activities in two alpine valleys in the Alps (Stubai Valley, Austria; Passeier Valley, Italy) analyzed by measurements and modeling activities (1) impacts of snow gliding on erosion risk and processes (Höller et al. 2009, Leitinger et al. 2008), (2) seasonal variability of surface runoff (Leitinger et al. 2010), and (3) effects of LUCC on erodibility and sediment loss (Tasser et al. 2003). All research questions followed a comparative approach on plots differing in land-use/cover (i.e. vegetation and soil parameters) and topography (i.e. slope angle, elevation,...). Vegetation analyses as well as soil analyses provide the necessary data basis to interpret the impacts of land cover on investigated phenomena and processes. Although investigated erosion processes have minor impact on slope stability in most areas of the Alps, the concurrence with labile soil profiles could induce erosion processes with high damage potential.
The results prove a link of snow-glide distances and erosion phenomena. By protective measures, snow forces on plants and trees have to be decreased to avoid vegetation removal. Once the vegetation cover is damaged, regeneration is unlikely due to limited vegetation periods and partly high surface runoff. Regarding surface runoff we observed highest quantities in autumn on managed areas whereas abandoned areas revealed hardly any surface runoff. Although absence of runoff is mainly the effect of high infiltration and drainage of dominant soil types, soil compaction in the uppermost soil layer by grazing animals and agricultural equipment lead to significantly increased surface runoff (25%). Interestingly, soil compaction is decreased presumably by freezing-and-thawing cycles and bioturbation processes during winter period. However, on areas lacking this break-up effect, soil erosion by surface water from bare soil - resulting from snow-glide damages - lead to increased sediment loss in spring. Referring to erodibility and sediment loss, aspect, slope angle, soil depth, land-use type (abandoned land), and rooting depth and root density turned out to be decisive factors influencing erodibility of alpine soils. Sediment loss was lower on traditionally managed areas than on intensively used meadows or pastures. Abandoned areas revealed least and - as expected - bare soil highest sediment losses.
By spatially explicit modeling of snow-glide distances and protective measures on vulnerable areas as well as adaption of land management to potential risk for surface runoff, vegetation cover is preserved and sediment loss significantly reduced. Hence, important ecosystem services as well as erosion risks rely on vegetation cover and its management.

References

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