Tropentag, September 15-17, 2021, hybrid conference

"Towards shifting paradigms in agriculture
for a healthy and sustainable future"

Spring Restoration through Sustainable Land Management in the Mid-hills of the Indian Himalaya

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Abstract

Of the estimated 3 million springs in the Indian Himalayan region, roughly 60 % have dried up or become seasonal. This phenomenon is occurring across the entire Himalaya, threating water security, biodiversity and livelihoods in both mountain communities and downstream areas. Rapid population growth has brought about extensive land-use changes, mainly through large-scale deforestation, overexploitation of forest resources, development and poor cultivation practices. These land use changes–coupled with climate change and rainfall variability–are impacting spring flows. The demand to restore springs has especially increased in the mid-hills of the Himalaya, and over half of the springs in the north Indian state of Uttarakhand have reportedly dried up. However, a lack of coherent perspectives and knowledge on the interrelations of springs, land use and land cover, surface runoff and groundwater regimes has hindered action to address spring restoration. The case study examines the micro-watersheds, or "springsheds" of two rural villages facing water scarcity in the mid-hills of Uttarakhand. The unique contribution of this work lies in using ground-based knowledge to classify and analyse land cover/land use types, followed by applying a watershed tool to estimate runoff and a water-balance approach to estimate groundwater recharge and potential spring discharges. Built on basic, systematic field-mapping (i.e., land use and cover, soil type, slope and springshed delineation) the calculations for runoff, groundwater and spring discharge are deduced against available water flow data for mapped springsheds. The results demonstrate that spring recharge is dependent on monsoon rainfall to sustain year-round flow, emphasising the need to reduce runoff and increase groundwater recharge during monsoon. Sustainable forest management, water harvesting and regenerative agriculture practices indicate that springs flows can be preserved or increased through locally adapted management practices. This includes afforestation and natural regeneration of broadleaved tree species and native grasses, agroforestry (e.g., tree species for fodder, fuelwood, fruits, nuts and medicine) traditional cropping systems with reinforced terraces, groundwater recharge structures (e.g., infiltration ponds, recharge trenches, check walls/ dams) and protection of traditional spring water harvesting structures

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(Naula and Dhara). The solutions are outlined from the perspective of the land users who implemented them.

Keywords: Agroforesty, drought mitigation, forestry, land use mapping, mountain watershed management, natural resource conservation, spring restoration, surface water hydrology, sustainable land management, traditional practices