CHAPTER: 06

INCLUSIVE SPRING SHED DEVELOPMENT FOR SUSTAINABLE WATER SECURITY IN INDIAN HIMALAYAN REGION

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***DOI:* https://doi.org/10.52458/9788196919535.nsp2024.eb.ch-06**
Ch.Id:- IIHMR/NSP/EB/USCIDI/2024/Ch-06

ABSTRACT

The Indian Himalayan Region (IHR), known as the water tower of Asia, confronts emerging water scarcity issues despite its perceived abundance. Home to over 75 million people, their lives hinge on groundwater from springs and streams rather than major rivers. Climate change, urbanization, deforestation, and altered land use patterns contribute to the diminishing perennial water sources, exacerbating drinking water availability challenges. Micro-studies reveal groundwater quality concerns, amplified by mountainous constraints. A pivotal response to this is engaging with natural processes for local groundwater regeneration. People's Science Institute (PSI) Dehradun, has successfully rejuvenated 1000 plus springs across ten IHR states benefitting 14,000 plus households. This work embodies a scientific and inclusive approach, addressing water scarcity through fundamental rights recognition, gender sensitivity, cultural preservation, community empowerment, and adaptive localized strategies. PSI's impactful interventions underscore the imperative of safeguarding water security in IHR and serve as a model for sustainable development in challenging terrains.

Keywords: *Water-scarcity, Springs shed, Ground water, Rejuvenation, Himalaya.*

INTRODUCTION

The mountain springs are groundwater sources which emanate from unconfined and confined aquifers (Tambe, et.al., 2011). Springs are the primary source of water for rural households in the IHR. These springs are known as *dhara, mool, kuan* in the central and eastern Himalayas and *chashma* and *naula* in the western Himalayas. Almost 80 percent of the water supply schemes are also spring based. Although there are Himalayan rivers but the water from these rivers is not readily accessible to the densely populated villages and towns in the mid-hills (900 – 2000m). These fast-flowing rivers cut deep gorges and flow several hundred meters below, while the glaciers are far above this critical eco-zone of the mid-hills. Therefore, the communities depend on rain-fed springs and streams for meeting their water requirements. Despite the key role that they play, springs have not received their due attention. Most of these sources are becoming seasonal or have dried up due to increased water demand, changing land use patterns, ecological degradation, and erratic trends in precipitation. leading to severe local water scarcities. Bacteriological contamination of springs is also a major problem. Lack of knowledge, understanding, and awareness of springs has further compounded the problem while also inducing elements of conflicts and haphazard development. There is, hence, an urgent need to restore, revive and sustain springs involving the local communities. People's Science Institute (PSI), a research and development organization based in Dehradun has been working on watershed and spring shed management in the IHR for the last two decades. The sustainable approach that it applies on the ground is based on the principles of Participatory Groundwater Management (PGWM). Spring shed development based on this approach, can help enhance rainfall infiltration into the ground, recharge springs, revive dysfunctional traditional water harvesting systems, moderate flood peaks and recharge streams and rivers. This chapter discusses the process of inclusive spring shed development for sustainable water security in the IHR along with measurable impacts and challenges to overcome.

BACKGROUND

a. Magnitude of the problem

A large section of the population of the Himalayan Region depends on natural spring water for fulfilling their domestic and livelihood needs such as drinking water, sanitation and irrigation. The dependency of majority of the population on spring water implies that with changing climatic conditions and rainfall pattern, a large number of villages, hamlets and settlements are facing potential drinking water shortage. In fact, half of the perennial springs have already dried up or have become seasonal and thousands of villages are currently facing acute water shortages for drinking purposes.

What is even more important to note is the fact that while glaciers are easily considered to be the source of the mighty Himalayan rivers, most of them are fed by springs. The non-glacial rivers clearly show how hundreds of springs provide the flows in stream and river channels even during the dry season. Any significant depletion in such spring flows at river origins will surely impact the flow of rivers. Hence, a high dependency on one hand and an increasing sensitivity to depletion on the other, make Himalayan springs a source that has become greatly vulnerable in the current context, despite their being part of a strong heritage, tradition and culture in the region. It becomes important to recognise spring water depletion as a nationally pertinent problem and to address it straightaway through preventive and corrective measures.

b. Initiatives for spring rejuvenation

Research Studies: Spring studies have been reported in the past by several researchers. They have shown that spring discharge depends on the rainfall pattern, vegetative cover and the geomorphology of the recharge zone (Valdiya and Bartarya 1989, 1991; Negi and Joshi 1996, 2004). They have attributed the drying of springs to changes in rainfall and land-use patterns, deforestation, forest fires, soil erosion, etc. These changes primarily limit the infiltration of rain water to recharge ground water.

The issue of rapidly drying mountain springs has also been addressed in more popular environmental literature (Agarwal and Narain, 1997). For fresh water supplies, groundwater in the form of springs has been the traditional and conventional source for the rural communities as well as for peri-urban and urban areas of Himalayan region of Indian subcontinent (Singh et al. 2014). There are also reports on scarcity of potable water in mountainous regions of Himalayas (Singh and Kumar 1997; Shivanna et al. 2008). Drying up of springs is more frequent in Himalayan region and even the perennial springs show an alarming decrease in the discharges (Valdiya and Bhartiya 1991; Shivanna et al. 2008; Ravindranath et al. 2011; Tambe et al. 2011). In addition to quantity issues, the spring water quality has also been reported to be declining due to anthropogenic factors and needs to be treated before using for domestic purposes (Nair et al. 2015). This is largely attributed to inadequate treatment facilities for water and wastes that are consequent pollutants and transmit waterborne diseases.

Efforts on ground: Several efforts like watershed development and the creation of spring sanctuaries have been used in the past for reviving springs. The Union Ministry of Rural Development's nationwide Integrated Watershed Management Programme (IWMP) adopted a 'Ridge to Valley' approach to augment groundwater. But the existence of faults and fractures often leads to a geographical disconnect between the recharge area and the discharge area. The recharge area for a particular spring may well lie in another watershed. A spring sanctuary approach for regenerating underground seepage through engineering, vegetative and social measures has focused on the recharge zone with more promising results (Negi and Joshi, 1998; Tambe et.al., 2011; Sikkim Dhara Vikas, 2009-2011). However, a lack of knowledge about the local hydrogeology drastically reduces the efficiency of identifying the recharge zone.

PSI and its partners have implemented participatory watershed development projects over an area exceeding 14,000 ha in Uttarakhand and Himachal Pradesh. In 2005, they assisted the Government of Sikkim to initiate spring shed development in drought-prone villages under the *Dhara Vikas* program. From 2012-2017, PSI successfully piloted the principles of PGWM at the Panchayat level in Thanakasoga Panchayat, Sirmour district of Himachal Pradesh. The work was scaled up to other states in the IHR involving the concerned government departments, community based organizations and private agencies. The institute has also been conducting training and field facilitation on spring shed management. These interventions have regenerated springs and have led to an improvement in water availability and quality in the selected villages. This paper uses some of the successful case studies from PSI's project sites to explain the process of spring shed management, the impacts, the challenges faced and policy recommendations to help scale-up and sustain the interventions.

MATERIALS AND METHODS

a. Area of work

During the last decade, PSI has successfully rejuvenated more than 1000 springs in 500 villages across ten IHR states benefitting more than 14,000 households (Fig. 6.1).

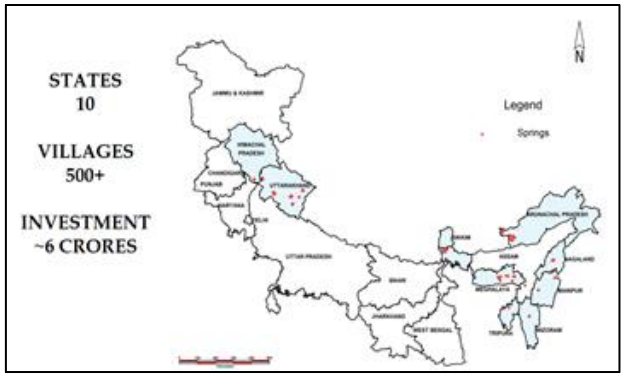


Figure 1: PSI's outreach in spring shed management in the IHR

b. Methodology

A clear methodology has been developed by PSI for spring shed management (Fig. 6.2). It includes both scientific and social measures.

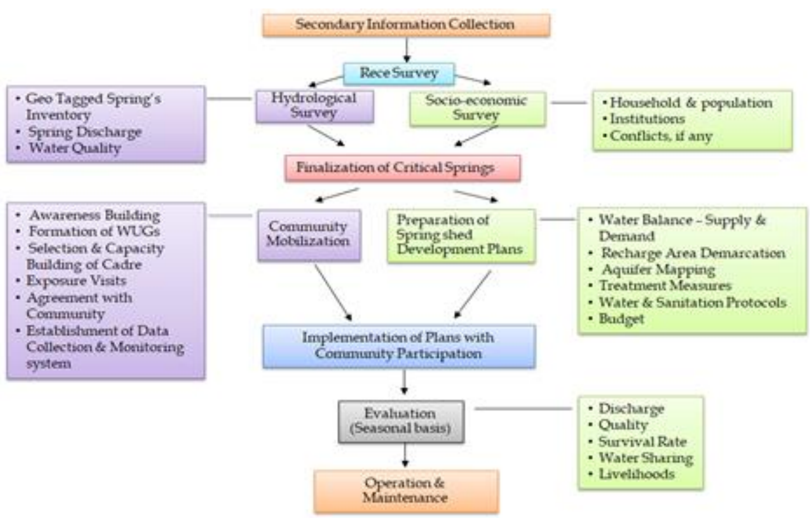


Figure 2: PSI's methodology for spring shed management

PSI's approach is based on the principles of Participatory Ground Water Management (PGWM) which includes recognizing groundwater as a common pool resource, studying the local hydrogeology, planning spring recharge interventions, and working towards sustainable and equitable use of the water resources by involving the local communities. The approach involves scientific understanding of groundwater using hydrogeological studies and understanding the social structure of the villages.

Hydrogeology is the study of groundwater. It deals with how water gets into the ground (recharge), how it flows in the subsurface (through aquifers) and how groundwater interacts with the surrounding soil and rock (the geology). Use of hydrogeology helps to identify the recharge area of critical springs more accurately. Geological cross sections are drawn to mark important rocks and the potential recharge area (Fig. 6. 3).

Understanding the social structure helps to determine the water needs of the people and their livestock and ensuring involvement of all the categories of people in the programme. Participatory Rural Appraisal (PRA) exercises, time trend analysis and household surveys help to determine the status of water demand and supply in the villages. Regular water quality monitoring, spring discharge and rainfall measurements are carried out for all the selected sources of water on a monthly basis.

c. Pre-Implementation activities

Identification of critical springs: To begin with, an inventory of all the water resources in the villages is prepared through hydrological and socio-economic surveys. Critical springs are identified based on low discharges, high dependency of community, and water demand and supply gap estimations. Awareness about groundwater, importance of springs, their rejuvenation and maintenance are carried out in the villages through *sandesh yatras*. The identified critical springs are finalized based on need assessment, socio-technical feasibility of recharge work to be done and community's willingness to contribute to spring shed development

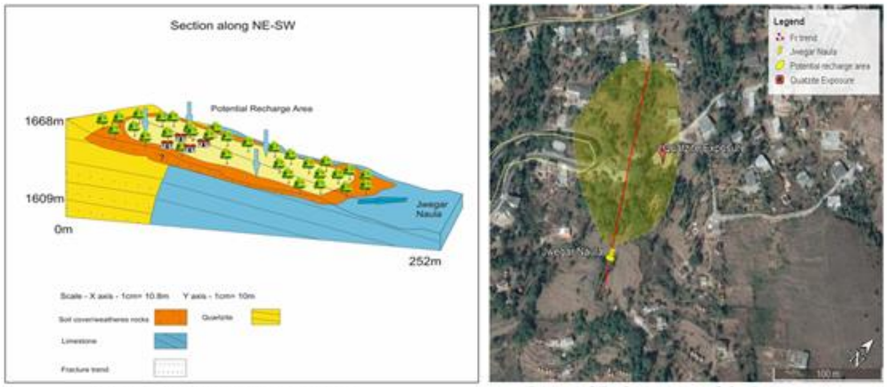
Thereafter, the potential spring recharge area is demarcated. Social, engineering and vegetative measures are planned and implemented as discussed below:

Social measures: This includes the following:

(i) PRA survey: PRA exercises help to gather information related to water resources directly from the people and to find out the status of village level institutions. Resource mapping provide information on resource use, access of different households in the villages to the water sources, mapping of seasonal and perennial water resources and the livelihood patterns.

(ii) Exposure visit: An exposure visit to a nearby successful pilot site is encouraging for the communities. The main objective behind organizing the exposure tour is to convince the villagers about the fact that groundwater management is practically possible and it can enhance their livelihood possibilities.

(iii) Street shows and awareness campaign in schools: These activities are carried out to mobilize the communities for participatory groundwater management. It not only helps to create awareness about groundwater and sanitation but also to build up relationship with the communities.



Conceptual Geological Cross Section *Potential Recharge Area of the Spring*

Figure 3: Geological cross section and identification of recharge area of spring shed

(iv) Formation of Water User Group and Water Management Committee: A Water User Group (WUG) is a general body that comprises of adult community members from all households that are directly dependent on the spring to meet their water demands and are also responsible to take care of the source of water. At least one member of each household should be a member of the WUG. A majority of the members should be women as they are the ones who face the challenges of fetching water for their families. A Water Committee is an executive body constituted in a democratic manner at the village or panchayat level. It has representation from various WUGs, Village Water and Sanitation Committee (VWSC) if it exists and members of Panchayati Raj Institution (PRI). These are formed for the overall management and supervision of the work done by the Water User Groups (WUGs). The committee members are selected in the aam sabha meetings in each village.

Consents are obtained from village panchayats and land owners of the recharge areas to carry out the work. Rules and regulations are decided for smooth functioning of WUGs, ease of implementation work and operation & maintenance.

The following rules are usually discussed and decided:

- The WUG will work as a nodal agency at the village level for groundwater management.
- All planning, implementation and management activities will be done through the WUG.
- They will hold a general meeting on a monthly basis to discuss the issues
- They will be responsible for cleaning and maintenance of springs, protection of plantation, sanitation and groundwater recharge work
- They will ensure equitable distribution of water
- Social fencing will be observed in the recharge area to prevent open defecation and grazing by animals

(v) Engineering measures: This involves preparation of estimates and planning for groundwater recharge activities. Continuous Contour Trenches (CCT) and Staggered Contour Trenches (SCT) are constructed in the recharge areas. The size, number and type of these structures are decided depending upon the hill slope. SCTs are the main recharge structures for pasture land where surface slope is less than 40 percent and CCTs are the main structures for agricultural land (Fig 6.4). The total area treated and the storage capacity of trenches is calculated in cubic meters.

Figure 4: Layout of staggered contour trenches

(iv) Vegetative measures: Plantation is an effective soil and water conservation measure. Plantation in the spring recharge area is often necessary to protect and restore the natural ecosystem and maintain the health of the groundwater recharge process. Native plants in the spring recharge area contribute to biodiversity, improve water quality, soil stability, and help to regulate temperature. Training and support are provided to the villagers for setting up nurseries in the villages. These were set up to grow grass, fruit and fodder saplings for plantation in the recharge area. Usually, plantation is done on high slope areas where physical works like trenching is not possible.

POST-IMPLEMENTATION ACTIVITIES

Some activities are carried out after completing implementation work. These are undertaken to promote sustainable use of water and to make the communities self-reliant. Such activities include:

(i) Introduction of low-water intensive crops and cropping methods: Villagers are motivated to SCI (System of Crop Intensification) and SWI (System of Wheat Intensification) for crop production. SCI is an agricultural production strategy that seeks to increase and optimize the benefits that can be derived from making better use of available resources: soil, water, seeds, nutrients, solar radiation, and air (Prabhakar et. al, 2017). This practice requires less water for irrigation and enhances crop production. The technique can be used for production of maize, rice, vegetables, grains, millets etc.(Fig 6.5).

E-ISBN- 978-81-969195-3-5, P-ISBN- 978-81-969195-0-4

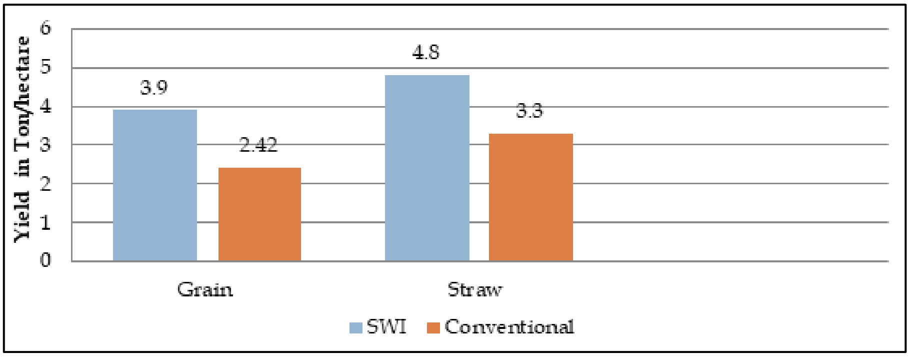


Figure 5: Comparative assessment between SWI and conventional method in Thanakasoga (2015)

(ii) Training and capacity building: Villagers are trained in carrying out various measurements and activities on a routine basis:

- Use of rain gauge & rainfall measurement
- Spring discharge measurement
- Testing of basic water quality parameters
- Preparation of organic manure
- Cleaning of baoris
- Monthly meeting process to discuss the water related problems
- Implementation of sanitary protocols/social fencing to protect the recharge areas

(iii) Development of water sharing mechanism: This practice is encouraged in village meetings so that people started sharing the enhanced spring discharge on rotational basis for other benefits. Irrigation tanks are constructed with voluntary contribution from the villagers to collected overflowing water for use. The water can be used for minor irrigation to grow vegetables for self-consumption or for sale. It can also be used for livestock rearing.

(iv) Replantation: Replantation in the spring recharge area is essential for maintaining and enhancing the natural processes that contribute to groundwater recharge. It helps sustain biodiversity, improve water quality, prevent erosion, and ensure the overall health and resilience of the ecosystem in these critical areas especially when the survival rate of the saplings planted initially is low.

(v) De-siltation of trenches: The trenches need to be maintained and desilted before the onset of rainy season every year otherwise the spring discharge gets affected.

The methodology can be summarized into six-steps for spring shed management (Fig 6.6). The outcome of each step has been mentioned in Table 6.1.

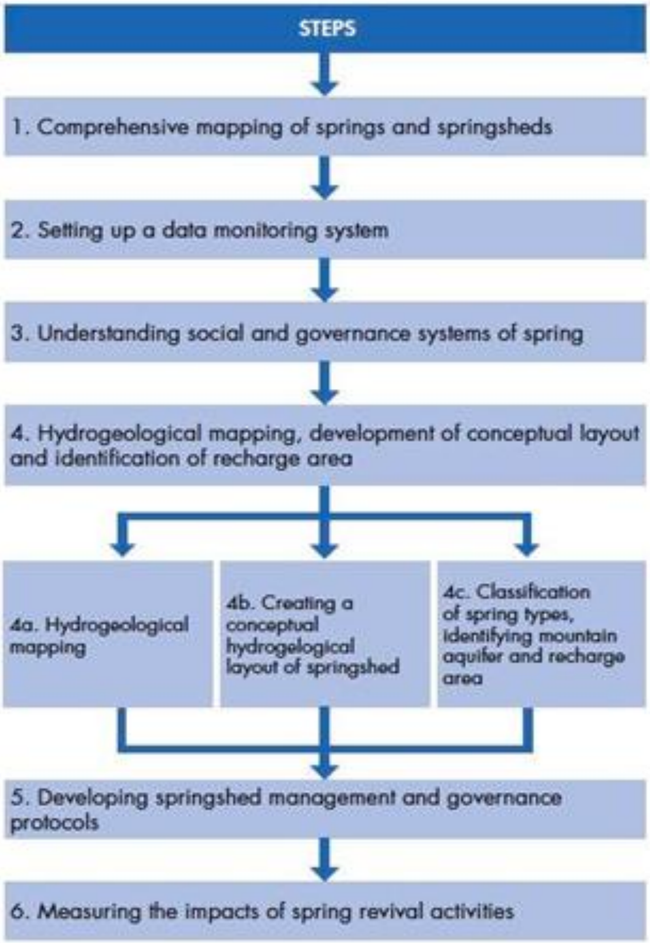


Figure 6: The six-steps methodology for reviving springs and improving spring shed management (Shrestha et al., 2018)

Table 1: Outcome of the six-steps methodology

S. No.	Step	Outcome
1	Comprehensive mapping of springs and spring shed	➢ Overview of watershed area ➢ Hydro geological data gets collected. ➢ Geo-tagged inventory of springs
2	Setting up a data monitoring system	➢ Selection of community resource person for spring discharge, daily rainfall and water quality monitoring. ➢ Installation of manual rain gauge.
3	Understanding social and governance system	➢ Understanding of village community and the overall context and the relation of the springs. ➢ History of village focusing on the water resources, trend analysis to understand the trend of spring discharge through social and resource mapping in PRA.

S. No.	Step	Outcome
4	Hydrogeological mapping, development of conceptual layout, and identification of recharge area	➢ Development of the conceptual 3-dimensional layout of the spring reflecting the geology and land use pattern ➢ Demarcation of the potential recharge area of the spring. ➢ Plan and budget of interventions
5	Developing spring shed management and governance protocols	Formation of Village Level Water Users Group (WUG) comprising of male and female members of households. Roles and responsibilities of the WUG are decided in terms of: ➢ supervision of sanitary protocols; ➢ holding regular monthly meetings; cleanliness around the source and recharge area; ➢ prevention of washing clothes, bathing and open defecation near the source and its recharge area; ➢ contributions and benefit sharing; ➢ *shramdaan*; ➢ monthly contributions for operations and maintenance; ➢ monitoring and financial transparency; regular water quality and discharge measurement, etc.
6	Measuring the impact of spring revival activities	➢ Impact assessment study of increase in discharge. ➢ Social impact study- How much time of women has decreased for water collection. ➢ Pre vegetation and post vegetation impacts.

RESULTS

Case Study 1: Increased spring discharge and protection of recharge area in Thanakasoga Panchayat, Sirmour District, and Himachal Pradesh

Thanakasoga Gram Panchayat is located in the Nahan block of Sirmour district in Himachal Pradesh. The discharge of springs (locally called "baoris") was reducing causing severe water shortages to the villagers especially during summers. Besides, the water was getting contaminated with faecal coliform bacteria due to the practice of defecation in the spring recharge area. PSI rejuvenated 5 critical springs located in three villages of this panchayat using the principles of PGWM. The implementation involving scientific, social, engineering and vegetative measures was planned in mid-2012 which got completed by end of May 2013. After interventions, a clear difference was observed in the discharge of treated and untreated springs (Fig. 6.7). The untreated baori B4 had a lower average discharge as compared to the treated baoris B1 and B2. This indicated an increase in the base flows which sustained water in the springs.

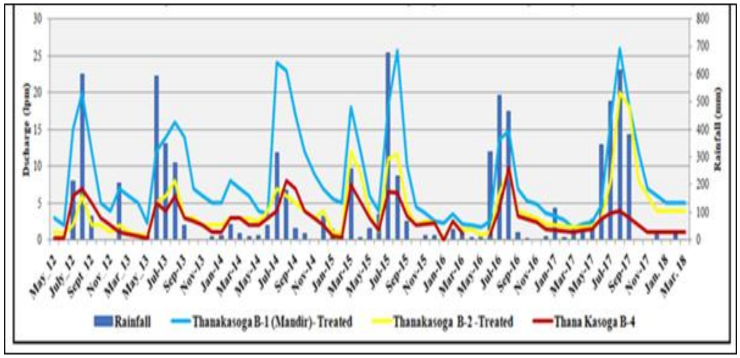


Figure 7: Comparison between treated and untreated springs in Thanakasoga village, district Sirmour, Himachal Pradesh

Self-imposed regulations by the communities or "social fencing" for the protection of recharge areas helped in reducing the bacteriological contamination in spring water. The graph below shows faecal contamination values for the month of May from the year 2012 to 2015. Each year there was a reduction in the number of faecal coliform counts which indicated that proper implementation of sanitary protocols can protect the recharge area and help in improving the drinking water quality (Fig. 6.8).

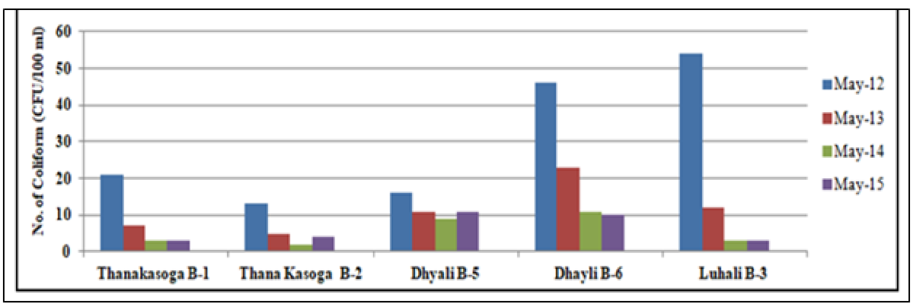


Figure 8: Reduction in faecal contamination with the help of social fencing in Thanakasoga village, district Sirmour, Himachal Pradesh

Case Study 2: Water security through increased water availability in Kinunger Village, Ongpangkong Block, District Mokokchung, Nagaland

Kinunger village falls under south Ongpangkong block of Mokokchung district in Nagaland. There are 5 springs in the village. But over the years the spring discharge had decreased owing to changes in the rainfall pattern and increase in water demand with growing population. Due to water shortages especially during lean season, people paid for water supply from the neighbouring village. Sebtsu tsubu spring was selected for rejuvenation because of its location (closest to the village), more dependency of the people and feasibility. It is a perennial spring and more than 80% of the households were entirely dependent on this spring for their drinking and domestic needs. The recharge area of the spring was about 1.5 ha. The slopes were steep therefore, engineering works was limited to only 0.8 ha. Depending on the slope, Staggered Contour Trenches (SCT) with varying sizes were dug. Plantation of grasses and shrubs was done on the bunds of trenches to avoid siltation of trenches.

As can be seen in the hydrograph (Fig. 6.9), the spring discharge increased from 2.9 Litres Per Minute (LPM) in June 2016 to 7 LPM in August 2017. This resulted in increased water availability for the villagers.

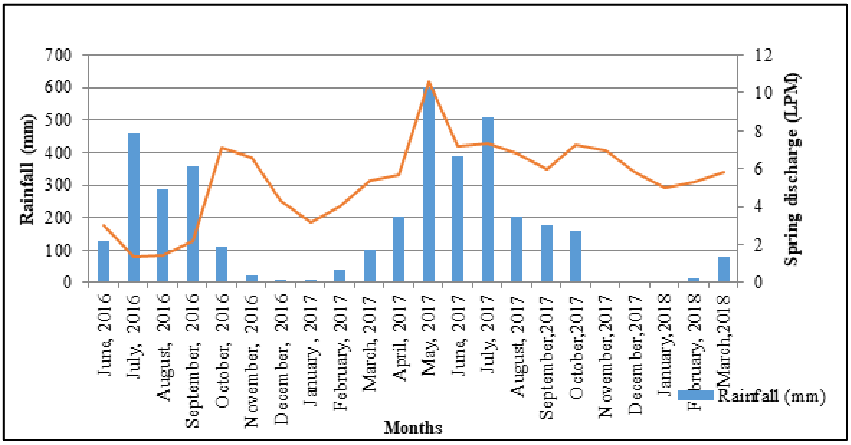


Figure 9: Sebtsu tsubu spring hydrograph

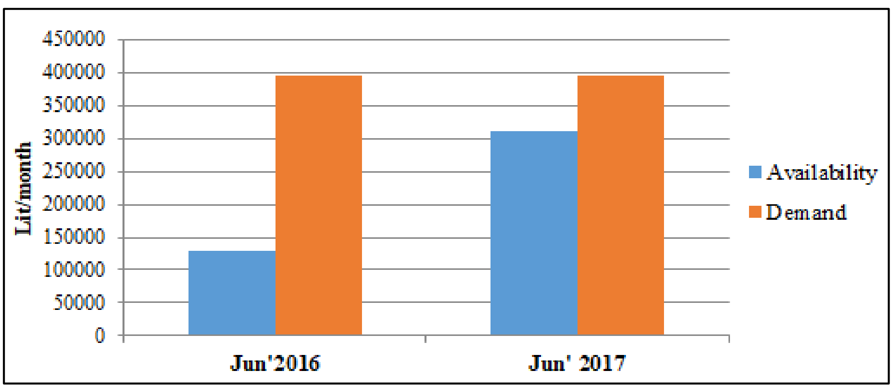


Figure 10: Water availability versus water demand in Kinunger village

The water availability increased from 18 Litres Per Capita Per Day (LPCD) in June 2016 to 43 (LPCD) in June 2017 (Fig. 6.10). The graph shows water availability and demand for the village in litres per month.

Case Study 3: Sharing Water from A Common Source Through Community Participation, Chargad Spring, Salga-Chibau Villages, Dehradun, Uttarakhand

Chargad Spring is situated 500 meters from Salga village in Dehradun, providing water to the entire village, which comprises 30 households. As part of conservation efforts, a comprehensive initiative was undertaken in the 2.53-hectare recharge area of the spring, involving the implementation of trenches, plantation activities, and the installation of fencing (Fig 11).

Following these interventions, the spring discharge witnessed a remarkable 1.5-fold increase, even during the lean season. Recognizing the positive impact of these measures, the community of Salga village extended their support by providing pipeline connections to another nearby village, Chibau, which has 25 households. This collaborative effort resulted in both Salga and Chibau villages now having access to a sustainable and ample water supply, addressing the water needs of the communities effectively.

Figure 11: Trenching work in a village

IMPACTS

The overall impacts of spring rejuvenation based on PSI's experiences are:

- Enhanced per capita water availability for drinking, domestic and minor irrigation purposes.
- Access to water gets extended to drier months (extension of 2 to 4 months in a year).
- Increased spring discharge leading to equitable water sharing amongst the communities.
- 30% to 50 % reduction in bacteriological contamination due to sanitary protocols.
- Establishment of community-based rainfall, spring discharge and water quality monitoring systems for decision making
- Creation of a cadre of trained para workers to continue the work in the villages.
- Reduction in time taken by the women to fetch water.
- Increase in biomass availability leading to enhanced fodder availability.
- Awareness of long term benefits of planting trees
- Increase in participation of community in water related issues and village development.
- Enhanced spring discharge leading to more availability and equitable water sharing among communities. It also motivates the farmers to use the water for minor irrigation.

DISCUSSION

Participatory spring shed development based on hydrogeological studies is effective in rejuvenation of springs in the IHR. It is possible to control bacteriological contamination by implementing social protocols in the recharge area. PGWM principles help to make the communities become more resilient to climate changes and also encourage them to maintain their local water resources. Regular

E-ISBN- 978-81-969195-3-5, P-ISBN- 978-81-969195-0-4

measurements for spring discharge, rainfall and water quality helps to monitor the situation and to take necessary decisions.

Strong village level institutions and mobilized communities are the key to the success of PGWM in any area. Involvement of the local communities can help in effectively managing groundwater, sharing water from a common source and even in resolving conflicts between villages. Village water security can be achieved through such activities under the government flagship programmes in close cooperation with other organizations.

The results obtained through this work influenced policy level decisions. Spring shed development was included in the list of activities under MGNREGA. Several agencies approached PSI for training in participatory spring shed development. The above achievements were possible through strong community mobilization and the formation of village-level institutions.

However, PSI faced many challenges as well during the course of its work. Inclusive spring shed development refers to an approach in water resource management that aims to involve and benefit all relevant stakeholders within a given spring shed or catchment area. The goal of inclusive spring shed development is to ensure the sustainable and equitable use of water resources while considering the diverse needs of the community. Community mobilization and their participation is the key to success in this type of initiative (Planning Commission, 2007). However, involving the communities is the most difficult task. It requires inclusion of people from various caste, class, age and gender groups in the villages. This kind of inclusion needs proper strategies, perseverance, time, adequate resources and locally feasible solutions. Quick results cannot be expected as each community behaves differently and the means used to mobilize the community of one area might not work for the community of another area.

Secondly, interventions like de-siltation and plantation need to be repeated after one or two years to maintain the spring discharge. Activities like hydrogeological studies, water quality monitoring cannot be carried out without proper training. But ultimately, the results obtained are promising and cost effective. It would be useful to increase understanding of the processes involved and encourage much wider uptake of the approaches for sustained water security in the IHR.

ACKNOWLEDGMENTS

We extend our heartfelt gratitude to the various government departments, community-based organizations, and generous funding agencies whose unwavering support has been instrumental in advancing PSI's impactful spring shed management initiatives in the IHR. Their collaboration and commitment have played a pivotal role in empowering communities and ensuring sustainable water security. Together, we are making a significant difference in the region, and we sincerely appreciate their invaluable contributions to this vital cause.

Disclosure Statement: The authors report there are no competing interests to declare and there are no conflicts of interest.