Inventorization of Spring Water Resources in mid hills of Himachal Pradesh, India

ABSTRACT

The study on spring inventory was conducted in the mid hills of Himachal Pradesh, India where 43 springs were inventoried in the Beas catchment area. Hydrogeological characteristics, such as geology, slope, aspect, elevation, rock and soil distribution, landuse, geomorphology, and spring discharge were utilized to access the condition of springs in the study area. The study showed that 40.12% of the springs have seen a drop in water flow and compared to the previous times, the water flow has increased in 4.85% of the springs. A total of 56% of spring is located in the forest, 32% in Agriculture land, 3% in grassland, 6% in Shrubland, 2% in built up area, 1% in barren land. 65% are depression springs, 28% are fracture springs, and 7% are contact springs. 2.32% of the spring sources had discharge rate <0.05 Lmin^{-1}. 79.06% of the springs have average discharge rate of 1-10 Lmin^{-1}. Rest of the 11.60% of the springs have discharge rate ranged from 10-25 Lmin^{-1}.Most of the springs are fed by annual precipitation and those located near the Beas valley are supported by river water course.

Key Words: Spring water, Inventorization, Mid hills, Seasonality, Discharge rate, Landuse.

1. INTRODUCTION

Natural water springs are the places on Earth's surface where groundwater emerges. This happens when groundwater rises to the surface as a strong flow or trickle via porous rocks and soils. Natural water springs are regarded as significant sources of drinking water and are frequently prized for their purity [1]. In addition, a lot of people go to springs for their therapeutic properties. Furthermore, springs can support the general health of nearby ecosystems and serve as crucial homes for a range of plant and animal species. Where an aquifer or water-bearing layer meets the earth's surface, natural groundwater flow emerges through joints, pores, fissures, and cracks to generate natural water springs [2].The orifice of spring is the location where water first appears. In these areas, springs provide the primary source of clean freshwater for the Himalayan inhabitants. Over 60–70% of the population in the Indian Himalayan region directly depends on springs to meet their demands for domestic and agriculture purposes.

Mountainous aquifer systems are under tremendous strain due to unpredictable rainfall patterns, ecological deterioration, and seismic activity brought on by changes in land use and cover for infrastructure development [1, 3].According to reports, half of the perennial springs have either dried up or turned seasonal, severely reducing the amount of water available for domestic use, including drinking, in hundreds of settlements throughout the Himalayas. Continued crisis will consequently affect millions of people in the mountainous regions [4]. Thus, it is determined that a thorough and accurate spring water inventory is required in order to guarantee that appropriate management is carried out in order to enhance sustainability. Since anthropogenic causes are reducing spring water supplies, it is crucial for future planning and management to inventorize spring water bodies, their quality, availability for use, and identification of other threats for their decline [5, 6].Therefore this study would inventorize the spring water sources in mid Himalayas for sustainable water resource management, ensuring community access to clean water and safeguarding fragile ecosystems, preserving biodiversity, and enhancing resilience to climate change impacts.

2. MATERIAL AND METHODS

2.1 Description of the study area

Mandi district is one of the major regions in mid hills of Himalayas. Mandi district is a densely populated and centrally located district of Himachal Pradesh. The district is entirely hilly, except a few isolated patches of small and fertile valleys. The district, with its headquarter at Mandi town, lies between 31°13' and 32° 05' north latitudes and 76°37' and 77°25' east longitudes and is covered by Survey of India degreesheet no 53A, 53E and 52D. The district is bounded by Kangra district on the northwest, Kullu district on the east, Shimla and Solan districts on the south and southwest respectively, Bilaspur and Hamirpur districts on the southwest. The climate of the district is sub-tropical in the valleys and tends to be temperate near the hilltops. In the higher region, the climate remains cold throughout the year. In winter snow often comes down to 1300 m amsl. Normally, it starts melting from the end of March from places lying below 3300 m. In summer, the whole Balh valley and other low altitudes are quite hot.

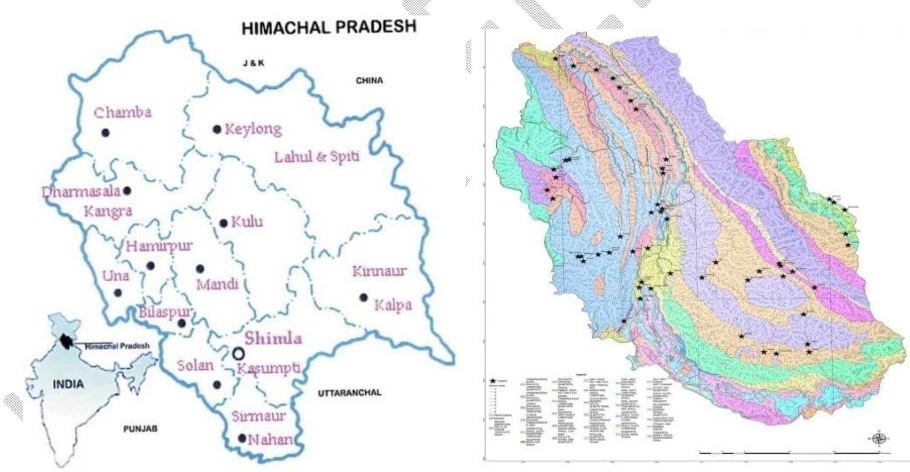

Fig. 1 Location map of the study area

2.2 Collection of Data for Inventory

A thorough district survey was carried out to inventorize (using both in-person interviews and pretested proforma) the spring water resources in the area. The Deputy Commissioner Office, Block Development Office, the Mid-Himalayan Watershed Development Division, the District Watershed Development Agency, Municipal Corporation Office, District Water Testing Laboratory, and each panchayat office were the places from which the secondary data was gathered from official certified records that were kept by these offices/departments. Additionally, pertinent information was gathered from census records and the HP Government websites.

The study was conducted during Pre and Post Monsoon seasons of the year. A geological hammer, burton compass, GPS (Garmin 64s), diluted hydrochloric acid (HCL), and water discharge measurement device were among the tools used to gather data. The procedures utilized in the analysis of spring inventory composites are depicted in the flow chart.

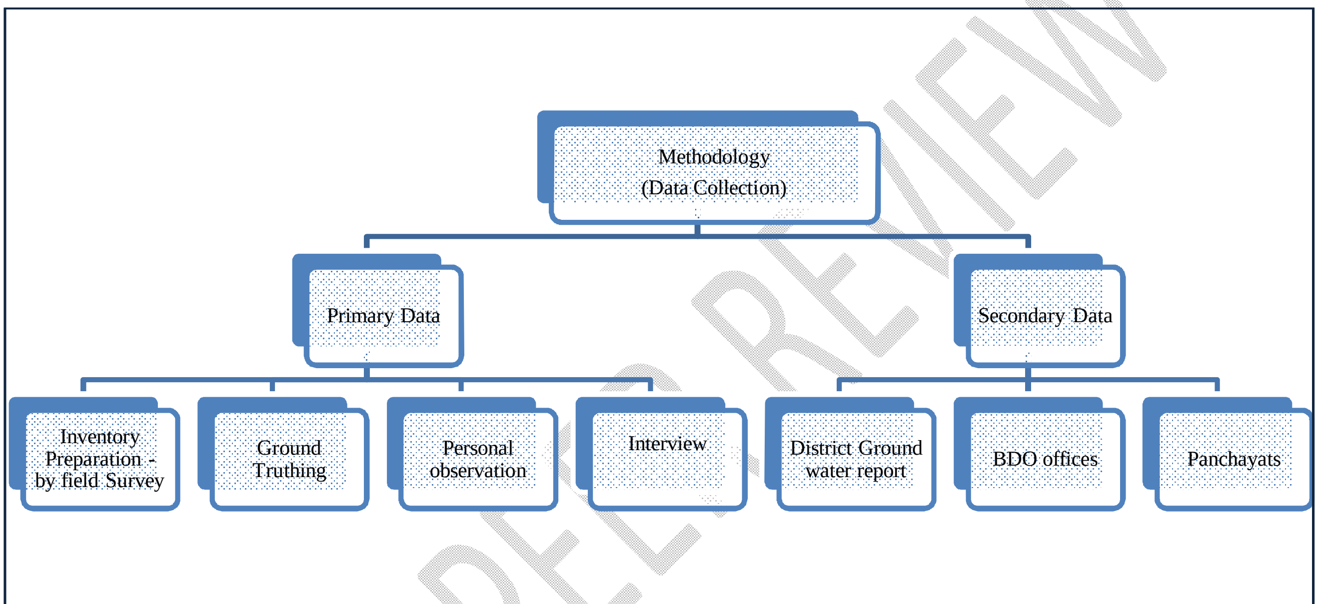

Fig. 2 Methodology

The spring inventory is carried out in the field to identify existing spring sources, type of spring, the type of rock, and, the discharge measurement. The volumetric approach was utilized to gauge the spring's discharge rate using a bucket and timer. A questionnaire survey was conducted in order to gather more data regarding the spring and its applications. After collection of data, the data has been analyzed through maps and diagrams. Data analysis has been done by Microsoft excel software and mapping by Arc GIS 10.4.1and Q-GIS 2.18 software.

3. RESULTS AND DISCUSSIONS

This study assessed the existing water availability, uses and its impacts on watershed hydrology in Beas catchment. The primary focus of the study was to locate and map existing spring sources and their status in terms of water discharge, uses, and their discharge trend. A total number of 43 springs (Figure 3) were spread across the Beas catchment.

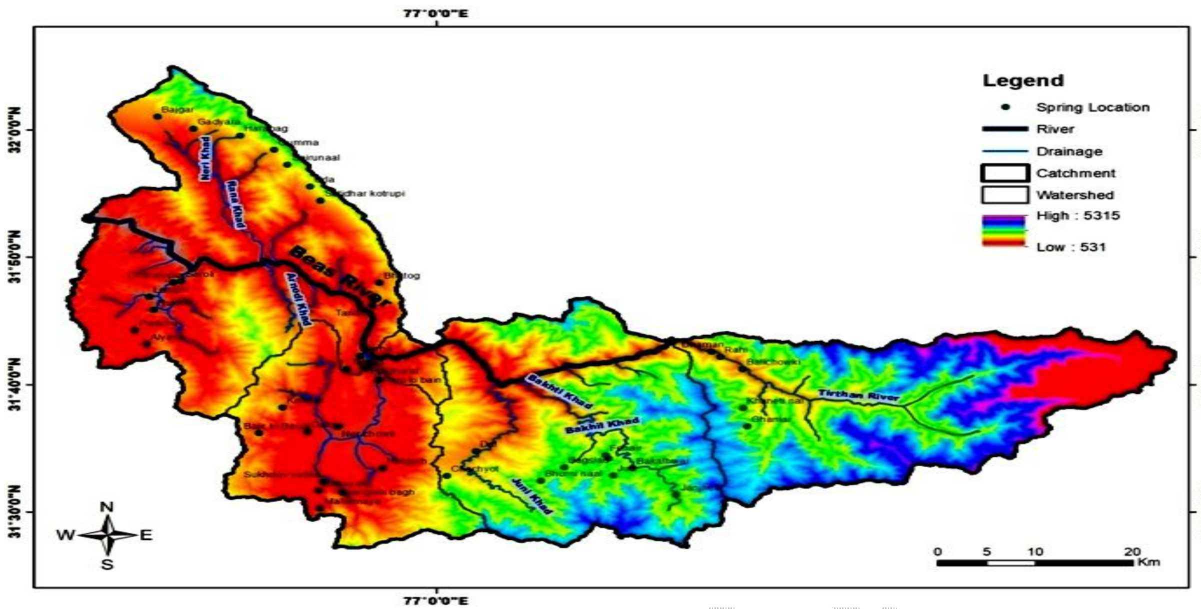

Fig 3 Beas Catchment map of showing location of springs

a. Seasonality of springs

The perennial springs with found in the research area are depression, fracture, and contact springs. When compared to the flow of previous years, it was discovered that the water discharge in most of the springs was declining. About 40.12% of the springs have seen a drop in water flow. In 52% of the springs, the flow of water is unchanging. Compared to earlier times, the water flow has increased in 4.85% of the springs, and 3.03% have totally dried up.

3.2 Types of Spring

Spring results from an aquifer being filled to the point that the water overflows onto the land surface. Most of the springs in that study area flow annually through the Beas River, while few dry periodically. Based on spring classification of (Bryan, 1919), 65% are depression springs, 28% are fracture springs, and 7% are contact springs (Figure 4). The depression types of springs are distributed chiefly in the alluvial deposits, consisting of gravel to sand particles overlying the bedrocks. The jointed and bedding plane of impervious rocks is represented by a fractured spring. A contact spring emerges at contacts where relatively permeable rocks overlie rocks of low permeability.

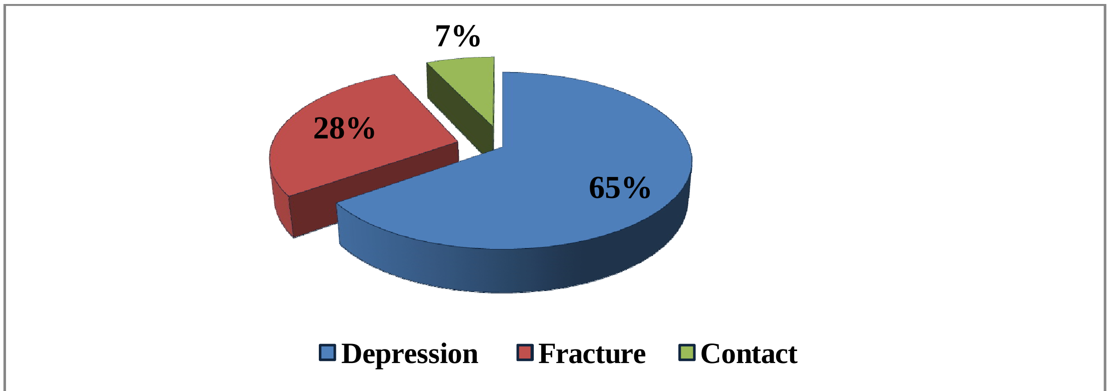

Fig 4 Types of springs in the study area

3.3 Landuse

The landuse map was prepared from the Data elevation model (Fig 5). Six landuse classes have been identified in the area: forest, agriculture land, grassland, shrubland, built-up area, and barren land. A total of 56% of spring is located in the forest, 32% in Agriculture land, 3% in grassland, 6% in Shrubland, 2% in built up area, 1% in barren land (Figure 6).

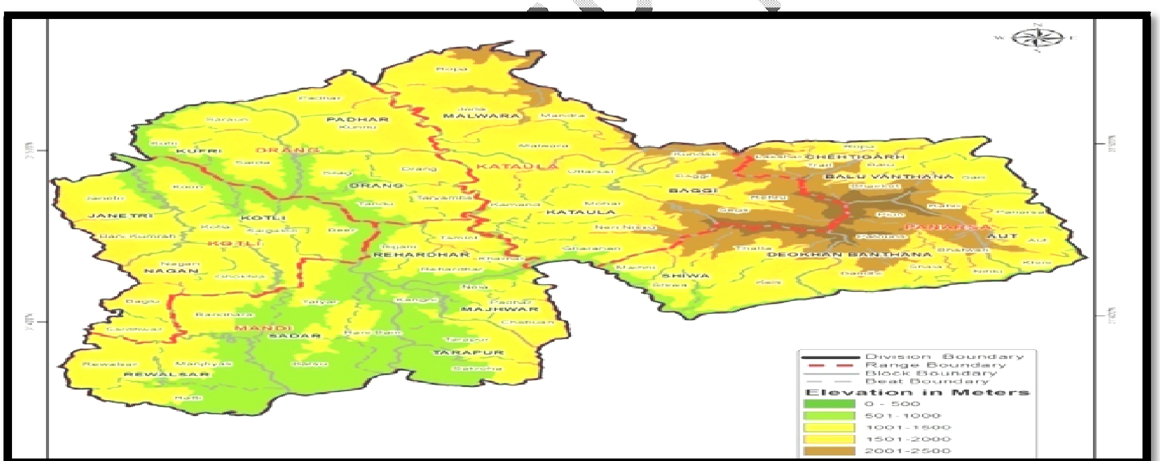

Fig 5 Digital Elevation map of district

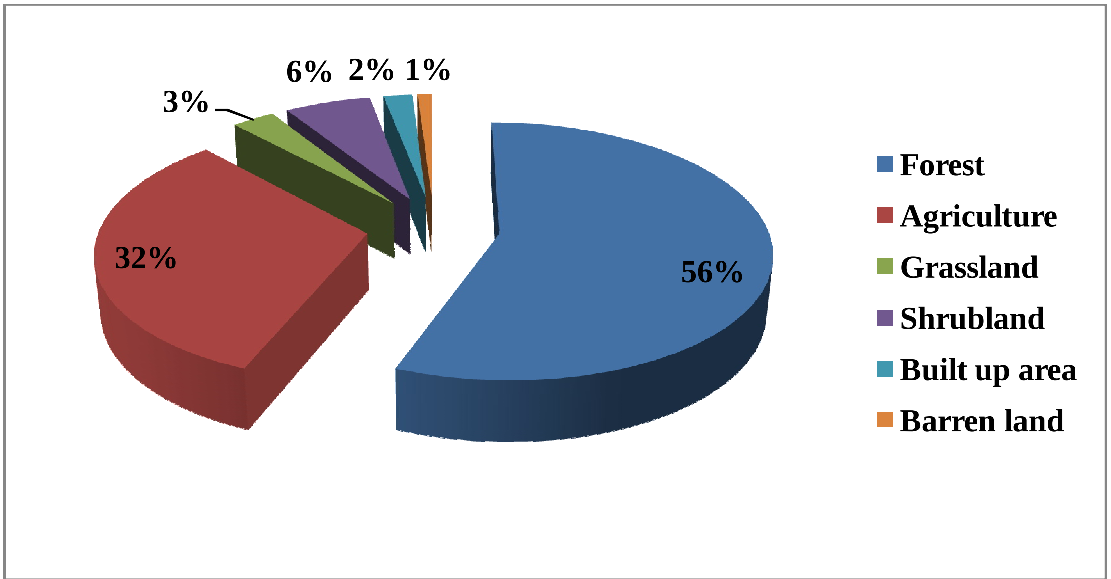

Fig 6 Springs under different landusein the study area.

The majority of the area is comprised of forest and agricultural land. The cultivation lands are an excellent site for groundwater percolation due to porous soil, but it depends on soil type [7,8]. Forest and grassland are classified under good groundwater prospects keeping in mind that these areas are generally water percolation through loose soil due to the primary root zone on the soil.

3.4 Engineered structure of spring sources

The condition of the spring at the source was observed (Fig 7). About 40% of the springs are open springs, 34% are concrete tanks, 12% are spring boxes and 14% are stone spouts. Since ancient times, people have utilized the most popular and affordable method of gathering water from opens springs in mountainous places. However, the available springs may get contaminated with germs, garbage, and other contaminants. To preserve spring water, though, the people have built concrete tanks or buildings in recent years.

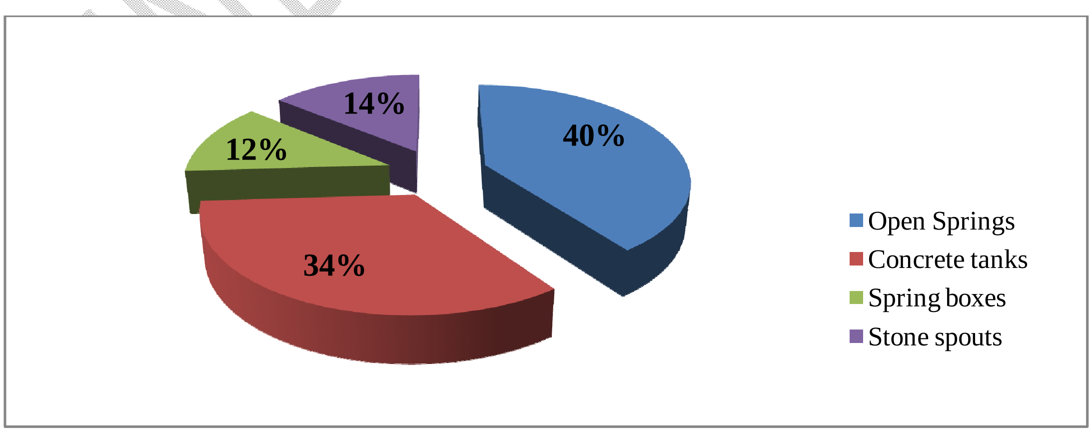

Fig. 7 Structure of spring sources

3.5 Spring water usage

Springs are the only dependable source of water supply in the villages as not all villages have access to an improved water supply system. In the past, springs provided sufficient water for their basic requirements, and local people observed that the rainfall has drastically declined over the past two decades [9]. However, in recent years, villagers have been facing a water shortage, and their springs are not producing sufficient water for their day-today activities The underlying causes of water scarcity includes over growing population pressure, landuse changes, infrastructure development, increased water demand, the introduction of modern technology, and the negative impacts of climate change [10,11]. Similarly, due to increasing transportation facilities, people made it an easy method to use water. They had to travel a long distance to bring water previously, but the people of this area made water storage concrete tanks and collected water using pipes from the distant river and distributed it to all the Hamlet. It was observed (Fig 8) that about 30% of water is used for drinking, 20% for irrigation, 19% for religious purpose (sacred groves), 18% for livestock population and 13% for other household purposes.

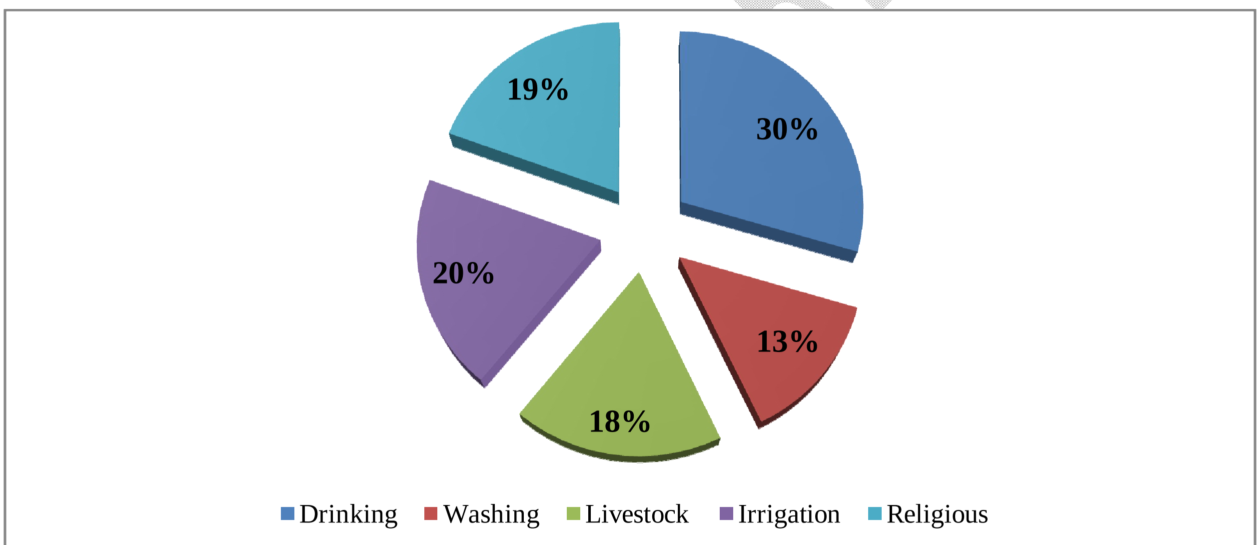

Fig 8 Spring water usage

3.6 Spring discharge dynamics

Measuring spring flow is another way of characterizing a spring's overall condition. The rate of water flow from the spring will vary with the seasons. The spring water discharge has been measured in pre and post monsoon of the year. 2.32% of the spring sources had discharge rate <0.05 $Lmin^{-1}$. 6.97% spring water sources had discharge rate in the range of 0.1-0.5 $Lmin^{-1}$. 79.06% of the springs have average discharge rate of 1-10 $Lmin^{-1}$. Rest of the 11.60% of the springs have discharge rate ranged from 10-25 $Lmin^{-1}$ (Fig.9).

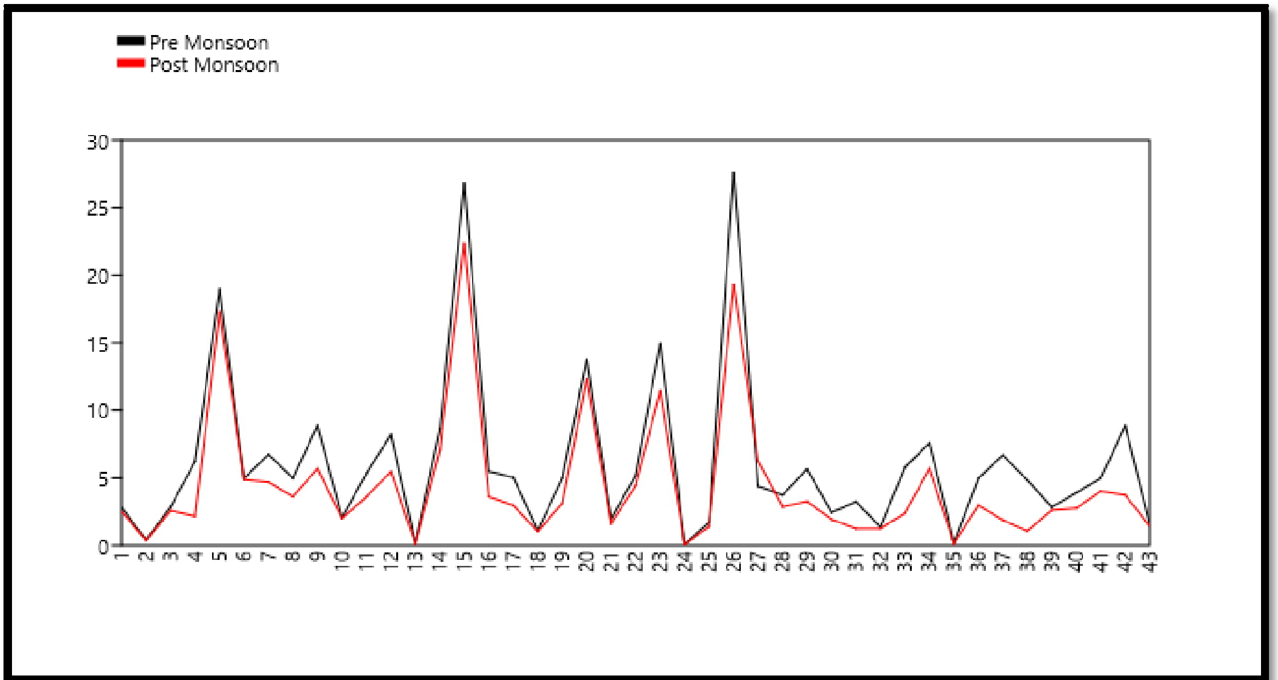

Fig 9 Discharge rate of springs

Managing thesespring can solve the problem of water for the growing population that community [7]. The spring discharge is the effect of geology, soil, vegetation, and soil [12, 13, 14]. The analysis of water discharge showed that about 10% of the springs have low discharge rate. Water level of spring is in decreasing trend as per survey reports. To fulfill the requirements of the rural and urban community's revival of these natural resources is very crucial. The amount of rainfall was trending downward, which supported people's beliefs and—most importantly—the Significant annual variations in rainfall have varying degrees of impact on the spring sources each year [15,16,17]. The disappearance of customary ponds, lakes, and wallows due to tectonic movement, as well as concreting and piping of sources, were other possible reasons that contributed to the drying out of springs in addition to variations in rainfall [18-21].

3.7 Major threats to springs in the study area

Reduction of the soil's natural water retention capacity due to agriculture, construction, and infrastructure development in the study region results in a decrease in the recharge of aquifers that sustain springs. The research area is experiencing rapid urbanization and construction, which is upsetting natural hydrological cycles and reducing the amount of water available in springs through increased surface runoff and decreased infiltration. Groundwater supplies can be depleted and springs may dry up as a result of unsustainable spring water extraction for domestic, industrial, and agricultural uses. Pollution from agricultural runoff, industrial activities, and domestic sewage is another major contaminant of spring water sources, rendering them unfit for consumption and agricultural use.

The current study provides a field condition of spring water occurrence and may be used for in-depth groundwater exploration, which satisfies the needs of local communities. The present research suggests the following actions in the future:

- Source Protection: Implement measures to protect the source area of the spring from contamination, such as pollution from agricultural runoff, industrial activities, or improper waste disposal [22],[23]. This may involve establishing buffer zones, controlling land use, and implementing regulations to safeguard the surrounding environment [13].
- Monitoring and Assessment: Regularly monitor the flow rate, water quality, and ecological health of the spring and its surrounding watershed. This data can help identify any changes or threats to the spring water resource and inform management decisions.
- Conservation: Promote water conservation practices to reduce excessive water use and maintain sustainable levels of spring water extraction. This may include implementing water-saving technologies, promoting efficient irrigation methods, and raising awareness about the importance of water conservation[24],[25],[26].
- Regulation and Governance: Develop and enforce regulations and policies governing the use and protection of spring water resources. This may involve establishing permits or licenses for water extraction, setting limits on withdrawal rates, and enforcing penalties for violations of water resource regulations [9].
- Community Engagement: Engage local communities and stakeholders in the management of spring water resources. Encourage community participation in decision-making processes, raise awareness about the importance of spring water conservation, and promote sustainable water use practices.
- Restoration and Rehabilitation: Implement measures to restore and rehabilitate degraded spring ecosystems [4]. This may involve reforestation efforts, erosion control measures, and habitat restoration to improve the health and resilience of spring water sources and surrounding ecosystems.

CONCLUSION

The comprehensive inventory of spring water resources in the mid hills of Himachal Pradesh is instrumental in understanding the intricate dynamics of these vital water sources. By meticulously cataloging the location, discharge rate, and usage of springs, this endeavor enables a deeper comprehension of the region's natural landscape. Such detailed information serves as the cornerstone for formulating evidence-based policies and interventions aimed at sustainable water resource management. It allows stakeholders to identify potential threats to these springs, such as pollution, over-extraction, or changes in land use, and to devise targeted conservation measures accordingly. Moreover, the inventory facilitates equitable access to water resources by ensuring that marginalized communities, often reliant on springs for their water supply, are not left behind in development initiatives. By fostering collaboration between government agencies, local communities, and research institutions, it promotes participatory approaches to water governance that prioritize both environmental sustainability and socio-economic well-being. Ultimately, the inventorization of spring water resources in the mid hills of Himachal Pradesh serves as a blueprint for integrated water resource management, balancing the needs of present and future generations while safeguarding the ecological integrity of this fragile Himalayan ecosystem.

FUTURE SCOPE

In future springshed revival plan implementation, assessment and monitoring of various other groundwater resources can be done.

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