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Seasonal variability of surface runoff for different land-use types in alpine landscapes

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Knowledge of surface runoff quantity for distinct hydrological units becomes increasingly important as many rainfall-runoff models use static surface runoff coefficients and therefore neglect eco-hydrological diversity. Especially in small-scale alpine catchments surface runoff and its contribution to mountain torrent runoff is frequently underestimated. Alpine ecosystems are faced with a rapid shift in vegetation patterns due to climate and also land-use change, which alters hydrological behavior in short timescales, even within a season. In a study in the Eastern Alps, Stubai Valley, Austria, surface runoff was investigated by using a rain simulator and accompanying soil water content and soil water tension measurements in different soil depths. Additionally, soil type, soil physical properties and phytomass were assessed. Analyzing more than 40 sprinkler experiments revealed significantly different surface runoff coefficients for different land-use / land-cover types. Moreover, managed areas revealed a clear seasonal variability of surface runoff. The results infer the necessity to consider intensity, duration and date of management when quantifying surface runoff. In other words, as surface runoff reaches the catchment outlet very quickly, water levels will raise much more than for very similar conditions at another date of the season. While almost no surface runoff occurred on abandoned areas, pastures showed high seasonal variability with surface runoff coefficients between 0% and 25%. The results are linked to land-cover type and soil physical properties, among which bulk density and resulting infiltration rates turned out to be most decisive. On pastures soil compaction by grazing cattle could increase stream flow dramatically. However, soil compaction in upper horizons (A-horizon, < 10cm soil depth) was reduced by freeze-and-thaw processes during the winter season. Thereby bulk density decreased and infiltration rates increased. The duration of this “recovery” might be dependent on trampling intensity.
Hence, soil physical properties and land management have to be considered more dynamic and interacting to model and assess reasonable values of surface runoff.