Far Western Review
A Multidisciplinary, Peer Reviewed Journal
ISSN: 3021-9019
DOI: https://doi.org/10.3126/fwr.v1i2.62134
Published by Far Western University
Mahendranagar, Nepal

The Gendered Implication of Declining Spring Sources in the Rangun Watershed Area

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Abstract

Rangun Khola watershed of Mahakali River Basin, located in Dadeldhura District in the mid-hill region of Nepal, serves as a model watershed for the region's challenges associated with climate change. Springs are the lifeline for human survival and ecosystems in such watersheds. Data of spring discharge change of 1,122 springs in the region between 1998 and 2008 estimated using recall method showed that spring sources are drying up raising critical concern not only in terms of ecological wellbeing but also in terms of the community's access to water. This study used data collected from focus group discussions and household survey to evaluate the gender implications of such dwindling spring sources in the watershed area. Results shows that historically, women have been managing the majority of the family's water demands. Due to declining spring water sources, women are becoming more time impoverished due to the lengthier time required for water collection, which has an effect on their own and their family' well-being. limited participation from women, the population most directly affected by climate change was found in local adaptation planning procedures. This study adds evidence of the gendered effects of climate change and advocates for the promotion of gender-responsive local adaptation planning in the water management sector.

Keywords: Women, water, climate change, poverty, gender sensitive

Introduction

Springs are groundwater discharge points that appear where a water-bearing layer (aquifer) intersects with the ground surface and water seeps out of rock pores, fissures, fractures, or depressions (Kresic, 2010). Unlike human populations of the valleys, plains, and great river basins downstream, many upstream mountain communities are dependent on natural springs to meet household and agricultural demands (Chapagain et al., 2019). Himalayan spring water caters to the needs of over 40 million individuals, a figure that surpasses the population of New York by approximately twice (Mahamuni & Kulkarni, 2012), occupies a significant portion of the Himalayan water budget (Andermann et al., 2012; Bookhagen & Burbank, 2010) . Springs are an important source of water for drinking and sanitation for mountain communities in the middle mountain watershed areas(G. C. S. Negi & Joshi, 2002). In Nepal, the contribution of these fissured groundwater springs is suggestively higher than the water runoff from the higher-altitude snow fields and glaciers of the Himalayas (Andermann et al., 2012). Springs are not only the device for community water demand fulfilment and an essential component of the ecosystem rather, but they are also an integral part of cultural and spiritual belief for mountain communities(Tambe et al., 2012). Thus, freshwater springs have tremendous ecological and societal significance in the mountainous regions of the Himalayas and should receive the highest priority for research and conservation actions aiming for sustainability.

As with many other communities of the world, water scarcity in terms of quality as well as quantity is one of the major challenges faced by mountain communities in the Himalayas (Sorlini et al., 2013; Wiegandt, 2008). The situation is further challenging for the residents in the middle mountain watersheds (Government of Nepal, Ministry of Population and Environment, Climate Change Management Division, 2017; Nepal et al., 2021; Sharma et al., 2019), where most of the settlements are far from the rivers and streams, laying at the bottom deep gullies and valleys below and construction of drinking water infrastructure is too expensive or prohibitive in such settlements (Merz et al., 2003; G. C. S. Negi & Joshi, 2002), leaving spring as the ultimate source of water. The mountain springs flowing under gravity, mostly fed by precipitation (Sharma et al., 2016) and discharged from the unconfined aquifer (Tambe et al., 2012) are under immense pressure due to the synergetic effects of multiple externalities. The anthropogenic activities, together with biophysical and social factors(Dass et al., 2021; ICIMOD, 2014), coupled with the complexity of changing climate and flow regimes(Merz et al., 2003; G. C. S. Negi & Joshi, 2002) are correspondingly imposing negative pressure on the spring sources in mountain areas. Drying up of spring water sources, especially in the mid-hill regions, started emerging as a common theme across the region (R. B. Shrestha et al., 2018). Recent research on Himalayan springs

(Agarwal et al., 2014; G. C. S. Negi & Joshi, 2002; Tambe et al., 2012) has highlighted the declining water levels in springs and even the drying up of the pre-existing sources of mountain lifelines. Declining spring flows with some perennial springs dried up are leading to increased competition for resources impacting the everyday life of mountain people's livelihood with grave consequences like outmigration and empty villages in the mountain (Gurung et al., 2019).

Globally, research has increasingly focused on determining the causes and consequences of declining water flows and drying spring sources in mountain pockets, which is indicative of the importance and urgency of gaining a better understanding of this issue springs (Agarwal et al., 2014; G. C. S. Negi & Joshi, 2002; Tambe et al., 2012). However, the studies of mountain springs are often discounted as compared to studies of basin-level water resources (Rasul, 2014).Over the last five decades, multiple studies in the greater Himalaya region have unveiled insights into the diminishing flows of springs and the contributing factors leading to the drying up of these water sources (G. C. S. Negi & Joshi, 1996, 2002; H. S. Negi et al., 2007). The systematic spring research in the mountain has shed light on the present status and natural spring dynamics in the localized mountains of the eastern and western Himalayas (Gurung et al., 2019; Poudel & Duex, 2017; Tambe et al., 2012; Tiwari et al., 2020) from various perspectives. Despite this relatively large body of research, there remains a gap in knowledge on how the impacts of drying springs vary across the Himalayas (Meixner et al., 2016). Even though the discourse of gender roles and water management is emerging as a niche research area in international forums (Panta & Resurrección, 2014; S. Shrestha et al., 2019) , its reflection on regional and local research is minimal. The hydrological system is an example of interconnected biophysical and social processes which demand an interdisciplinary approach to study rather than a scientific perspective only (Vogel et al., 2015).

The studies so far initiated in the western mountains have attempted to document the status of spring sources (Adhikari et al., 2021) highlighting the increasing water crisis in western Nepal (Gurung et al., 2019). However, the gender aspects of changing springs resources are somehow missing (Agarwal et al., 2014; Chapagain et al., 2019; Jeelani, 2008; Poudel & Duex, 2017) and questions on spring change dynamics relating the social hydrology (Adhikari et al., 2021; Chinnasamy & Prathapar, 2016; G. C. S. Negi & Joshi, 2002) are in research. Understanding the biophysical setup along with changing socio-political context from both a scientific and societal perspective is vital to address the issue of water resource management in rural mountains (Poudel & Duex, 2017) So, with the objective of supporting the holistic picture of water management status in Rangun Khola watershed, this research is intended to highlight the present status of spring resources along with documentation of gendered implications of changing spring water dynamics on local communities. The study is thus expected to add a steppingstone in the spring research sector and further support policy recommendations for a sustainable water resource management approach in the Rangun Khola watershed of Far West Nepal.

Methodology

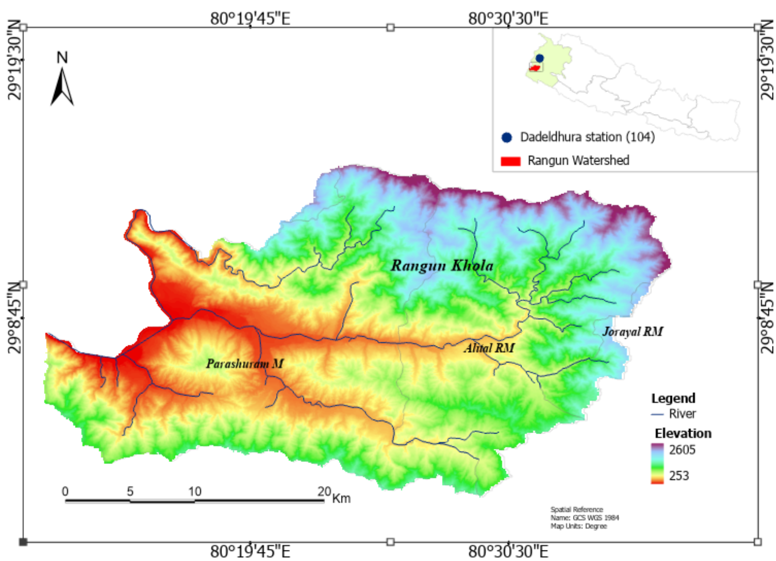
The overall methodological framework applied for the research includes the application of both primary and secondary data to assess the status of springs, trends in spring discharge, analysis of peoples' perceptions and gendered implications of the changes.

Study Site

Two Siwalik hill ranges around Rangun Khola, make up the Rangun Khola Watershed In the far western part of Nepal, (Dhital, 2015). The watershed falls mostly in the Dadeldhura district (Parashuram municipality and Alital rural municipality) and touches slightly a portion of the Jorayal rural municipality in Doti district in Sudur Paschim Province. With a surface area of 687 km2 and an elevation of 300 meters (roughly equivalent to the height of the Empire State Building in New York City) for the southern confluence fo Mahakali River to the northern vicinity of the Mahabharat range at 2500 meters, this vast region presents a variety of viewpoints regarding its geographical dimensions.Rangun Khola watershed is one of the seven watersheds in the Mahakali River Basin (Paani, 2019).

Figure 1

Rangun Khola watershed



There is local variation in temperature with a gradient resulting in a climate varying from a tropical climate in the south to a warm temperate climate in the north, with an average annual temperature between 10°C to 25°C in the watershed. The average annual rainfall for 1998-2018 was 1,347 mm for the watershed, with the highest amount of rainfall (448 mm) received in July during the monsoon season, while the lowest (7 mm) is recorded in the winter month of November. The steeply sloping topography of the watershed, together with high rainfall, makes the watershed susceptible to flood, landslide, and river cutting. According to the population census of 2021, the total population of the watershed is 53,873, among which 25,606 (47.5%) are male and 28267 (52.5%) females. The watershed represents a rich ethno-linguistically diverse community with 8.8% Indigenous (Janajaati), 75.8% Brahmin, Chhetri, Thakuri, Sanyasi, and 15.2% minority (Dalit) groups (CBS, 2021).

Method

The study has adopted both quantitative and well as qualitative research approaches. It involves scientific quantitative documentation of springs, measuring the flow and accessing the spring status of the watershed. The spring source location of 1122 springs was mapped manually with Global Positioning System (GPS) by a team of experts and trained citizen scientists. The details of each spring, including location, aspects, type, surrounding environment, use, dependency, flow rate, and trend, were collected using a mobile application, with a structured questionnaire uploaded in Kobo Toolbox (https://www.kobotoolbox.org/). The spring discharge was estimated by bucket method (761 springs), surface floatation method (33 springs) and recall method (328 springs) during the year 2018. Time taken to fill a 20-litre vessel at present and between 1998 and 2018 was applied for the flow rate validation purpose (Adhikari et al., 2021).

The data obtained from the recall method were derived as spring discharge, and trend analysis was performed to see the variation in spring flow in the watershed. Even though the past flow was recorded through the recall method the present flow measurement was done by the bucket and float method, which helped to cross-validate the perception data obtained by the recall method. All the location coordinates of the springs, recorded using GPS, were converted to ArcGIS shape file point features for further analysis. The springs classification was conducted based on flow rate as demonstrated by (Meinzer, 1923), where springs were classified into eight different classes. The spring discharge change was thus the basis for change determination.

A household questionnaire survey using a stratified random sampling technique by the USAID Paani program in 2018, was used to understand water source management impact and implication issues related to the perception of communities in the Rangun Khola watershed (Paani, 2019). Three subsections of questions on livelihood, drying water sources, and community perception of climate change, each section including 10-20 multiple choice questions, were applied to collect household-level information. A total of 232 households were surveyed, comprising 10% of the total respondents from the selected strata, spread over two municipalities within the Rangun Khola watershed. Among the total respondents, 48% were male, and 52% were female, which is representative of the population structure of the watershed.

The household survey documented information on household dependency and accessibility to water sources, gender roles in water management, the perceived implication of changing water availability, and climate change variability. Simple statistics such as mean, standard deviation, frequency, and range were calculated using MS-Excel for community perception assessment. Focused group discussions were conducted at nine representative locations to document community perception of spring sources, water management and impacts of climate change. Similarly, eight key informants, including local leaders, representatives from department agencies and academics, were interviewed to validate the community perception and access the ground status of gender inclusion in the water management sector.

Results

Sociocultural Characteristics of Respondents

This section explores the sociological setup of the community within Rangun Khola watershed. It includes demographic structure, livelihood dependency, water sources dependency and water management roles and responsibilities.

The Rangun Khola watershed represents a rich ethno-linguistically diverse community with a predominance of Brahmin/Chhetri /Thakuri/Sanyasi (BCTS) (61%) followed by 26% of Dalit, and 13% of local indigenous groups of Magar. The dominant ethnic groups in the study area are Indo-Aryan ethnic groups close to 90% of the population. Nearly 15% of the population belongs to landless households, while 85% have access to land and are involved in agricultural practices. The livelihood of the community is primarily based on subsistence agriculture, where almost 86% of the household's primary livelihood option was agriculture and livestock rearing. Overall, seasonal migration and foreign employment have the second highest share (5%) in income sources after agriculture. The involvement in the non-agricultural sector accounts for 14%, which resembles the national scenario (CBS, 2011).Household income diversification in livestock, poultry, seasonal migrating and labor migration, fishing and off-farm jobs are the mechanisms many households adopt as risk aversion techniques against economic shocks.

Household Water Dependency and Access

Rangun Khola watershed has a complex network of five river systems and 135 streams of various sizes accounting for a total drainage density of 0.77km/km^2. However, when it comes to domestic water needs, households in the watershed are prominently (96%) dependent on open-access spring sources. Piped water (76%), surface water (20%), and well water (4%) are the major water sources accessed by the community for household water demand fulfilment. Only 5% of the households reported having access to private water sources within their household premises, while 95% reported travelling at least 15 minutes to access public water sources. Among these sources, almost 80% were seasonal sources as compared to 20% year around availability. Uses of water are primarily for domestic and agricultural needs; a very small portion is reserved for construction purposes. For agriculture, households were found prominently depending upon traditional water sources, such as rainwater (58%), irrigation canals fed by rivers (55%), ponds/lakes (25%), and groundwater (3%), while an insignificant portion was found using modern techniques of solar lifting.

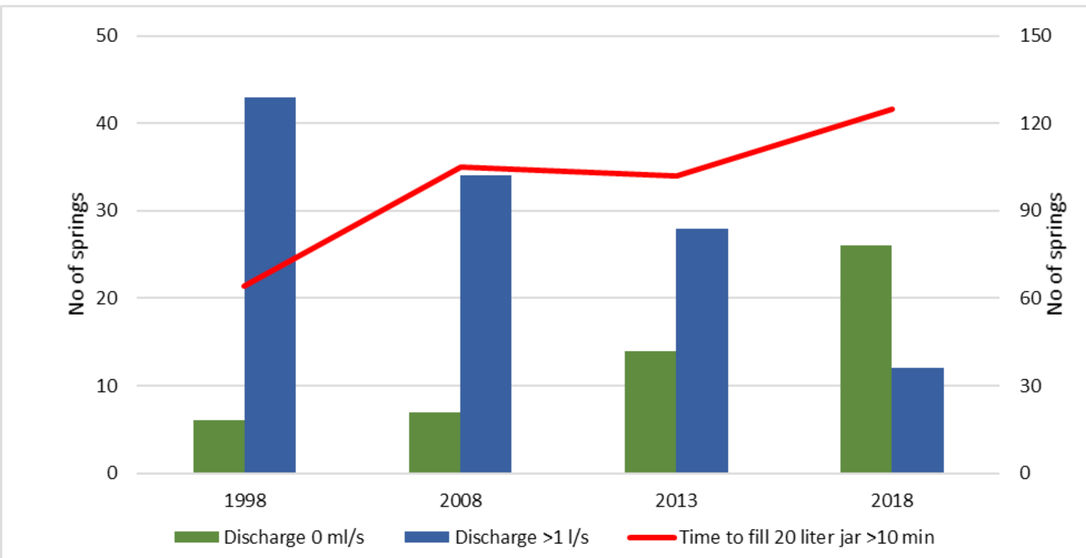
Status of Spring Sources

A total of 1,122 spring sources were mapped within the Rangun Khola watershed; in Parashuram (743), Alital (364), and Jorayal (15) local administration units. The spring density in the study area was 1.63 springs/km2. Among the total mapped springs, 90% were perennial, and 10% were seasonal. Based on the type of springs, the most prominent (56%) were open springs, followed by ponds (19%), stone spouts (13%), and concrete tanks (12%). Almost half (46%) of the mapped springs were located within or in proximity to forest, followed by 27% close to agricultural land, 18% adjacent to shrub land and 9% in the barren land area. Among the mapped springs, 80% of the springs were used for household and agricultural water demand, while the rest 20% were indirectly serving ecological needs. A large variation in household dependency (1 household/spring up to 300 households/spring) was recorded in the Rangun Khola watershed with an average spring dependency of 17 households/spring. The spring discharge classifications done for the mapped springs revealed that the springs are in the discharge range of 0 to 3.33 l/s. The commonly encountered springs (52%) have medium discharge in the range of 0.01-0.1 l/s, while 27% of the springs had a discharge more than 0.1 l/s, almost 19% of springs had discharge less than 0.01 l/s, and 26 springs had already dried up with no discharge at all.

Based on community perception, extended spring sources assessment over 20 years revealed that the springs are showing declining flow with a worsening condition in recent years (Figure 2). The flow rate has drastically changed as compared to the past 20 years. Comparative assessment of spring flow rate, the number of springs with high flow rates have reduced significantly, while the group of springs with lower flow rates has increased. Of 43 springs with a flow rate >1 l/s 20 years ago, now only 12 have maintained this flow rate, while from the 420 springs with a flow rate of 0.1 l/s there are now only 282 springs. In addition, 20 years ago there were 381 springs with a flow rate of 10-100 ml/s, this has increased to 581, and even the number of springs with <10 ml/s flow rate have increased from 4 to 35 within 20 years with a concurrent increment in several springs with a flow rate less than 0.1 l/s. Consequently, the number of dried-up sources has increased significantly in the recent 10 years, from one to 26.

Figure 2

Number of springs with a declining flow rate and increasing time to fill 20 liter jar, in 1998, 2003, 2008, 2013 and 2018, indicating declining spring flows at source



Community Perception and Vulnerability to Changing Context

During the investigation of household perceptions about ongoing changes in climatic conditions, more than 80% of households reported that the water availability, at source as well as productive water availability in the form of precipitation, has decreased significantly compared to the past decade. The empirical data from these assessments were consistent with community perception, where almost 88% of the respondents reported declining spring water sources as a major implication of concern for household livelihood. This is also consistent with spring source mapping data depicting 77% decreasing water sources. Almost 70% of households reported difficulties due to these drying water sources.

Considering the perceptions of these implications by households, drying water sources was the most prominent issue reported by 65% of the households, followed by impacts on plant phenology (59%), agricultural productivity (53%), water collection timing (45%), and indirect implication on the range of livelihood activities as reported by almost one-third of the households. Almost 75% of the responding households stated that increasing higher temperatures and consequent upsurge of drought and weather-related natural calamities (e.g., floods and landslides) are an increasing trend.

Owing to the immediate implication of drying spring sources on livelihood, almost 15% of households were trying out a range of risk aversion activities to reduce the immediate impact on livelihood. Among the respondents who were using risk aversion activities, almost 95% were centered on household-level interventions, such as increasing their seasonal migration activities (48%) and adjusting finances by borrowing money from local sources (41%). However, less than 5% were trying to search for an alternative water resource, such as community-level interventions.

Even though implications are visible at the household level, less than 25% of the households were undertaking coping or adaptation actions on the ground. Among the range of options, plantation was common practice reported by 23% of the household, followed by gabion wall construction (11%). Water scarcity was continually pointed to as an aggravating issue; however, water source protection was adopted by less than 7% of the households. Protecting water sources was still lacking its place in the top two adaptation interventions against changing climate. Furthermore, there were negligible efforts to adopt adaptation measures, such as canal rehabilitation, bio embankment, and tunnel house, while alternative livelihood options were initiated by less than 2% of the households in the watershed.

Gendered Roles in Water Management at the Household Level

Water management at the household level is mainly led by women (87%), while irrigation water management, it is equally shared between women (48%) and men (52%). Regarding water collection from sources, 73% of households reported practicing shared roles, while 26% reported the task as the sole responsibility of women.

Even though it was reported a shared role in the household interviews, focus group discussions (FGDs) revealed that women usually bear most of the burden for collecting daily water with few exceptions. Due to the very physical nature of this work, a task that, over time, can accelerate physical ailments, particularly in the back and abdomen, many women complain about associated physical complications such as back and abdominal pain and prolapsed uteri.

Regarding accessibility to water sources, almost 14% of the respondents reported unequal access to water sources. Detailed assessment of these respondents revealed that socio-cultural factors (reported caste-based discrimination (64% of respondents), religious cause (44% of respondents))was one of the long-term reasons behind the inaccessibility to public water sources. On the contrary, 68% of respondents reported drying spring sources as an impending challenge in the water accessibility sector. Caste and religious issues were there as a social construct, but now the water shortage adds to the existing difficulties and indicates future challenges. The changing natural circumstances, and the pre-existing unequal access to water sources, highlight the seriousness of the issue in the watershed.

The household survey revealed that water collection timing is one of the raising issues of the watershed. Almost 23% of households must travel more than 30 minutes daily to collect drinking water to fulfil their domestic water needs. Almost 43% of the respondents needed to travel >15 minutes to collect drinking water, and 15% even reported travelling more than an hour. With prominent dependency on public water sources in the Rangun Khola watershed, almost 82% of households indicated there were declining water sources, and consequently, there were aggravating water scarcity issues in the community.

Gendered Participation in Water-Related Local Adaptation Planning

Local institutions such as community forest user groups, irrigation groups, cooperatives, etc., were found to be involved in the management of water and related resources in the watershed area. However, almost half of the Dalit respondents (48%) and Brahmin/Chhetri/Thakuri (46%) reported being unaware of the presence of formal groups in the watershed, and less than one-third were members of some local groups. While the participation of women and marginalized community members was found to have increased in the local groups, yet women and marginalized groups hold only 3% of the key positions in the user groups. During key informant interviews, it was revealed that such participation is mere tokenism and voices of women and marginalized groups are rarely considered while making key decisions in the groups. During FGD, it was found that community members were also unaware of local and community adaptation plans. Few elite men in the community were involved in the decision-making process of LAPA. Even when included in such decision-making forums, women from marginalized groups such as Raute and Dalit communities reported feeling discriminated against when they participated in mixed groups.

Discussion

The changing water situation in the springs in the Rangun Khola watershed has been perceived as an increasing concern by the residents. However, due to existing differentiation among women and men in terms of roles related to water management at the household level, the increasing risk of water scarcity has greater negative impacts on women (Udas et al., 2019). The gender disparity in terms of workload in rural Nepal has been widely reported. Women in this watershed area are having less time for other productive tasks, social interactions, and leisure due to the greater time required for household water management.

As women were found to be the major water managers in most households, women are at the forefront of bearing the consequences of increased water collection time and decreased water accessibility. Previous research on other watershed areas of Nepal has shown that in such situations, women are found to travel farther and spend more time in water collection resulting in an increased workload for women (S. Shrestha et al., 2019). In the Rangun watershed, the drying water sources or shifting water course is a much more serious concern for women in households where they are already found to be spending more than 15 minutes to an hour travelling significant distances for water collection. Eventhough 70% HHs have access to piped water at this stage within the watershed, the decline in water sources is expected to make associated implication at the distributing system as well. The only difference will be that earlier women needed to wait at spring sources now they need to wait at the tap. So if we really want to address these issue on time its high time to do better planning for source protection.

Collecting drinking water is widely considered a women's task (Brown, 2003; S. Shrestha et al., 2019). The existing inequalities in terms of access to water is another concern indicated by this study. Similar studies have shown that women face an additional challenge in securing water for irrigation during water scarcity and have to depend on their male kin or neighbours for timely access (Panta & Resurrección, 2014). As spring water dries up in Rangun Khola watershed, the current inequalities in water access are likely to exacerbate, increasing the vulnerability of some households of lower caste groups and women. Due to the seasonal outmigration of men, women are increasingly getting involved in irrigation water management, thereby adding to women's workload and stress.

Despite the increasing role of women in water management, both for domestic water and irrigation water at the household level, women are found to have a limited decision-making role in the water-related planning process. Ongoing gender mainstreaming efforts in the water sector in Rangun watershed has been found to be largely inadequate to change the historical perception of it as a masculine domain and promote gender-equitable participation in water management at different levels. The finding corroborates with similar studies in other regions of Nepal where the women are involved in local water user groups to meet the policy guidelines with limited emphasis on effectively including their needs and interests (G. Shrestha & Clement, 2019; Zwarteveen, 2006).

Conclusion

Springs in the Rangun Khola watershed provide various ecological services. The community in the watershed relies on the spring water for drinking, irrigation, washing/cleaning, livestock feeding, local grinding mills (ghatta), micro hydropower, recreational activities, aquaculture, etc. Declining water in these springs is adversely affecting the lives and livelihood of women and men dependent on these springs as their primary water source. Particularly, the existing gender norms that make women responsible for household water management put them at the forefront of coping with increasing water scarcity with limited resources. However, limited adaptation mechanisms are developed at the community level to address the issue of drying water sources.

Limited participation of women and marginalized groups in water user groups and other natural resource management committees within the watershed is of concern for developing inclusive and gender-responsive local adaptation plans. Future research is needed to provide an in-depth understanding of the changing water-society relationships from an intersectionality perspective and the necessary interventions needed to empower women and marginalized groups to secure their access to water in the context of changing climate. This is also going to be critical for the effective implementation of any Local Adaptation plans as men are increasingly out-migrating (seasonally) as an alternative livelihood triggered by the changing water situation.

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