

Abstract

Natural springs are the lifelines for human survival. Yet, declining flows and drying spring sources are a critical challenge faced by rural communities across the Himalayas. Deteriorating spring sources in the eastern and western Himalayas are evident, however, the status of spring sources is poorly understood in western Nepal. A trans-disciplinary assessment of social and political context is the combined package required for a holistic picture for sustainable water resources management. This study assessed the status, drivers of changes, and challenges for spring resources in the Rangun Khola watershed, far western Nepal. Spring sources mapping of 1,122 springs within the watershed documented the status and spring flow trends. Land Use Land Cover change trajectory analysis, climate trend and indices analysis along with household perception, development, and political scenario analysis were the supplementary assessment procedures applied for understanding the impact and implication of different drivers of change on spring sources.

Spring source mapping, based on flow measurement, indicated that most sixth and below magnitude springs are a prominent source of drinking water for the communities in Rangun Khola watershed. The flow trend assessment revealed that almost 76% of springs are showing a continuous declining flow trend with 2% already dried up. In the watershed communities, almost 82% of households perceived reduction in water resource availability over the past 10 years or more and attributed those disturbing developments to climate change and human activities. Gradual fragmentation of land and deforestation of 50 km² between 1990-2018 to create agricultural land and expand urban areas has seriously impacted natural spring flows in Rangun Khola watershed. Even though a 30 m by 30 m LULC map assessment did not reveal any significant association with changing spring discharge, the micro landscape assessment of immediate spring surroundings revealed that undisturbed vegetation is supportive of spring flow maintenance. Similarly, local climate data assessment revealed that temperature is significantly increasing while precipitation patterns are showing alteration in form of increasing frequency of localized high-intensity rainfall events. This local climate variability is concurrent with drying spring sources and consistent with the local community's perceived local manifestation of microclimatic changes and its implication on spring sources. Changing global and microclimate and local vegetation cover is one of the leading natural stressors for spring sources in the Himalayas. Moreover, the growing population and haphazard rural road

expansion are overexploiting and interfering with spring resources in the Himalayas. Changing spring flow dynamic and its implication on local livelihood and society are evident in the communities; however, government and local households are lagging in taking direct actions to mitigate the problem.

The study documenting the status, characteristics, stressors, and challenges for spring resources in Rangun Khola watershed informs future research and sustainable spring watershed planning and management interventions. The research outcome is expected to be potentially beneficial for spring source conservation, spring watershed protection, and a crucial component for integrated water resource management and planning in appropriate watersheds.