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Sustaining Himalayan Springs Amidst the Emerging Water Crisis

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Abstract- The significance of spring water is fundamentally integral to the livelihood of the Himalayan population. Springs are the chief providers of drinking water for households, agricultural, and industrial applications, especially in the Himalayan region, and contribute to the ecological richness and ecosystems in the Himalayas. Despite their crucial significance, springs continue to attract minimal attention. Over the last couple of decades, a noticeable drop of about 60% in low-discharge springs has been documented. With the escalation of population growth, relentless climate change, and rapid urbanization, springs face several significant threats to their survival. There is growing evidence that the springs of the Himalayas are experiencing desiccation, a reduction in discharge, and deterioration in water quality. In the Himalayan territories, springs hold significant importance in the context of cultural and religious beliefs. They are considered purest form of water and are frequently associated with different gods, rituals, and mythologies. These springs were regarded as sacred due to their intrinsic connections to regional deities and rituals of worshipping water. Heat, glacial melting and rainfall patterns are the anticipated alterations that are projected to influence the quality & quantity of water substantially. Springs rejuvenation could offer a climate-adaptive approach benefiting the Himalayan ecosystems and livelihoods, improve water accessibility, and help to accomplish any of the Sustainable Development Goals (SDGs). Spring-shed management based on aquifer systems combines scientific knowledge, community participation and collaborative partnerships in springs revival, thereby generating policy attention on spring water across the region.

Keywords: Himalayan springs, Hydrogeology, Sacred springs, Water scarcity, Climate change, Anthropogenic contamination, Water conservation.

I. INTRODUCTION

A Multidimensional Perspective on Spring Water Systems in the Indian Himalayas: Water is essential for sustainability and maintaining ecological balance. Both its availability and quality are most important for human civilizations and the ecological systems. Nonetheless, these factors are jeopardized by the ramifications of climate change (Chapagain et al., 2019). Before the advent of applying agricultural practices, hunting-gathering societies must have depended on springs before humans initiated the excavation of wells for access to groundwater. Traditionally, spring water is regarded as pristine and uncontaminated because of the self-purification processes that take place during percolation and transit through both superficial and confined aquifers (Aayog, 2017).

The ecological niche within hilly and mountainous regions is contingent upon the accessibility of water resources, wherein springs assume a pivotal function (Upreti et al., 2024). (Upreti et al., 2024). A spring is a natural opening in the ground through which water emanates directly from the aquifer to the surface of the Earth. The source of this potable water is from seasonal rainfall that soaks into the natural floor, which is ground. The determination of spring water quality is influenced by the surrounding land cover, rock-water interaction, and human activities in the upland and nearby areas, whereas the discharge of the springs is reliant on the replenishment of the subterranean aquifers, their sizes, and their types (Thapa et al., 2020).

The historical origins of springs are familiar to local inhabitants referred as Khals, Chal, Gharats, and Naulas (Sharma, 2016). According to (Siddique et al., 2019; Taloor et al., 2020) in Indian Himalayan communities, between 60% to 70% of the population directly depends on springs to meet their domestic & livelihood needs. Additionally, springs are highly valued with respect to culture and religion for these communities. The springs have enormous ecological value and serve as a home for a myriad of flora and fauna. Springs contribute substantially to the economic well-being of the surrounding local communities. The biggest threats to all those who depend on the spring water resource are the risk of desiccation and degradation of water quality. Springs are under threat because of the effects of climate change. The depletion of spring sources as a result of natural and anthropogenic factors (Barheyan et al., 2023). Table 1 presents statistical data on the dependence of the Himalayan population on springs.

The Himalayas are often called 'Hydrological Towers of Asia' or 'The Third Pole'. Outside of the two poles, it serves as the origin for ten major Asian rivers and encompasses the largest accumulation of snow and glaciers (Verma & Jamwal, 2022). The Indian Himalayan region is home to more than 31 million people, which makes up about 16.2% of the country's total geographical area. They show vulnerability to anthropogenic changes and global climate change (Chapagain et al., 2019; Pachauri et al., 2015). Particularly affecting the spring systems, the interaction between climate change and anthropogenic activities is regarded as a substantial risk to the groundwater aquifers.

The Himalayas are well endowed with water resources, including springs, glaciers, lakes, rivers, and streams. A source of natural water, springs are commonly deemed safe because of the natural process (filtration) from which they benefit as water percolates & flows down aquifers. They had representation on a specific interface between the aquatic and terrestrial habitats, sustaining biodiversity that regulates their water quality (Ansari et al., 2015; Siddique et al., 2019).

Table 1: This table summarizes the information regarding the number of villages reporting springs and associated surface flow irrigation schemes that actually originate from springs in the various Himalayan States of India (Aayog, 2017; Ranjan & Kumar Pandey, 2020).

Region	Division of Himalayan States	Number of Villages identified with Springs	Total number of Villages	% of Villages documented with Springs	Surface Flow Irrigation Schemes through Spring Channel-Based	% of surface flow irrigation systems based on spring channel
	Arunachal Pradesh	2086	5589	37.3%	15	0.3%
Eastern Himalayas	Assam	2997	26395	11.4%	265	9.4%
	Manipur	1405	2581	54.4%	0	0.0%
	Meghalaya	3810	6839	55.7%	246	3.0%
	Mizoram	453	830	54.6%	1252	23.3%
	Nagaland	639	1428	44.7%	27	0.1%
	Sikkim	425	451	94.2%	29	2.0%
	Tripura	141	875	16.1%	2	0.6%
	West Bengal (Darjeeling)	221	688	32.1%	1	0.6%
	Total	12177	45676	26.7%	1837	4.1%
Western Himalayas	Himachal Pradesh	2597	20690	12.6%	29	0.2%

	Jammu & Kashmir	3313	6553	50.6%	0	0.0%
	Uttarakhand	594	16793	3.5%	20182	64.7%
	Total	6504	44036	14.8%	20211	42.5%
	All Himalayan States	18681	89712	20.8%	22048	23.9%

II. HYDROGEOLOGICAL FRAMEWORK OF HIMALAYAN SPRING SYSTEMS

This section outlines the structural and functional diversity of Himalayan springs, detailing aquifer types and recharge mechanisms, flow dynamics, and water chemistry. It highlights how geological formations, climate, and land use influence spring discharge, mineral composition, and contaminant pathways. Finally, it emphasizes the ecological role of springs as biodiversity refugia and indicators of groundwater quality.

Aquifer Dynamics and Spring Typologies in the Indian Himalayan Region: The spatial dispersion, storage, and dynamics of water within the aquifer system are governed by the hydrogeology of the springs. Groundwater is retained in the pore spaces, fractures or fissures within the rock material and is driven by gravitational forces. Stock and movement characteristics of an aquifer such as quotients to store water (Storage coefficient), referred to as "storativity," and capacity to convey water (conveyance capacity), referred to as "transmissivity," determine whether it will be a perennial or seasonal (Kulkarni et al., 2015).

Springs in the Himalayan region are classified into five types: depression, contact, fracture, fault, and karst —predicated on the structure-bound mechanism for its recharge. Depression springs manifest at topographic lows; Contact springs where permeable rocks are in contact with impermeable rocks; Fracture springs occur in lithified rock; Fault springs are located along geological fault lines; and Karst springs in carbonate rocks or limestone (R. B. Shrestha, 2018). The chemical makeup of source water and its transit through subsurface flow paths significantly influence the spring chemistry. The characteristics of aquifer material, geophysical configurations, and residence time influence discharge and water quality (Ansari et al., 2015).

Recharge Mechanisms and Flow Dynamics Insights into Spring Systems: Springs epitomise the subsurface to surface water flux and provide a connection between surface and subsurface hydrology through intricate pathways. The aquifer discharge is governed by precipitation patterns, groundwater replenishment area aspects, and the type of aquifer which feeds the springs (Aayog, 2017; Kulkarni et al., 2015). At high altitude, springs are also fed by the snow melt and glacier retreat (Jeelani et al., 2017). 'Water towers' serve as a supply system for several springs in a specific region. (R. B. Shrestha, 2018).

The characteristics of the recharge area and storage capacity of the aquifer affect the discharge of the springs. Perennial springs show a slow and gradual recession in flow, while seasonal springs show a steep recession (Kumar & Sen, 2018; Verma & Jamwal, 2022). Hydrochemistry, isotopes, and tracers are employed to determine sources, trajectory pathways of flows, altitude of regions of recharge, and residence time for springs at different space and time scales (Thakur et al., 2020). Time series analysis of temperature and electrical conductivity has revealed rapid flow and limited storage capacity of superficial aquifers (Verma & Jamwal, 2022). Hydrological reactions witnessed by springs rely upon geostructure underneath.

The volume, quantity and directionality of fractures found within a system of fractured springs dictate the behavior with most ending up with fast flows for short distances (Hamza et al., 2017). For karst springs, recharging is done by point sources such as conduits and sink streams with high fluctuation in flows and susceptibility to changes in precipitation patterns (Jeelani et al., 2017; Shah et al., 2022).

Mineral Composition and Contaminant Pathways in Springs: Spring water chemistry is governed by the aquifer material the weathering processes of the geological strata, the residence time of water in an aquifer & climate. Residence time, the time a particle or contaminant requires to transit from infiltration to discharge has an impact on the quality of spring water (Fetter et al., 2017; Verma & Jamwal, 2022). Extended groundwater flow patterns and residence time facilitate the natural attenuation of specific contaminants. Manmade activities & local hydrogeology across the springshed influenced both the water quality and water flowing routes (Dosskey et al., 2010; Verma & Jamwal, 2022).

Springs of the mountain are known for superior-quality water which are abundant in inorganic compounds. Dominant ions include SO_4^{2-}, Mg^{2+}, Ca^{2+}, and HCO_3^- (Jeelani et al., 2011). TDS and geology affect the water type: low TDS springs have Ca–Mg–HCO_3, elevated TDS springs have Ca–Na–HCO_3–Cl, and in karst springs have Ca–HCO_3 or Mg–Ca–HCO_3 (U. Saravana Kumar et al., 2014). Ca–HCO_3 and Ca–SO_4 type water are contributed through glacier melt and snow melt at the higher altitudes (Jeelani et al., 2011).

The main processes affecting the chemistry of spring water include ion exchange, carbonate dissolution, silicate weathering and dissolution of minerals. Through aquifer materials, pollutants like Arsenic, fluoride, and iron can be contributed (Ansari et al., 2015; Jeelani et al., 2011; Verma & Jamwal, 2022). The spring's water quality varies with recharge zone and land use. Agricultural land terrain tends to have low dissolved oxygen, higher electrical conductivity, and increased NO_3^-—levels while locations within the forest areas reveal low electrical conductivity, total dissolved solids, and ion concentrations. Urban environments show a positive correlation between population density and nitrate (NO_3^-) concentration. Inter-basin groundwater flow, intense rainfall, and subsurface flow paths can swiftly transport pollutants and affect watershed-scale water quality (Verma & Jamwal, 2022).

Spring Ecosystems as Refugia: Linking Groundwater Quality to Biodiversity Conservation: Springs are among the world's most productive and endangered ecosystems. Functions as headwater wetlands connected to surface water systems, groundwater-dependent, forming a triadic transitional zone between the surface water, groundwater, and terrestrial systems.

Influenced by the interactions occurring in riparian, hyporheic, and vadose zones that shape spring ecosystems, any disruption in any one of these areas directly impacts their functioning (Barquín & Scarsbrook, 2008). Figure 1 illustrates springs as natural interfaces that represent transition zones where ecosystems converge, while also depicting the threats that impact their sustainability. Springs provide a home to multiple microhabitats and host a diverse array of aquatic, wetland, and terrestrial species. They frequently act as biodiversity hotspots and refuges for survivor species.

Especially in agricultural landscapes, spring habitats, in aquatic plants & animals can serve as a valuable marker of groundwater quality. In addition to their high degree of endemism and biological richness, springs make ideal locations for long-duration ecological investigations. Beyond biodiversity, springs provide significant ecosystem services and serve as socio-ecosystems, meaning that their revival requires restoring both social and ecological functions (Cantonati et al., 2020; Thapa et al., 2020; Verma & Jamwal, 2022).

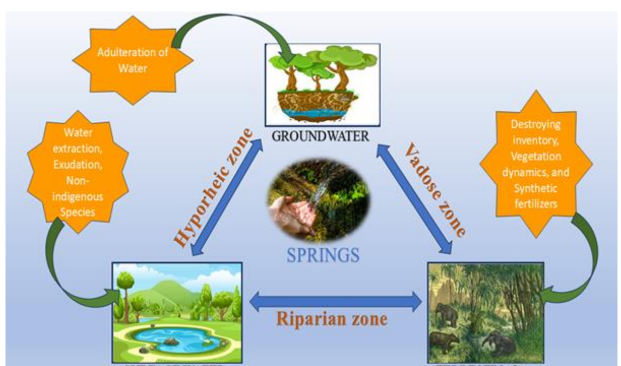

Figure 1 Representation of transition zones by springs, marked by the convergence of contrasting ecosystems.

III. SOCIO-CULTURAL AND ECONOMIC RELEVANCE FOR HIMALAYAN COMMUNITIES

The springs play a crucial role in sustaining the daily lives of residents in the Himalayan area. Springs are main sources of safe potable water, irrigation and animal rearing, especially for rural Himalayan areas. Approximately 90% drinking freshwater supply is founded upon springs in Uttarakhand; in Manipur villages 65% rely on springs; in Sikkim, 80% of rural households rely on springs; and about 64% cultivable areas of the Indian Himalayan Region springs serve as the sole source of irrigation (Siddique et al., 2019). The socio-economic and environmental implications of spring conservation are all-year-round access to water supply, improvement in health outcomes, improvement in household income and lessening poverty incidence, reduced time and energy burden, environmental protection, cost savings for treatments and women's empowerment, as women are mainly involved in water collection.

The non-access to safe water supply hinders economic development, prevents development towards gender equality and increases the chances of health hazards due to water-borne illnesses (Ranjan & Kumar Pandey, 2020). Springs are endowed with intrinsic religious, cultural and ritual value. They are esteemed as holiest sources of water and often associated with deities and rituals. In Hindu mythology, Jal Devata is acknowledged as the God of water, and numerous springs are venerated as sacred pilgrimage sites. People visit springs for ritualistic baths during auspicious occasions, with thermal springs like Manikaran, Vashishth, Kheerganga, and Kasol believed to have healing powers for bone and skin ailments.

Springs are intertwined with purification, deity manifestations, mythological narratives, rendering them important religious and cultural landmarks. Additionally, springs are integral to community management systems and traditional water harvesting. Such structures are baoris, naulas, panihars, nauns, dharas, chharedus, chaals, khals, and khatris which facilitate the storage of rainwater and the recharging of aquifers. For the purposes of irrigation and gharats (watermills), channels tap springs like kuhl and guhl. These infrastructures, often centuries old, were built by local rulers or elite families and are maintained as community-owned resources, however, disparities in access exist contingent upon caste or social standing. Lack of safe water reduces economic development, inhibits progress toward gender equality, and increases the chances of health danger due to water-borne illnesses (Dhiman et al., 2023; Kulkarni et al., 2021; Risko, 2018).

IV. EMERGING CHALLENGES AND THREATS

This section highlights the multifaceted threats to Himalayan Spring systems, including climate-induced shifts in precipitation and temperature that are converting perennial springs into seasonal ones. It examines how land-use changes, deforestation, and forest type transitions reduce spring discharge and degrade water quality. The section also addresses contamination from both geogenic sources and anthropogenic activities such as agriculture and poor sanitation. Finally, it underscores how rapid population growth and catchment degradation jeopardize the long-term sustainability of spring-fed communities in the Himalayas.

Climate-Induced Decline of Perennial Springs in the Indian Himalayan Region: As result of rising water demand, environmental degradation, & land use change, the flow has been noted to be decreasing. In the context of climate variability and thermal increase, an increase in precipitation rate and reduction in its temporal distribution, and substantial fall in winter rain, in the Indian Himalayan Region (IHR), the issue of dying springs is becoming more and more prevalent. According to NITI Ayog, Himalayan aquifer systems are being impacted by seismic activity, irregular precipitation, and a decline in ecosystem health correlated with land use change for infrastructure expansion.

It is reported that half of the more than 3 million perennial springs identified across the IHR States have either already dried up or become seasonal, and thus creating vital water shortages for thousands of Himalayan villages. As has been documented, perennial springs are converting to seasonal and springs discharge has diminished during the prior decades due to altered precipitation trends and anthropogenic activities. (Aayog, 2017; Tambe et al., 2012; Verma & Jamwal, 2022). With a rapidly evolving climate, the mean yearly temperature in the IHR is expected to intensify at the estimated rate of 0.06 °C per year, leading to a warming of 1–2 °C (in certain places up to 4–5 °C) in the region by 2050. It is anticipated that precipitation would become more unpredictable and intense, resulting in heightened surface runoff and diminished recharge of the aquifer (A. B. Shrestha et al., 2015).

Impacts of Land-Use Change and Forest Cover Transformation on Spring Hydrology: The transformations in urban and agricultural landscapes have profound impact on aquifer systems, thereby threatening the availability and purity of water. (Verma & Jamwal, 2022) mentioned that reduced precipitation and deforestation have culminated in a reduction in spring discharge by 25%–75% has been observed in the Gaula River basin.

In the Nainital district of Uttarakhand, extensive deforestation, reduced percolation, and high runoff activities have caused 159 natural springs to entirely dry up over the last 30 years, and 50 have become seasonal. Declining spring discharges are also associated with the reduction in Quercus dominated forest cover and its substitution with pine forests, which exhibit substantially higher transpiration rates than do native forest species in the region (Ghimire et al., 2014). The presence of settlements, deforestation, open grazing, construction activities, and the intensified use of farm chemicals in spring recharge zone pose significant risks to spring water quality (Verma & Jamwal, 2022).

Geogenic and Anthropogenic Contaminants in Himalayan Spring Systems: The contamination of water resources is an emerging global environmental concern, and water sources such as the springs of Kashmir are subject to significant anthropogenic impacts from nutrient enrichment, urbanisation, untreated sewage, eutrophication, presence of heavy metals, sediment load, and land use changes at the catchment scale, all of which deteriorate their water quality (Bhat et al., 2022; Verma & Jamwal, 2022).

Both geogenic and anthropogenic factors influence spring water quality. Geogenic contaminants such as iron (Fe) and fluoride (F) are found in springs. The most commonly reported man-made contaminants in springs are faecal coliform and nitrates, linked with agriculture and poor sewage, as well as livestock waste management. The contamination of spring is due to Cl^-, SO_4^{2-}, NO_3^- and faecal coliform bacteria is highly reliant on septic tanks & lack of sanitation facilities by linking with it (Ansari et al., 2015; Verma & Jamwal, 2022).

Demographic Expansion and Catchment Degradation: Threats to Spring Sustainability in the Himalayas: The escalation of the population has experienced a significant increase of 70.21%, at a rate of approximately 26% conversion of forest areas to agricultural land, both relatively elevated for the mountainous setting (Panwar, 2020; Tiwari & Joshi, 2012). (Tambe et al., 2012) mention that human activities like forest fires, deforestation, and infrastructure expansion degrade catchments and have a negative effect on spring discharge. Reduced spring discharge increases the water demand in this region. Under these circumstances, the human population's long-term sustainability in the Himalayan region is now questionable.

V. STRATEGIES FOR SPRING REVIVAL IN THE HIMALAYAS

From Participatory Groundwater Management to National Action Plans: In recent times, initiatives are gaining lots of momentum to recharge and preserve springs. Numerous state governments, Non-Governmental Organisations (NGOs) and Civil Society Organizations (CSOs) are fostering awareness of the vital essentiality of springs and building the ability to safeguard, develop and manage “spring-sheds” across the country. Most spring safeguarding efforts follow a similar methodology at the community level: mapping spring-sheds through hydrogeology assessment; rejuvenation, protection or augmentation of recharge; dissemination and sharing of relevant knowledge; monitoring and management of springs (Aayog, 2017).

The largest share of the Earth's subsurface water flux terminates in springs or streams. Rejuvenation of springs has the potential to present a climate-adaptive strategy for both socio-economic well-being & natural environment in the hilly and mountainous areas of the Himalaya. Moreover, it increases water accessibility and promotes the accomplishment of Sustainable Development Objectives (SDGs). According to estimations derived from various pilot studies, approximately 60% of low-flow springs serving small settlements in the Himalayan region have shown a noticeable drop (Aayog, 2017; Kulkarni et al., 2021; Margat & Van der Gun, 2013).

Many organizations have taken commendable initiatives aimed at springs restoration. People's Science Institute (PSI), Dehradun to implement spring water management in the Thanakasoga–Luhali Panchayat area located in Sirmour district of Himachal Pradesh, used a spring-shed management framework grounded in Participatory Groundwater Management (PGWM). In Uttarakhand, the Central Himalayan Rural Action Group (CHIRAG), effectively rejuvenated approximately 100 springs in the Kumaon Himalayas by deploying para-hydrogeologist teams. Himmothan in Dehradun, in collaboration with Tata Trusts, launched "Mission Spring Revival" in Nagaland, scaling up the hydrogeology-based model. Through the Dhara Vikas & MGNREGS initiatives, the Rural Development Department of Sikkim Government rejuvenated 700 springs.

With the support of Tata Trusts, the Eleutherian Christian Society (ECS) in Nagaland has successfully demonstrated spring-shed management in more than 10 areas to improve water security. The Department of Soil and Water Conservation, Government of Meghalaya, has mapped 60000 springs has created a management plan for 5,000 springs spread over 11 districts. With the help of Arghyam, the Spring Initiative unites a range of stakeholders from the Himalayas, Eastern, and Western Ghats who are committed to fostering advancing knowledge, practices and policies related to spring-shed management in India. ACWADAM has provided both expert support and institutional strengthening, especially in hydrogeology and aquifer management (Kulkarni et al., 2021; Verma & Jamwal, 2022).

Rejuvenating springs in Nepal and other Himalayan nations is promoted and supported by the International Centre for Integrated Mountain Development (ICIMOD). In 2017, NITI Aayog established a working group focused on the 'Inventory and Revival of Springs of Himalaya for Water Security' to assess the scope of spring-related challenges through the examination of initiatives & best practices to shape policies and action plans. Numerous civil society groups (CSOs), government bodies, and academic/scientific institutions are currently involved in spring revival projects. An increase in spring discharge and a decrease in faecal coliform contamination are the results of such programs (Aayog, 2017; Siddique et al., 2019). Although there is a growing number of interventions, multiple challenges continue to impede their success.

Frequently, there are competing agendas among academicians, policymakers, and practitioners. Research on springs has been a deeply specialized subject, ignoring socio-economic dimensions while focusing on biophysical attributes. As a result, many research proposals are unable to deliver effective remedies. The spring-centric approach of present revival programs makes scaling up challenging. Precipitated water is lost from hilltops due to high slopes. By digging ponds, tanks, and trenches within spring catchments, water can be conserved and groundwater recharged. Soil erosion can be prevented through the cultivation of plantlets along these trenches. Lakes or ponds facilitate the restoration of spring aquifers, while artificial springs recharge can update the storage capacity of subterranean reservoirs.

Conducting fieldwork in the Himalayan areas is very challenging due to difficult terrain, inaccessibility, and the occurrence of landslides & floods. Additionally, there is a deficiency of spring information in India; at the moment, no comprehensive database exists for sites, type, discharge rate, or water quality of these springs. The main reason why data is not available is a lack of knowledge & awareness of utility (Aayog, 2017; Ranjan & Kumar Pandey, 2020; Verma & Jamwal, 2022).

VI. FUTURE PROSPECTS FOR SPRINGS CONSERVATION AND THE WAY FORWARD

There is an urgency of the crisis that needs to expand in the Himalayan region spring-shed initiatives by modernizing methods to tackle the convoluted challenges facing spring water resources is coming under as a result of evolving socio-economic conditions brought on by climate change and variability. An extensive, multifaceted approach is the only aspect of restoring, conserving and protecting springs.

Collaboration between various stakeholders like government departments, researchers & residents of the area is required, with a meaningful emphasis on enhancing the ability to build neighbourhood and grassroots institutions. Initiatives based on grassroots science initiatives involving the indigenous populations are commonly advantageous in bolstering stakeholders' awareness and facilitating comprehensive field surveys as well as long-term observation of the spring dynamics. Future research endeavours may be advanced through the inclusion of monitoring sites and continuous assessment and the use of data tools like Artificial Intelligence & Machine learning to evaluate urban populations' dependency on traditional springs.

Such new-generation technologies (remote sensing, sensors and data analysis) could be leveraged to enhance the accuracy & efficiency for monitoring water quality of springs. Emerging pollutants can be identified through the advancements in purification technologies. Regulations and guidelines for spring water quality assessment should be re-evaluated in the light of current scientific knowledge on spring water systems and response to climate change, land use change or other stressors. In light of current scientific knowledge on spring systems and their potential impact on stressors were rules, regulations and guidelines for spring water quality assessment should be re-evaluated and updated.

VII. CONCLUSION

Spring rejuvenation, development and protection initiatives will enhance the water availability and quality, promote socio-economic advancement, lessen the threat from water-borne diseases and safeguard the environment. Springs supply water for drinking, irrigation and maintaining the local ecosystem, and comprise the critical resources for Himalayan communities. However, their long-term sustainability has been jeopardized by unsustainable land-use practices, fragmented management approaches, and a lack of scientific understanding.

The findings of the study suggest that these aspects of life in the Himalayas are not mutually exclusive, but interlinked in this traditional context. The correlation between the local population's relationship with the land, its natural springs, and reverence for these resources is so crucial to their sustainability and overall well-being of the inhabitants. We also insist that the expenditure involved in treating the drinking water from other sources can be saved if springs are tapped, tied to water management setup, and sustainably managed. Therefore, protecting and restoring springs is not only an ecologically necessary but also a socio-cultural priority for promoting sustainable water security and robustness in the Himalayas.

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