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Headwater streamflow regime in the Garhwal Himalaya (India) severely disturbed after advanced forest degradation

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Abstract:

Springs and stream discharges have been declining for decades in the Lesser Himalayas andboth forest degradation/removal and reforestation have been blamed for this. About 80% of the annual rainfall is delivered within fourmonths rendering ecosystem water retention of paramount importance.We comparevariations in streamflow totals and stormflow response (2008–2011) for two similarly sized headwater catchments in the Garhwal Himalaya (India) having equal geology (phyllites/dolomites) but contrasting land cover, viz. undisturbed (Arnigad, 286 ha) vs. degraded oak forest (Bansigad, 190 ha). Recession analysis suggested no deep leakage losses, allowing meaningful comparisons. Annual runoff coefficients for Arnigad ranged between 44% (dry year) and 61% (wet year) with an overall mean of 53.6%. Corresponding values for Bansigad were 53–69% (mean 62.3%) indicating greater total runoff (~250 mm yr^{-1}) from the degraded forest. Stormflow contributions to overall runoff at Arnigad were modest at 8–11% (73–259 mm yr^{-1}) and occurred mostly during the monsoon (78–98%). Both absolute (545–1226 mm yr^{-1}) and relative (~48%) stormflow amounts were much higher at Bansigad and occurred also during the post-monsoon (15–22% of all events vs. 73-82% during monsoon). Baseflows from the intact forest were higher throughout making up ~90% of total flow at Arnigad vs. only 52% at Bansigad. Despite lower evaporationlosses, flow recession for the degraded forestwas much faster (k = 0.023–0.033 day^{-1} vs. 0.0071–0.0095 day^{-1} for the intact forest) and flows ceased early in the pre-monsoon (March) while streamflow at Arnigad was perennial. These findings lend support to the traditional view thatconserving (old-growth) forest ensures optimal hydrological functioning and underscorethe need to avoid excessive loss of topsoil and organic matter upon forest usage/removal if soil water retention and groundwater recharge are to be maintained.

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