Tracing recharge zones for spring sources in the mid-hills of Western Nepal using stable isotopes

Luna Bharati[1], Sanita Dhaubanjar[1], Karthikeyan Matheswaran[2], and Ambika Khadka[1]

[1]International Water Management Institute (IWMI), Nepal (s.dhaubanjar@cgiar.org). [2]Stockholm Environment Institute, Thailand, [3]Aalto University, Finland

1. Context

Springs, a major source of water in the hills and mountains of Nepal, are drying up. Since 2014, with funding from the Asian Development Bank and the Nordic Development Fund, the "Building Climate Resilience of Watersheds in Mountain Eco-Regions" (BCRWME) project is working to provide 45,000 households in vulnerable mountain communities with access to more reliable water resources via spring or surface water sources. Despite the recognition of springs as a livelihood driver in these communities and the observed alarming trends in the drying up of springs, a scientific understanding of mountain springs in Nepal has not been established. Under BCRWME, the International Water Management Institute (IWMI) is leading comprehensive research characterizing mountain springs and identifying science-based interventions that can increase reliability and water availability in springs. IWMI is conducting isotope analysis in Banlek and Shikarpur in western Nepal to investigate hydrological processes in mountain springs and identify recharge zones for these springs.

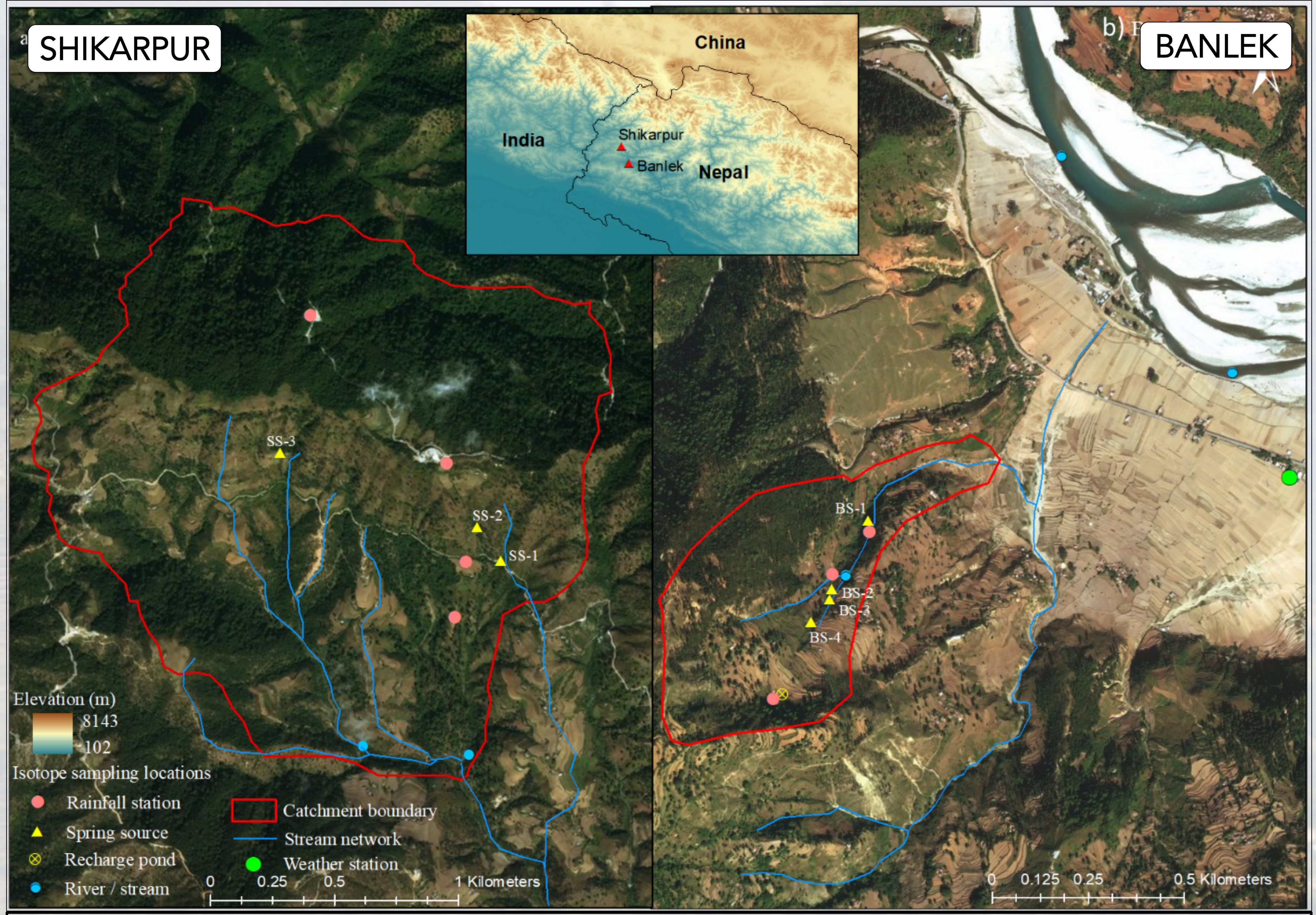

Figure 1. Map of study sites Shikhapur (left) and Banlek (right) showing location of springs and isotope sampling points.

2. Methods

The study areas in Banlek and Shikharpur consist of 4 springs each. Water samples were collected from rainfall at six different elevations, springs in Shikarpur (three) and Banlek (four) and major streams in both the catchment and analyzed for their isotopic composition (δ18O and δD). Water samples were collected from surface water weekly in wet season (June-September) and fortnightly in dry season. A total of 422 water samples were collected between August 2015 - March 2017. The isotopic ratios of oxygen and hydrogen in the precipitation and springs systems were analyzed to infer locations of groundwater recharge zones.

3. Results:

It is evident from the isotopic composition of rainfall and Local Meteoric Water Line (LMWL) that rain fed by the Indian monsoon and winter westerlies vary in isotopic compositions due to the difference in source of the moisture causing the rain and its trajectory. The isotopic signature of springs did not show apparent spatio-temporal variations observed in the rainfall events, falling very close to the LMWL indicating dominant contribution from rainfall. However the prevalent settings and built infrastructure to use spring flow might have contributed to inadvertent mixing of spring with surface runoff leading to similar rainfall dominated isotopic composition across springs.

The spring isotopic signature in both catchments falls within the narrow band of -9.55 to -8.06 ‰ for δ18O and -67.58 to -53.51 ‰ δD across seasons. The estimated mean recharge elevation ranges for springs fed by unconfined groundwater sources are 2600 to 2700 m asl for springs SS-1 and SS-2 in Shikarpur catchment and 1000 to 1100 m asl for springs BS-2 and BS-3 in Banlek catchment. All the recharge zone estimates are located above the highest rainfall sampling locations for the isotope analysis. The estimated recharge elevation range for spring SS-3 in Shikarpur catchment is 2720 to 2760 m asl, which is more than the maximum mountain elevation range of 2681 m asl within the study area. This abnormal value reiterates the findings from hydrometric analysis that the spring SS-3 is fed by source other than unconfined groundwater. It is possible that the recharge areas for spring SS-3 lies in other facets of the mountain range that explains slightly different isotopic composition compared to springs SS-1 and -2. Similarly recharge zones estimated from δD for Banlek catchment provided unreasonable values for all the springs indicating probable errors during the sample analysis stage. Combining insights from the hydrometric and isotope analysis, it can be suggested that springs SS-3, BS-1 and BS-4 fed by sources other than unconfined groundwater.

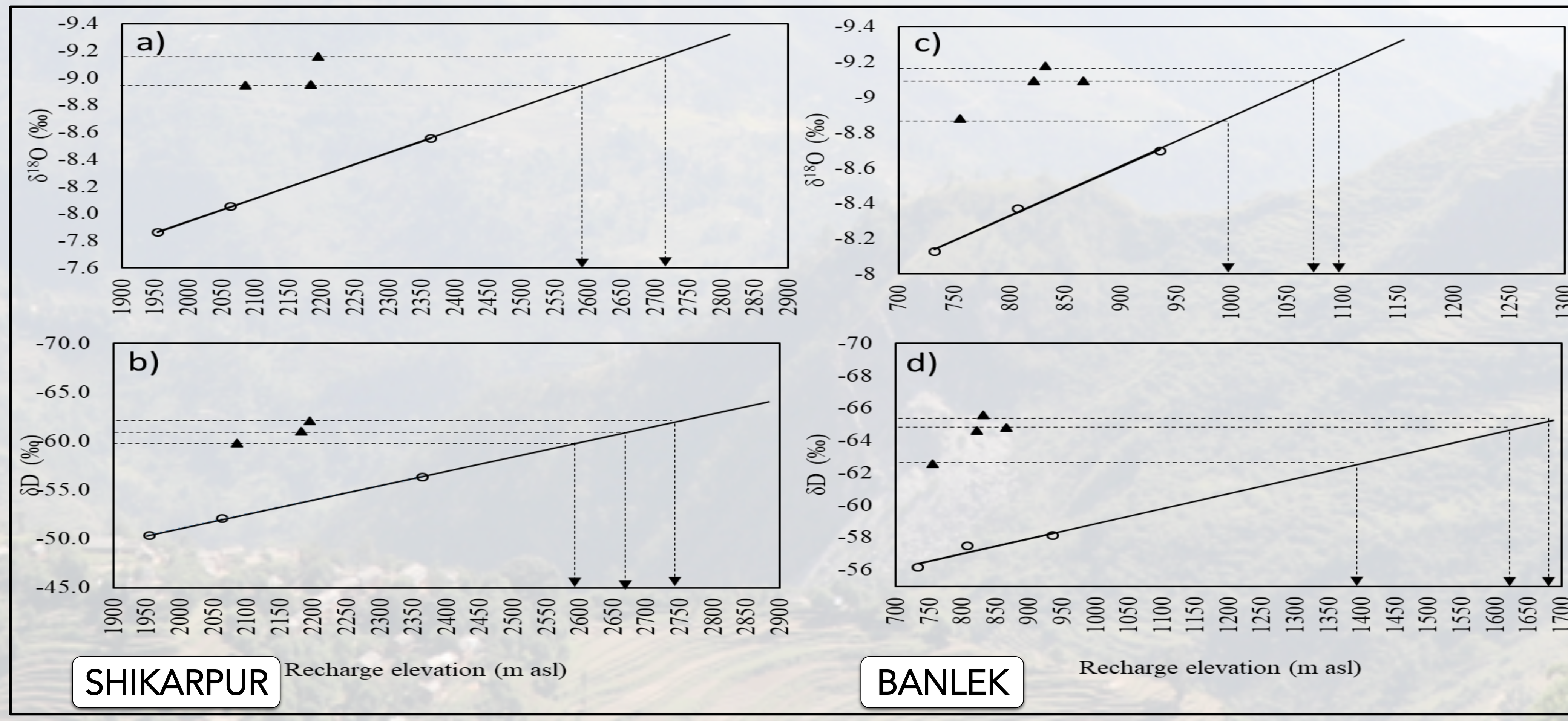

Figure 2. Weighted mean δ18O and δD of precipitation vs altitude showing the estimated mean recharge elevations of springs in a-b) Shikarpur and c-d) Banlek catchments

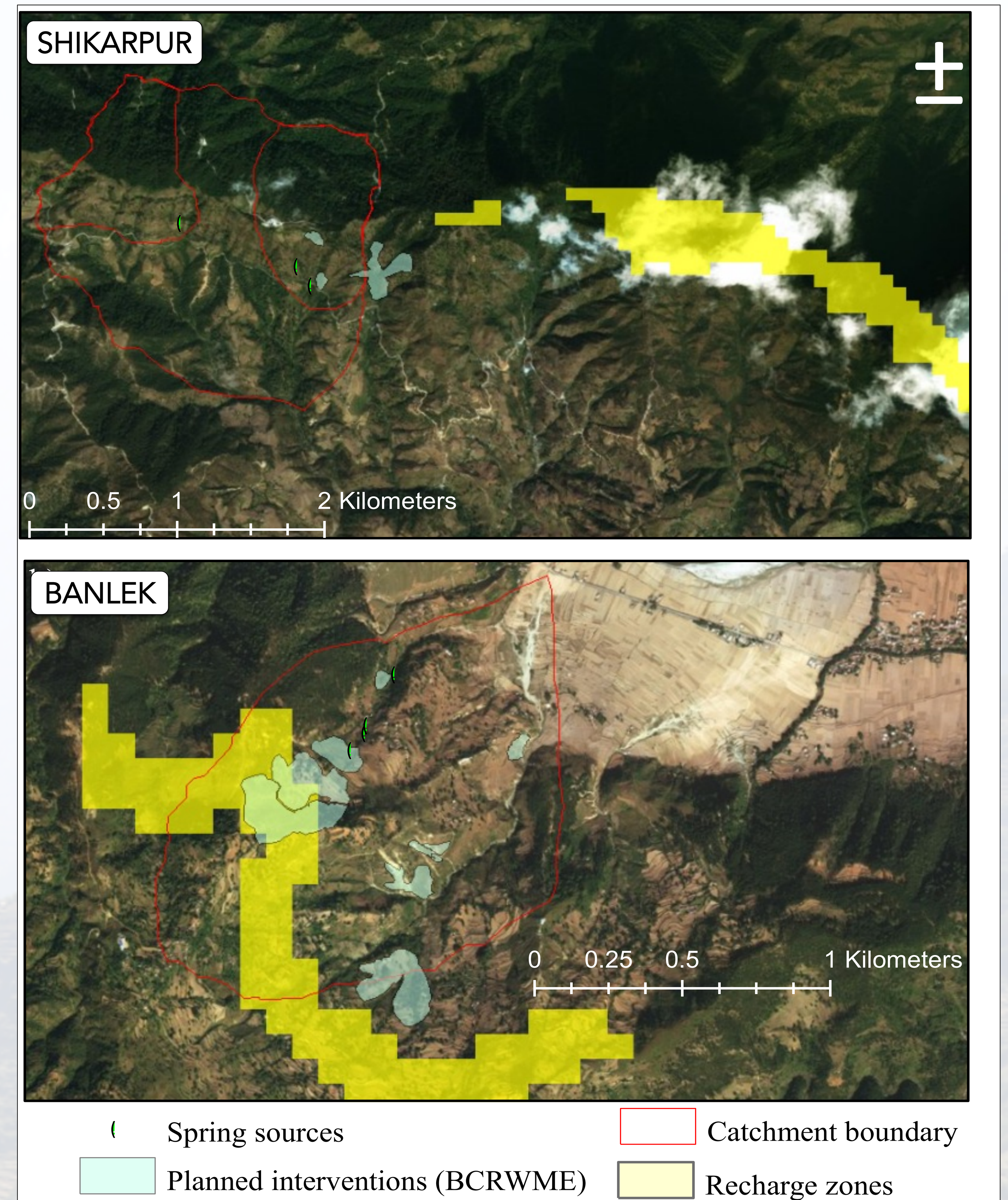

Figure 3. Isotope based recharrge zones in Shikhapur (top) and Banlek (right) and location of planned interventions at the sites.

4. Forging Ahead

.This study piloted the use of isotope analysis to understand springs in Nepal. While the potential of isotope analysis for future use is strong, to understand these springs better, it is imperative to expand the sampling in spatio-temporal scale. Detailed hydrogeological and hydrochemical survey should be done to further verify recharge zone identified by isotopes.

Collaborators:

CGIAR RESEARCH PROGRAM ON Water, Land and Ecosystems

IWMI International Water Management Institute

CONSERVE SOIL AND WATER, PROMOTE GREENERY DSCWM

A water-secure world
www.iwmi.org

Funded by:

NDF Nordic Development Fund

ADB

CIF CLIMATE INVESTMENT FUNDS