Drinking Water Issues and Development of Spring Sanctuaries in a Mountain Watershed in the Indian Himalaya

Authors: G. C S. Negi, and Varun Joshi

Source: Mountain Research and Development, 22(1) : 29-31

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2002)022[0029:DWIADO]2.0.CO;2

Mountain Research and Development Vol 22 No 1 Feb 2002: 29–31

Drinking Water Issues and Development of Spring Sanctuaries in a Mountain Watershed in the Indian Himalaya

G. C. S. Negi
Varun Joshi

The Himalaya harbor a wealth of springs and shallow wells used for drinking water and other household purposes. However, discharge from these sources has declined in recent decades—some springs have even dried up—making water a crucial development issue in the region. This article describes a field experiment to increase spring discharge with simple ecotechnology (spring sanctuary development) in the recharge zone of a nearly extinct spring in a Himalayan microwatershed in Uttaranchal. In the years after the experiment, water discharge increased from 1055 to 2153 L/d (1995–2000). Though much of this increase was probably because of above-average rainfall in the dry season of 2000, the results are very encouraging. In addition, the discharge of all springs in the watershed was pooled and more rational use of water was promoted.

FIGURE 1 Schoolgirls fetching water conducted from a spring by a cement pipe. (Photo by authors)

Drinking water: A major problem

The Himalaya provide water to millions of people in the highlands and lowlands. In many mountain and hill areas, water for drinking and household consumption is taken mainly from shallow wells (*naula*) and springs (*dhara*). Discharge from these sources has decreased dramatically. Long queues at water points and women and children carrying water from increasingly distant sources are common sights in many regions of the Himalaya today (Figure 1). Some people resort to collecting water during the night. Others collect unclean water, inviting water-borne diseases.

Management issues aggravate the water problem. In 1994, of the 5804 government drinking water schemes in the Central Himalayan region of India, only 64% were functional. The rest were either partially (21%) or completely (15%) defunct. Water taxes were too low and did not cover operation and maintenance costs. Attempts to introduce progressive increases met with resentment. Moreover, water schemes face a "tragedy of the commons" syndrome because community participation is often lacking. The involvement of private contractors has frequently resulted in low-quality construction, leakage, and damage to sources.

Changing land use and land cover is another issue in water management. Studies indicate that deforestation, grazing

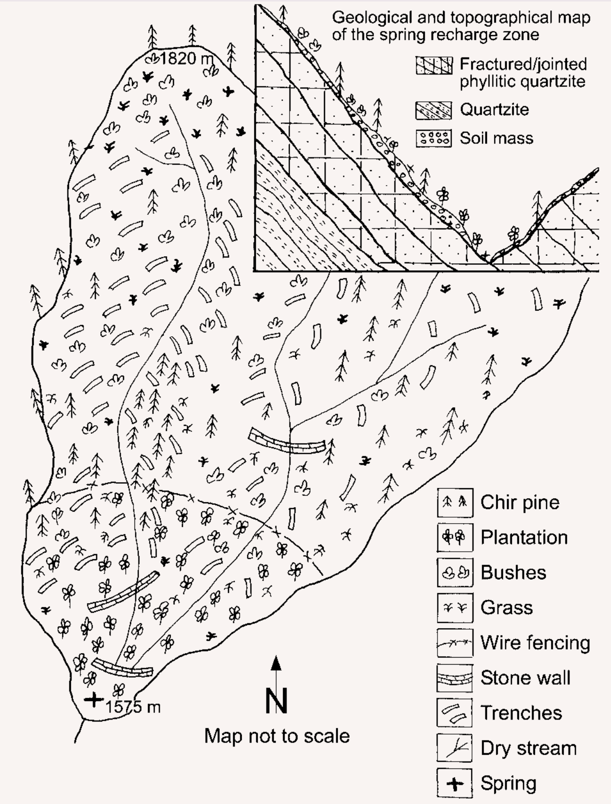

FIGURE 2 Bioengineering treatments in the recharge zone of a spring in Dugar Gad Watershed. (Sketch by authors)

and trampling by livestock, soil erosion, forest fires, and development activities (roads, mining, construction, etc) reduce infiltration capacity. Water is lost to runoff; it does not percolate into the soil to recharge groundwater. River flow during the rainy season is often more than 1000 times higher than during the dry season, resulting in a "too little and too much water" syndrome. The problem is how to increase water retention in fragile, erosion-prone mountain watersheds in order to obtain sustained discharge during the dry season (April–June). As information on spring types and on spring discharge in relation to rainfall, geology, topography, vegetation, and land use is meager, there is a need for site-specific experiments on approaches and technologies that could increase water retention.

Water resources and household water consumption in the Dugar Gad Watershed

Studies have shown that infiltration of rainwater into the spring recharge zone is increased through engineering and vegetative measures, which augment discharge in downslope springs. Our aim was to verify these results under central Himalayan conditions. We selected a nearly extinct spring in the Dugar Gad Microwatershed—a typical watershed in the Pauri-Garhwal district in the central Himalaya. Two-thirds of the 1876 mm annual rainfall accrues in the rainy season. About 37% of the rainfall runs off as stream flow. Discharge of water resources is drastically reduced during the dry season. Ironically, discharge from some springs is not used because of the absence of intake structures or neglect of minor water yield. Total water consumed per capita for household activities is 27 L/d, used for washing clothes (25%), cleaning utensils (20%), drinking and cooking meals (13%), toilets (17%), bathing (14%), and cleaning the house (11%). This is less than the WHO per capita standard of 60 L/d.

Erratic rainfall, undulating topography, geology, land use, and land tenure create a great variety of spring recharge zones in mountains. All these factors have an effect on water yield and seasonality of springs. Our studies of the 5 springs in the Dugar Gad Watershed, carried out at the same time as the recharge zone treatment of 1 of the springs, indicate that discharge is mainly a function of rainfall. Mean annual discharge ranges between 0.5 and 2.9% of the annual rainfall or 5.3 and 29.4 L per 1000 L of rainfall. This indicates that most rainwater is lost through runoff, evapotranspiration, or deep perco-

TABLE 1 Ecotechnological measures applied in the recharge zone of a near-extinct spring.

Engineering measures	Vegetative measures	Social measures
Trenches (15–30 cm deep and 1–20 m long) dug along contours Mud-and-stone walls (1 m high and 10 m long) constructed for water retention A total of 150 pits dug for plantation and infiltration Barbed-wire fencing built around the spring	Planting of *Alnus nepalensis, Prunus cerasoides* (deciduous), and *Quercus leucotrichophora* (evergreen) seedlings Application of pine leaf litter to barren spots Protection of recharge zone from grazing, cutting of fuelwood and grass, and wildfire	Local community was consulted about implementation of engineering and vegetative measures, especially with regard to protection of recharge zone People were convinced that water scarcity could be overcome if spring discharge was stored in leak-proof tanks, if loss of water could be reduced (piped supply), and if community distribution was rationalised

TABLE 2 Discharge of a near-extinct spring treated with engineering and vegetative measures in Dugar Gad Watershed.

	Rainfall (mm)		Mean spring discharge per day (L/d)		Total annual spring discharge (m^3/y)	Water retention (% of rainfall)
Hydrological year (1 Jul–30 Jun)	Apr–Jun (≅90 d, dry season)	Jul–Mar (≅270 d)	Apr–Jun (≅90 d, dry season)	Jul–Mar (≅270 d)		
1994[a]–1995	110	846	1055	50,388	12,403	7.0
1995–1996	201	1366	1271	59,009	16,494	5.7
1996–1997	428	831	3081	56,998	15,881	6.8
1997–1998	243	1052	4093	31,790	9190	3.8
1998–1999	154	1183	1360	109,024	30,409	12.3
1999–2000	505	982	2153	124,036	34,416	12.5

[a]Data for spring discharge recorded from 1 Aug 1994.

lation. Discharge declines sharply where recharge zones have steep slopes. Concave topography, abandoned terraces, thick bush growth, and occasional grazing had a positive effect on spring discharge. A definite pattern between spring discharge and recharge zone characteristics has not yet been elaborated, but it can be stated that spring yield is influenced by a complex set of factors and that land use change in the recharge zone has a direct bearing on discharge.

Ecotechnology to recharge springs

In order to test the effectiveness of ecotechnology in increasing spring discharge, a near-extinct spring in Dugar Gad was selected for "spring sanctuary development" in 1994. In June 1995, the recharge zone of this spring, about 18.5 ha in size, was treated with engineering, vegetative, and social measures (Figure 2; Table 1). In the 1994–1995 hydrological year (1 July–30 June), which was the control year, annual discharge amounted to 7.0% of the rainfall. This figure increased to 12.5% in the 1999–2000 hydrological year. In the years in between, discharge varied between 3.8 and 12.3% (Table 2). Spring discharge doubled during the dry season, from 1055 L/d in 1995 to 2153 L/d in 2000. However, much of this increase was because of greater rainfall in 1999 and 2000, compared with the control year. Decline in spring discharge during 1998–1999 may be attributed to loss of water caused by the increased demand of the revived vegetative cover of the recharge zone, siltation of trenches, and other engineering measures. In the control year, the vegetative cover (89%) consisted of a few scattered pine trees, bushes, and intensively grazed forage. By 1998–1999, the vegetative cover had increased to 96%.

Drinking water management: A complex task

In addition to recharge zone treatment, pooling is an option for meeting normal household water demand, especially if the water is distributed through piped gravity schemes to minimize losses. Surplus water can also be stored in the rainy season for dry season use. Today people collect water when there is demand, whereas springs overflow the rest of the time. Pooling may be socially difficult, because springs in specific villages are restricted to the village community; villagers resort to them in times of dry weather or when government drinking water schemes fail. Solutions must thus be site-specific and consider such diverse features as rainfall, recharge zone characteristics, water-use patterns, and local traditions.

Increased water availability during the dry season (April–June) would be a great help to many mountain communities, including Dugar Gad. Spring sanctuary development could help achieve this aim. But investigations must be conducted for a longer term before conclusive results are possible. Moreover, the state government should enable inhabitants to assume greater responsibility for local water management, because this can curb mismanagement and waste. Hence, water management and spring recharge require multidimensional approaches, including engineering and biological as well as social and managerial measures.

AUTHORS

G. C. S. Negi and Varun Joshi
Land & Water Resource Management Core Programme, G. B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, PO Box 92, Srinagar–Garhwal 246 174, India.
gbpgu@nde.vsnl.net.in

G. C. S. Negi and Varun Joshi currently work at the Land and Water Resource Management Division, Govind Ballabh Pant Institute of Himalayan Environment and Development, Garhwal Unit, Srinagar. For the past 10 years they have specialized in forest ecology and environmental geology, respectively. Their work focuses primarily on research and development with special reference to the Himalayan region.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the scientific inputs and facilities provided by K. Kumar and by the Director of the G. B. Pant Institute, Kosi–Almora.

FURTHER READING

Negi GCS, Joshi V. 1996. Geohydrology of springs in a mountain watershed: the need for problem solving research. *Current Science* 71:722–776.

Negi GCS, Joshi V, Kumar K. 1998. Spring sanctuary development to meet household water demand in the mountains: a call for action. *In:* G. B. Pant Institute of Himalayan Environment and Development. *Research for Mountain Development: Some Initiatives and Accomplishments.* Kosi-Almora, India: G. B. Pant Institute, pp 25–48.

Singh AK, Pandey RK. 1989. Changes in spring activity: experiences of Kumaun Himalaya, India. *Environmentalist* 1:75–79.

Valdiya KS, Bartarya SK. 1991. Hydrological studies of springs in the catchment of the Gaula River, Kumaun, Lesser Himalaya, India. *Mountain Research and Development* 11:239–258.