

Spring Protection: Step Towards Water Security and Sustainable Rural Water Supply

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ABSTRACT

Safe and reliable supply of drinking water is a fundamental human right. Lack of access to safe water mostly in developing countries is causing serious illness and death of millions of people every year. It also impedes economic development, prevents progress towards gender equality and puts human health in danger. In the Himalayan region, springs are an important freshwater source for the survival of humans. In recent years, it is reported that springshed is drying and polluted due to climate change and human activity. Such as increasing urbanization, construction (such as roads, hotels, tourist spots, houses and other infrastructures), deforestation, agricultural practices, and dumping of domestic, agricultural and industrial wastes. Hence, proper springshed development and protection plan will benefit us to protect spring from drying and contamination. Community participation is an important element of each watershed development projects such as water management, which requires continuous maintenance and protection to achieving long-term sustainability. Generally, after completion of any development project, many developed structures/constructions have left abandoned or damaged due to lack of care. Thus, for long term sustainability or running of the project, proper maintenance and care are required. It will be possible only by community involvement in the project.

Keywords—Community Participation, Protection, Restoration, Spring Box, Water Security

I. INTRODUCTION

Safe drinking water supply and satisfactory sanitation are fundamental human rights [1] and a vital contribution to economic development. Ensuring their accessibility would contribute tremendously to human wellbeing, food security and women empowerment. In this way, ensuring rural water security is among the most significant obligations of the administration around the world [2]. Increasing urbanization and anthropogenic activity have greatly affected the earth's natural environment and adversely affect human wellbeing. Contamination of water source put human health in danger. The WHO reports that about 80 per cent of the disease are waterborne such as diarrhoea, typhoid, hepatitis, cholera, poliomyelitis, encephalitis, skin infection and gastrointestinal are spreading through contaminated water. Developing nations are especially worse affected due to insufficient accessibility of consumable water and the absence of good medicinal services frameworks [3].

It is estimated that more than 5 million spring support communities in India's mountain range from Niligries to the Himalayas. But these important resources are under threat due to increasing water demand environmental degradation and climate change [4]. Many research evidences show that the discharge rate and water quality of springs are declining in numerous regions of the nation [5, 6]. A survey in Sikkim found that half of all spring discharge rate is declined in the state [7,8]. Similar impacts are being noticed in all hilly areas of India. Depleting the aquifer in the mountainous region is a dangerous sign for the communities living in this region[9]. Communities are almost completely dependent on springs for drinking and other household use [10]. When perennial spring is becoming seasonal or dried living communities struggling to meet the demand [6,11]. Also, it is noted that the water quality of the springs is deteriorating day by day due to changing land, improper sanitation and other anthropogenic activities [12]. The potential cause of contamination in groundwater/springwater is shown in table 1. In this region, communities consider spring is a holy water source that is safe for drinking and household uses [13]. Declining in the water supply or quality will affect not only village-level drinking water, but also regional occupations, human health, biodiversity, agribusiness, tourism

industry, power generation, and other industries. So, new efforts are needed to protect springs to ensuring water security, biodiversity and ecosystem sustainability [4]. There is also a need to raise awareness among relevant policy and decision-makers, and to develop skills and share information on this basic theme with field experts and community members. The main objective of any spring protection programme is (i) to protect the catchment of the spring and (ii) to protect the spring head from contamination. Many NGOs, research groups and state agencies are also working on spring management program in Uttarakhand, Himachal Pradesh, Sikkim, Nagaland and Meghalaya. Also, Sikkim and Meghalaya government has initiated state-wide programs to inventory, monitor, protect and rejuvenate springs.

Table 1: Potential Causes of Contamination/Quality Deterioration of Groundwater/Springwater:

Type of Problems	Underlying Causes	Contaminants of Concern
Aquifer Pollution[14]	Inadequate protection of vulnerable aquifers against wastewater discharges, leachates from industrial/urban activities and fertilizers from the agricultural field.	Pathogens, heavy metal, arsenic, chloride, nitrate or ammonium, sulphate, boron, dissolved organic carbon, aromatic and halogenated hydrocarbons, certain plastics.
Saline Intrusion [14]	Due to excessive abstraction saline ground water-induced to flow into the freshwater aquifer.	Mostly sodium chloride and also due to manmade contamination.
Naturally Occurring Contamination [14]	Related to the chemical evolution of groundwater and solution of minerals due to excessive abstraction and manmade pollution.	Mostly soluble iron and fluoride and sometimes arsenic, manganese, selenium, magnesium sulphate and other inorganic species.
Contamination at Spring eye or source point	Human activities like bathing, washing of legs, clothes, dirty water collection containers and other items around the water points. Presence of cracks or dirty drainage channels, location of springs downhill, untidy water point and surroundings.	Mainly pathogens like Escherichia coli.

II. SOURCE AND RESOURCE PROTECTION

Climate change and human activity have a great impact on the karst hydrological process. In many places of the world, human activity has the primary factor that influences the groundwater system [15]. So, to avoid human activity in the springshed area by defining the setback distances and other protection measures [16]. The main objective of spring protection is (i) to improve the recharge of the aquifer, and (ii) to prevent the contamination of the aquifer recharge area. Both objectives will help in assuring water availability and quality.

A. Improve the Recharge of the Aquifer: To prevent possible contamination delineate the recharge area of the spring by using isotope, hydrochemistry, RS & GIS techniques.

- I. Collect background information of identified area: First collect the background data of springs such as land use, settlements, distributions of springs and geology. Additionally, to understand the local geography and culture might be including topographic and geological maps [17, 18].
- II. Reconnaissance survey: After collecting the secondary data conduct the reconnaissance survey with local people to obtained the information of spring such as spring distribution, land use, forest and vegetation patterns, the local socio-economic situation, local road distribution, and others. This reconnaissance survey data will help in planning the fieldwork for comprehensive mapping of springs and data collection and designing the social-economic survey [17, 18].
- III. Map springs and collects data: After the field survey of the entire area systematically and including local people. All springs and other available water sources such as ponds, lake, wells, and others should be obtained using a GPS to provide an inventory or develop a geotagged map with the help of remote sensing and GIS (shown in fig. 1). Also, collect some preliminary socio-economic information, household dependency on each spring, nature of distribution, use of spring water, people (or especially women's) perception of present water quantity and quality and any changes in last decades, and conflicts related to ownership [17, 18].
- IV. Delineate springshed area: After the comprehensive mapping of the springs in the area of interest is to identify smaller sub-sets of springs located within a recharge area for long-term monitoring. A recharge area is chosen as the working unit for spring mapping and monitoring. It contains several springsheds as it extends across a valley-ridge-valley system located in two or more adjacent watersheds [17, 18].

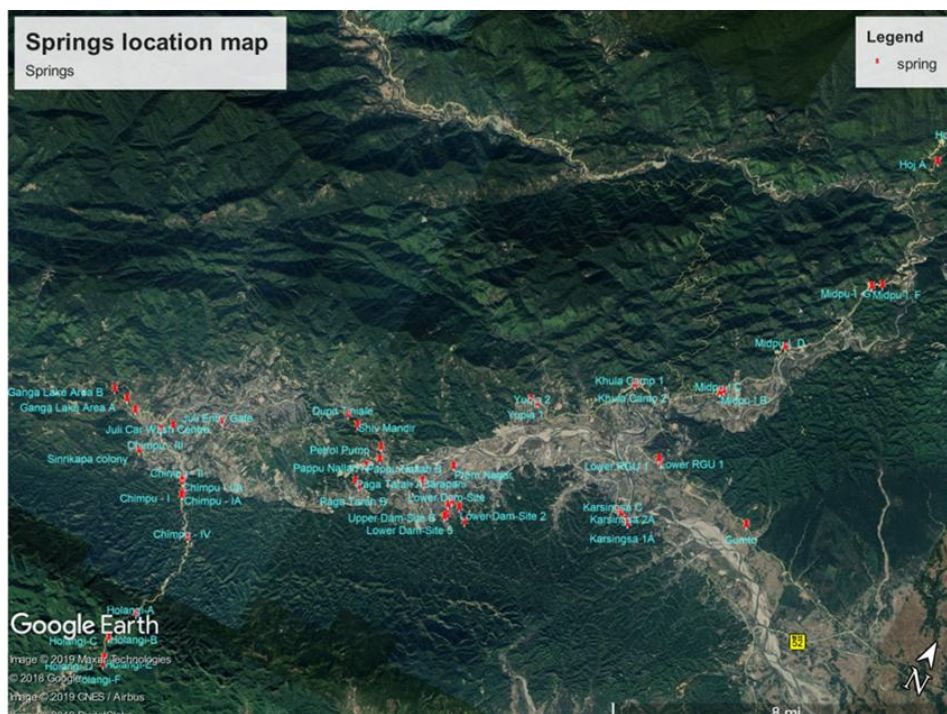


Fig. 1: Spring location map (Papum Pare district, Arunachal Pradesh)

- B. Recharge Area and Spring Head Protection:** To improve the recharge of the aquifer it is necessary to maintain the land use of the recharge area, and restrict the human or animal activities in the recharge area. Such as new constructions, deforestations and agricultural activities, etc. To restrict the activities and protect the spring, local user or communities will make the rules after analyzing the situation and the most suitable actions that can be taken locally. Grow trees/plants in the recharge area to stabilize the soil and reduce erosion (except eucalyptus plant or other plants that will be competing for water). Pine trees or indigenous species plants are useful in recharge improvement and reduction in soil erosion. Conflicts between communities are also a problem in spring protection. Also, protect the spring surrounding by fencing with barbed wire or an alternative barrier at least with a 50m radius decided by the community. Also restrict human activities in this area such as farming, grazing, and hunting [19].
- C. Protection from Probable Contaminations and Its Preventive Measures:** Contamination of spring water will be controlled by using different preventive and control measures, such as
- a) **Inventory of the contamination site:** Water flows through soil and cracks in rocks and recharges the aquifer it may be contaminated by contaminated sites.
 - Reconnaissance survey: Conduct a reconnaissance survey to identify the contamination sites and their type in the spring recharge area. Identify the all-potential contamination sources such as industrial sources, medical waste, sewage, pit latrines, livestock gathering points, and agricultural activity [16]. Also, measure the type of threats discharged by these sources.
 - Notify the communities about identified contamination sites and type of threats: Inform the communities member about the contamination sources situated in recharge area and level of threats may occur due to these sources.
 - b) **Implementing the management measures to prevent, reduce or eliminate threats to drinking water:** Protection of spring aquifers will be achieved by prohibiting/banned the possible contamination activities, probable contamination, remediation of contaminated groundwater, and detection of contamination.
 - c) **Restrict the probable contamination activities:** To prohibit contamination in spring water restrict the land use that could release the contaminates by involving regulations and ordinance, such as prohibiting or restricting land use that could release contaminants in the recharge area.
 - Restrict the animal and human activity in the catchment area to prevent pollution.
 - To prevent contaminated water intrusion in spring water, construct the cut off drain.
 - No latrines should be located within 30m u/s or d/s of a spring,
 - Construct spring box or use loose stones and gravels to protect the spring eye to prevent contamination
 - Fenced the area around the spring to avoid access by animals or provide the overflow water outside the protected zone where the animal can take water.

- Prohibit the new constructions in the recharge area.
- Restrict any activity in sensitive regions that involve the use of hazardous substances or releases any hazardous substances. Such as (i) prohibiting gas stations in sensitive groundwater areas, (ii) restrict the application of pesticides, fertilizers and any other hazardous substance, (iii) restrict the disposal of industrial and household sewage insentive region, and (iii) restrict the dumping of any types of garbage's (medical waste, industrial waste, household waste and other wastes).

D. Remediation of Contaminated Groundwater/Springwater:

- a) Detection of Contamination: Measure the water quality (salinity, TDS, EC, pH, temperature, and other chemical and biological contaminants) of all springs in the study area regularly to identify the contamination. These data will be helpful for the planning of spring protection.
- b) Public education and training to the communities about spring protection measures: Public education and training are the single most important aspects of groundwater protection.
 - Public education can increase the awareness of threats to drinking water sources.
 - People can learn how to protect communities water sources,
 - People can know how water-borne diseases are spread.
 - Help them understand the importance of clean water and how polluted water affect communities' health.
 - How to clean the polluted groundwater?
 - For regular measurement of spring discharge and testing water quality, trained the community members.

III. DEVELOPMENT OF SPRING PROTECTION BOXES

Generally, the spring box should be constructed to source protection. Figure (3) is showing the construction of a collecting chamber [20]:

Step 1: Clean vegetation near or above the spring head. Divert surface water by constructing a cut-off drain, to prevent entry at the spring source. Divert spring water temporarily to permit the construction of the collection chamber.

Step 2: To protect the source head place large stones and construct the collection chamber.

Step 3: Additionally, add layers of impervious material above the spring head for more protection.

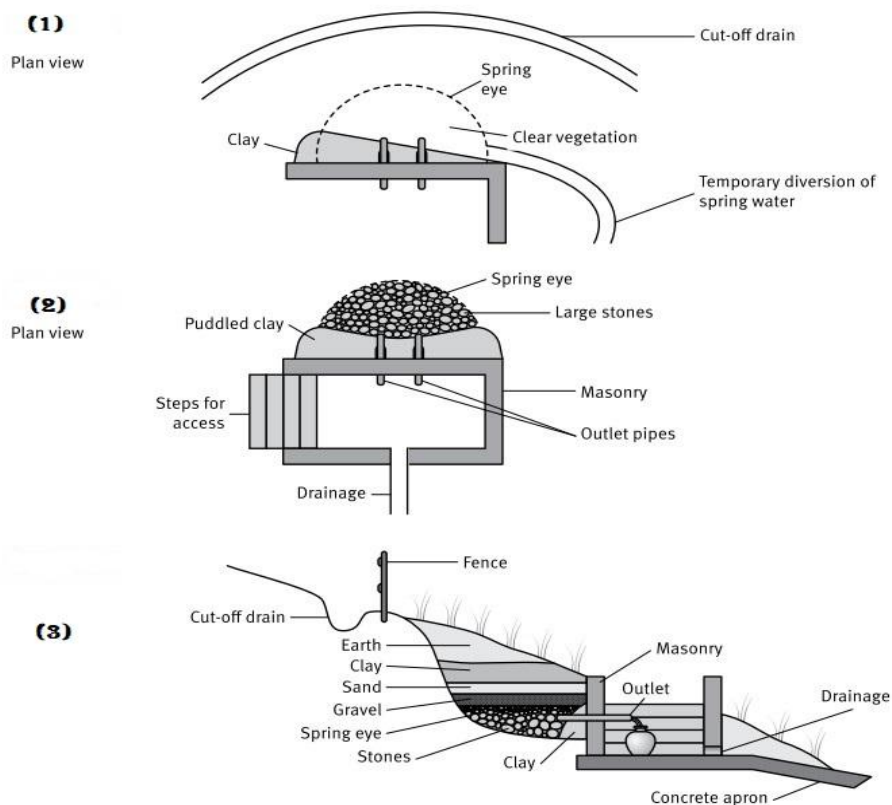


Figure 3: Stages of spring protection [20]

Construction of spring box prevent mixing of runoff water in spring and the entire structure protects from soil erosion around the spring. It also protects spring form any contamination from roaming animals. Apart from the protection of spring water spring box has also different uses. It harvests water to fulfil the peak demand and it helps to the settling of suspended particles. If sand or gravel filters have attached it reduces turbidity. Two springs are shown in figure 4, protected spring (shown in Figure 4(a)), which has the lesser possibility of contamination at the source point due to surface water mixing, bathing, washing, and garbage dumping, while unprotected spring (shown in figure 4(b)) has higher possibility to contamination.



IV. COMMUNITY PARTICIPATION IN SPRINGSHED PROTECTION

Community participation is an important element of each watershed development projects such as water management, which requires continuous maintenance and protection to achieving long-term sustainability. Community participation plays an important role in springshed development and management practices [22]. Local communities know the characteristics of the spring such as seasonal variation of discharge and other site conditions and also, they know about remotely available spring location, especially, hunters and graziers [23].

A. Communities role in springshed protection and restoration: Springshed development plan may include protection and restoration of springs or even recharge of groundwater as per need of the community. Such as, if the community is facing water shortages in the dry period, the primary objective would be to increase the discharge rate of spring. If intense grazing, deforestation, and forest fires are the major cause of drying or decreased discharge rate, then the goal would be to reduce human pressure on springshed. Secondly, if springs (or other freshwater water sources) are dried and water scarcity is observed throughout the year or the community is forced to abandoned the village, the secondary objective would be rejuvenating or restore springs or other water sources. Develop structures such as ponds/lakes, challs, check dams, trenches to increase natural infiltration rate. Also, restore ecological function by plantation of native species plants to increase soil cover. Involvement of local communities is necessary for every step of spring development practices.

B. Necessary Steps to Protect Groundwater/Springwater by Local Communities: The major reason for the contamination of groundwater is human itself. So, it is polluted by peoples and it needs to be protected by people. Steps to protect groundwater must be followed by local communities [24]:

- a. Dispose of household garbage, chemicals at official dumping,
- b. Train the community about waste management,
- c. Avoid synthetic fertilizers and adopt organic fertilizers,
- d. Limit the use of fertilizers and pesticides,
- e. Use sealed septic tanks and empty them regularly or if possible then connect to a local sewerage system,
- f. Tell your neighbours and educate your children about how to protect our water,

C. Spring Protection Measures used by Hilly Communities in Northeast India: Many hilly communities know the importance of springs. So, they are protecting spring water by using traditional knowledge. Some of the protection measures followed by local communities are

- a. **Fencing and Plantation:** One the basis of their traditional knowledge communities identifies the recharge area of springs and adopt the fencing around the identified area. Also, they adopt plantation in the spring source area. These practices reduce human and cattle interference in the recharge area. The limitation of these practices is (a) identification of recharge area, and (b) Selection of plants for plantation. Common peoples understand the recharge area of springs is the only surrounding area of springs, but it may differ. Without a proper scientific study of springshed, the recharge area can't be properly identified. Also, wrong selection of plants for plantation in springshed. Peoples think the plant can attract water and they select any plants. Always, select local plants or which has a lower water consumption ration.
- b. **Devithaan or Sacred Groves:** At many places' local communities worship water source sites as Devithaan or sacred droves. It helps to prevent human interference in the source area. Also, it helps in preventing contamination practices (such as throwing garbage or litters) at the source area, because people think this is a holy site. Additionally, these practices also prevent water from biological contamination and keep the water clean for potable use. The main limitation of these practices is they protect the immediate area near the spring eye. For protecting the actual recharge area, such kind practices need to be done in taking a much larger catchment area.

D. Maintenance of Sprig Box and Catchment Area: Maintenance of spring box and catchments is an essential factor for the long-term running of the water supply project. Generally, working agencies construct many structures for springshed development such as the construction of spring box, trenches, check dams, ponds and other water harvesting and protecting structures. But after completion of the project, these structures have left abandoned. After some time, due to no care and maintenance, it may fail due to landslide or soil erosion, roaming animals, growth of vegetation at the site. Once or twice a year clean the spring box chamber, and repair any damages. Clean each year catchment drains, repair fencing, or other protected works. The local community and users of the spring should be trained in the correct maintenance of the spring inlet and system and the rationale for the protection of the catchment areas. Local legislation may also be useful in protecting the catchment area above the spring.

V. CONCLUSION

Every year millions of people died worldwide due to the lack of freshwater access. In the Himalayan region, springs are the primary source of fresh water supply. In the last few decades, this important source is drying and polluted due to lack of care. The availability of drinking water for human and livestock are diminishing due to drying of springs and deteriorating of water quality. The increasing urbanization, industries, hotels, picnic spots, intense grazing and farming, high use of synthetic fertilizers and pesticides affect spring health. So, there is a need for the implementation of protection and restoration measures of springshed to sustain in this scenario. Different steps of source or resource protection have discussed above, from identification to remediation of issues. Community participation is an important step in the springshed development programme. They know the local geology, spring sites and other important details. But they need proper training to tackle the issues. Generally, after completion of any project, many developed structures have left abandoned or not in use due to lack of care. Thus, for long term sustainability or running of project proper maintenance and care is required. It will be possible only by community involvement in the project. Also, for developing or protecting water source manpower is required. Hence, community participation is the most important element of any watershed development project.

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