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The Himalayan Springs: A Cultural and Religious connect

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Abstract

The springs of the Himalayas have long been recognized as essential resources for local communities, supplying fresh drinking water and serving various household needs. The glacial-fed rivers, flowing through profound gorges, are not been beneficial for water security and livelihoods in rural areas. Whereas, Springs are linked to a distinctive ecosystem that supplies water to communities and wildlife, fostering biodiversity in the area and influencing the landscape of the region.

The Himalayan Springs are currently experiencing an acute shortage due to mounting pressures from various factors. A significant number of springs are facing decline or reduced water flow as a result of climate change, deforestation, resource over-exploitation, and incoherent water management practices. It is crucial to implement community-based initiatives aimed at conserving and rejuvenating the Himalayan Springs through effective watershed management, rainwater harvesting, and sustainable agricultural practices.

Introduction

The Himalayas extend over a width of 250-350 km and a length of 2400 km, flanked by two significant structural features: Namcha Barwa (7782 m) to the east and Nanga Parbat (8125 m) to the west (Fig. 1). The Himalayas incorporate the Indo-Brahmaputra-Ganges Alluvial Plain with an average elevation of 200 meters to the south and the Tibetan Plateau, with an average elevation of 5000 meters in the north (Fig. 2). The collision between the indenting Indian Plate with the Eurasian Plate, no later than 57 million years ago (Leech et al., 2005, 2007; Singh, 2019), resulted in the formation of the Himalayas. The rise of the Himalayas has led to significant climatic transformations, influencing the onset of monsoons, the development of glaciers, and establishing the region as a major water tower of the world, often referred to as the third pole. The youngest and tectonically active Himalaya originated and evolved through a piggy-back style of shortening and thickening of the crust, resulting from the collision and ongoing convergence of the Indian plate with the Eurasian plate (Jain et al. 2002; Yin, 2006 and references therein) (Fig. 1). The Himalayan region has been divided into four distinct litho-tectonic units, arranged from north to south: the Tethyan Himalayan Sequence (THS), the Higher Himalayan Crystalline (HHC), the Lesser Himalayan Sequence (LHS), and the Sub-Himalaya (Jain et al., 2002; Yin, 2006; Singh et al., 2009, and references therein). The mountain belt exhibits a straightforward, curved, and cylindrical structure, representing the youngest mountain system globally, which renders it ecologically delicate and significantly susceptible to various threats.

The Himalayas serve as the origin of numerous significant rivers that are perennial, fostering the growth of human civilisations throughout history. The interplay of climate and human intervention over time has resulted in altering landforms, influencing the distribution of human settlements. Within the various river systems, three primary river systems stand out, interconnected by numerous significant tributaries. These rivers serve as a classic illustration of antecedent rivers, traversing through the Himalayan range via primary geologic structures (Montgomery and Stolar 2006) and post-date both metamorphism and the formation of collision-related structures (Singh, 2018). The river systems have played a crucial role in the erosion and transportation of substantial sediments originating from the Himalayan region, subsequently depositing them

in the foredeep basin located in front of the prominent mountain chain referred to as the Indo-Brahmaputra-Gangetic Alluvial Plain (Singh et al., 2010; Singh and Singh, 2020).

In addition to the Himalayan River system, which serves as a vital water source for the region and its plains, the Himalayan springs represent natural sources of fresh water that emerge from the Earth's surface as groundwater in the Himalayan area. Nonetheless, the majority of springs remain uncharted and lack systematic observation. The springs hold significant value, contributing to biodiversity and the preservation of natural vegetation. They play a vital role in managing surface runoff and are essential for the existence of mountain communities, supplying drinking water, irrigation, and water for livestock. In recent years, these springs have encountered several significant challenges, including reduced discharge and even complete drying. Additionally, pollution resulting from increased human intervention such as agriculture and tourism has led to the emergence of waterborne diseases within local communities. The absence of clear boundaries and the studies on their hydrogeological characteristics pose challenges to the planning of conservation and restoration initiatives. The swift pace of urban development, invasion of forested areas, and practices in agriculture that lack sustainability are contributing to diminished spring flow and the exhaustion of water resources.

Springs

The springs have spring-shed from where the water is channelized and retailed. It relies mainly on groundwater sources and their continuous flow from subsurface reservoirs. These reservoirs involve the infiltration of water into the ground via cracks, gaps, and unconsolidated materials, which replenishes the underground reserves, with the water eventually making its way to the surface. Springs play a crucial role in managing surface runoff and mitigating the risks of landslides.

Springs in the Himalayas play a vital role in supporting local agriculture, ensuring access to drinking water, and maintaining biodiversity in the area. While the majority of cultivated land relies on rainfall, approximately 64% of the irrigated regions in the Himalayas are supplied by springs (Wester et al., 2018). Advocating for water-efficient agricultural methods, including rain-fed farming, can alleviate the strain on spring water resources.

The springs are referred to by various names in different regions, including *Chashma* in Kashmir, *Naula, Dhara*, and *Simar* in Uttarakhand, *Khal, Dhan* and *Gul* in the Western Himalayas, *Mul* in Nepal, and *Kuan* in the Central and Eastern Himalayas. A *Naula* is a traditional water structure constructed from stones, featuring a porous floor that resembles a hut, which encompasses the spring and is regarded as a temple. These hold significant importance and are intricately linked to cultural and religious traditions. Rituals such as weddings and naming ceremonies exhibit significant interconnections. In the Kumaoun region, a newlywed bride performs a ritual prayer at *Naula* or *Dhara* upon her arrival at her husband's home, signifying profound respect for the community's water sources. *Khal* refers to a compact, confined channel or dam designed to gather water from a spring or stream. This water is subsequently redirected for multiple applications, including consumption, agricultural irrigation, and household use.

Certain communities in the Himalayas frequently dedicate springs to particular deities and engage in various rites and festivals that signify the beginning or end of the spring season. The rituals play a crucial role in safeguarding the springs, while also guaranteeing a plentiful supply of water for both agricultural and domestic purposes.

Spring water retention and the flora

The region adjacent to the spring, known as the riparian zone, typically exhibits significant biodiversity. The relationship between spring water retention and the plant life of spring-shed is profoundly interconnected. It operates as a reciprocal process: where water exists, plants thrive, and where suitable plants are present, water is retained. Springs ensure a reliable source of water. A variety of plant species have evolved

to flourish in habitats characterised by consistent moisture levels. Plants found in wetlands, including mosses, ferns, and certain grasses, frequently flourish in proximity to spring-fed streams or wetland areas. In wetland areas, water movement decreases, facilitating enhanced absorption into the soil, which in turn supports the growth of plant life. Spring water frequently contains minerals and nutrients that enhance the adjacent soil. Over time, this can foster a rich ecosystem, promoting a wide variety of plant species. Additionally, springs typically sustain a fairly stable temperature year-round, thereby establishing microhabitats for plant species that might struggle to thrive in areas with considerable temperature variations.

The deodar (*Cedrus deodara*), commonly referred to as the Himalayan cedar, is an important tree species indigenous to the mountainous areas of the Indian subcontinent, particularly the Himalayas. It is a perennial conifer recognised for its impressive stature and the significant ecological function it serves. Deodar trees engage in various interactions with their surrounding ecosystem that can significantly affect moisture retention and soil stability. The extensive root system of the deodar tree plays a crucial role in preventing soil erosion. Through the stabilisation of soil, these trees effectively minimise surface runoff and promote water retention, facilitating the infiltration of moisture deep into the ground. The thick canopy of deodar trees offers substantial shade, which lowers evaporation rates from the soil and aids in maintaining moisture levels in the surrounding soil, thereby supporting the growth of plants in the understory and other vegetation. When these trees are fertile, they offer enduring ecological advantages, such as sustaining a healthy water cycle via transpiration and contributing to the overall moisture equilibrium in the environment. The presence of sterile or non-reproducing trees could have implications for long-term sustainability, potentially resulting in decreased forest cover, which may impact local water retention. In mountainous watersheds, deodar trees play a crucial role in managing water flow. The roots of the tree play a crucial role in maintaining stable groundwater levels, thereby supporting the springs and local water sources. The capacity to absorb water from precipitation and subsequently release it in a controlled manner plays a crucial role in sustaining the flow of adjacent streams and rivers, thereby mitigating abrupt fluctuations or periods of dryness. The Deodar meadows create a unique microclimate, and to protect these communities, it is essential to designate them as sacred spaces. This ensures that the microclimates formed in these areas remain undisturbed. A prime example of this is the Tarkeshwar Mahadev temple located near Lansdowne in Uttarakhand. The absence of these factors results in heightened soil erosion, intensified surface runoff, and a reduction in water retention.

The Oak trees, especially the common oak (*Quercus robur*) and white oak (*Quercus alba*), serve as vital elements within numerous temperate ecosystems and significantly contribute to water retention. Oaks possess various traits that contribute significantly to their ability to retain moisture in the soil and sustain healthy ecosystems. Oak trees possess extensive and deep root systems as well that can reach far into the soil. This contributes to the preservation of soil structure by mitigating erosion, especially in regions susceptible to intense rainfall or slope-related erosion. Their extensive root systems enable the absorption of water from deeper soil layers, thereby enhancing the land's overall capacity for water retention. The root system of oak trees establishes pathways in the soil that enhance water infiltration. This facilitates the penetration of rainwater or irrigation into deeper soil layers, thereby aiding in the preservation of groundwater levels. This process also mitigates surface runoff by enhancing soil permeability, thereby promoting water retention within the landscape. The shedding of Oak trees in autumn results in a substantial accumulation of organic matter on the forest floor. The accumulation of leaf litter serves as an organic mulch, effectively aiding in the retention of soil moisture. The application of mulch effectively minimises evaporation, maintains a consistent soil temperature, and facilitates deeper infiltration of rainwater into the soil profile. Oak forests play a significant role in water retention, not just through their biological

processes but also by affecting the dynamics of adjacent streams, rivers, and groundwater. The thick oak canopy captures rainfall, decelerating its descent to the earth and facilitating greater water absorption into the soil, thereby mitigating swift runoff. In numerous areas, oak trees flourish in proximity to wetlands, which frequently serve as zones with significant water retention. The roots of oak trees in these environments play a crucial role in regulating water levels by absorbing excess moisture during wet periods and gradually releasing it during drier times. The elimination of oak trees via deforestation or land development can result in a notable reduction in the soil's ability to retain water. The absence of oak trees leads to an increased risk of soil erosion, elevated evaporation rates, and heightened surface runoff, all of which diminish the soil's capacity to hold moisture.

Chir pine trees in the Himalayas exhibit a range of both beneficial and detrimental impacts. Chir pine trees, widely used for timber and resin, display invasive characteristics (Kumar et al., 2013; Pant & Tewari, 2015; Nautiyal, 2015; Negi, 2019; Das et al., 2019). The Chir forests exhibit a remarkable capacity for regeneration on degraded soils, facilitating natural expansion via seed dispersal from a young age, with significant seed production taking place each year (Sinha, 2002). The seed has a lower weight than other species, such as the Himalayan cedar (*Cedrus deodar*), and is easily carried by the wind (Sinha, 2002). At present, Chir pine has proliferated across the mid-hills, effectively encroaching upon oak forests at elevated altitudes, mixed forests at lower altitudes, and areas that have been disturbed (A. Nautiyal, 2015; Sinha, 2002). Their highly flammable needles, combined with the prevalence of dry, pre-monsoon conditions, also play a role in contributing to forest fires. Fires have the potential to diminish soil nutrients and modify soil structure, which can affect the long-term health of the ecosystem. Additionally, they adversely influence the understory vegetation, leading to a decrease in both the diversity and abundance of plant species (Kumar et al., 2013). These species are classified as invasive, hindering biodiversity and contributing to the decline of grassland ecosystems. Chir Pine forests are characterised by shallow root systems, and the forest floor is often blanketed with pine needles. These needles have a waxy texture that impedes water infiltration and contributes to a decrease in spring water flow. The dense accumulation of pine needles and their resin content restricts the growth of undergrowth and enhances surface runoff, thereby diminishing the likelihood of water infiltrating the soil. As a result, their ability to recharge groundwater and support springs is less effective compared to broadleaf forests, like oak forests.

Conservation and Rejuvenation

Conservation and rejuvenation of the springs in the Himalayas is crucial for sustaining ecological equilibrium and supporting the livelihoods of millions of people reliant on these vital water sources. Comprehending the geological and hydrological characteristics of springs is crucial for effectively planning a recharge area, considering flow patterns and seasonal fluctuations.

Local communities play a crucial role in the conservation of springs. Engaging communities in initiatives that empower individuals to monitor and manage their local springs can enhance the effectiveness of rejuvenation efforts. The process entails fostering awareness and educating communities about sustainable practices in land and water management, as well as creating water user associations dedicated to the fair distribution and safeguarding of water resources.

The rejuvenation can be accomplished through a range of strategies across the entire spring catchment areas, including the implementation of recharge structures such as check dams, pits and contour trenching, as well as recharge wells, tanks, soil conservation efforts, the promotion of rainwater harvesting, and the restoration of natural vegetation. These measures aim to enhance infiltration, safeguard the soil from degradation, and foster water absorption. The presence of forest cover is essential for regulating water flow and reducing soil erosion within the catchment area. Planting trees, particularly in the catchment zones of springs, contributes to

enhanced water retention and recharge. Spring-shed requires suitable land use and land cover planning to facilitate the natural recharge of rainwater into the springs.

Gully plugging serves as a crucial method for constructing barriers that mitigate erosion in hilly areas, thereby decreasing sedimentation that obstructs springs. Small check dams effectively reduce water flow, providing additional time for water to infiltrate the soil, thereby replenishing underground aquifers. Recharge pits are excavated near springs or regions with elevated water flow, facilitating the movement of water to replenish the underlying aquifers.

The regulation of land use, encompassing urbanisation, construction, and infrastructure development, ensures the preservation of the natural water cycle.

The traditional practices of spring recharge in the Himalayan region serve as a vital link between local communities and their natural surroundings. Numerous communities have employed traditional recharge methods such as stone *spouts, kuls, ghads* (irrigation channels), and water temples. Revitalising and modernising these techniques presents a sustainable approach to spring recharge. In times of water scarcity, conventional approaches to water rationing have been employed, including the limitation of water flow to specific areas according to seasonal demand. At elevated altitudes, springs frequently emerge from substantial natural wells, or *Jhee*l. Communities meticulously oversee these springs, utilising indigenous knowledge to build barriers and pathways that direct water flow while preventing over-extraction. In certain villages, it is the duty of community leaders to oversee the protection and sustainable use of the well.

Terrace farming represents a prevalent agricultural technique in which farmers construct stone or mud walls to establish level plots. These methods are referred to as *khattas* or *pats*. The implementation of these terraces effectively mitigates soil erosion while enhancing the soil's capacity for water retention. Well-managed terraces effectively reduce the speed of water movement downhill, facilitating the recharge of springs and ensuring a steady flow of water. The departure of individuals from the hilly region results in the neglect of agricultural land, consequently disrupting terrace protection and contributing to soil erosion and the depletion of spring recharge.

In Uttrakhand, many villages formed *Pani Panchayat* to revitalise traditional community water management, resulting in the effective restoration of springs. The major outcome of the restoration and reclamation of the springs was community engagement in local stewardship to ensure sustainable usage and conservation, integrating traditional knowledge with modern technology for optimal outcomes. The project has included the cleaning of spring outlets, the reinforcement of stone barriers, and the protection of adjacent woodlands. Increased spring discharge facilitated continuous irrigation, allowing the population to cultivate crops in a delicate ecosystem.

Conclusions

Springs occur due to the infiltration of water into the soil, which facilitates the replenishment of aquifers. The waters are distributed through the appropriate flora and ecosystem of the region, gradually making their way to the surface over time. The retention of spring water is crucial for sustaining local plant life, as it ensures consistent moisture, enhances soil nutrient levels, and fosters a balanced ecosystem. Springs serve as critical areas for biodiversity, nurturing plant species that have evolved specifically to thrive in a consistently moist environment.

Approximately 25% of active springs have transitioned from perennial to seasonal status as a result of human activities. This shift is impacting the delicate ecosystem and contributing to the depletion of these springs, highlighting the urgent need for conservation and rejuvenation efforts. The integration of sustainable water management practices with active community involvement has the potential to preserve and revitalise the health of the Himalayan Springs.

The revitalisation of Himalayan springs necessitates a comprehensive strategy that encompasses ecological restoration, active community involvement, sustainable land management practices, and robust policy

backing. Through dedicated efforts and partnerships among local communities, experts, and governmental bodies, the springs in the Himalayas can be rejuvenated to guarantee that these essential water resources persist in supporting the region's ecosystem and its inhabitants. Educating the general public about the significance of spring recharge, water conservation, and sustainable practices is crucial.

Deodar trees significantly contribute to water retention due to their extensive root systems, the shade they provide, and the organic matter they generate. Healthy and fertile trees play a crucial role in maintaining ecosystem stability, improving soil water retention, and supporting the local hydrological cycle. Nonetheless, when deodar trees reach a state of sterility, it may impact their ability to reproduce and the long-term ecological advantages they provide. Furthermore, any type of deforestation or degradation of deodar forests can interfere with water retention processes, resulting in ecological instability. Oak trees play a significant role in enhancing water retention due to their extensive root systems, canopy structure, leaf litter accumulation, and contribution to the local water cycle. Through the stabilisation of soil, reduction of evaporation, and enhancement of soil structure, oak trees play a crucial role in preserving moisture within the environment.

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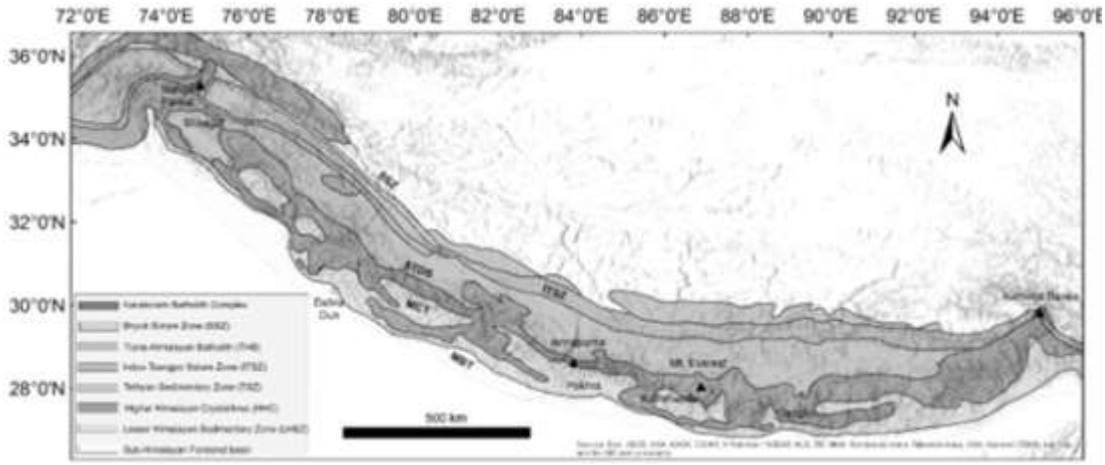


Figure 1: Geology and Tectonics of the Himalayan Collision Zone (figure taken from Singh, 2019)

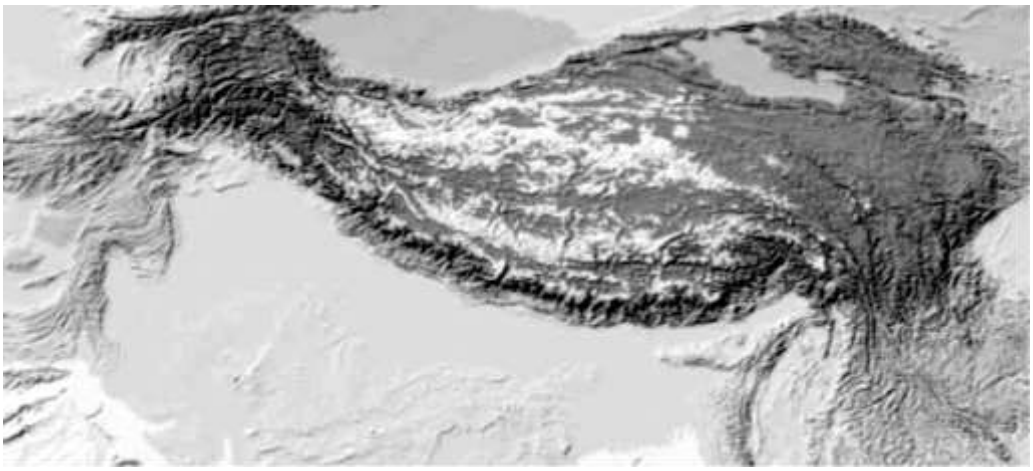


Figure 2: Raised map of north India, Himalayas and Tibetan Region