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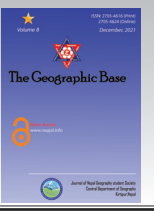

Water Resources and Adaptation Strategies to Water Scarcity at Sukajor Village in Ramechhap Municipality

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Abstract

Climate change has stressed water resources. Water availability and its management is critical for rural livelihood including farmers. Decreasing water supplies have been causing negative impact to rural people's livelihoods in mid-hills of Nepal, particularly for crop production during the dry months of the year. People are coping with different adaptation strategies that varies with time, situation, and available technology. In this context, the main objective of this research is to study water resource and adaptation strategies of local people of Sukajor-7, Ramechhap Municipality. Primary and secondary data were collected using GPS survey, household survey, KII, FGD, and field observation. The study result shows water supply has not met the demand, only 74.5 percent of total daily drinking water demand has met. Though traditional water management practice exists, water demand has not fulfilled yet. However, water management system was traditional as they kept water sources open, and was not able to store the water so that they had to travel to the water sources located at longer distance. The supply of water is insufficient even though

the people had made intake in the sources and operated lift system in Chhatiwane, Agaute and Chimkhi. People harvest rain water as alternative sources of water.

Introduction

Water is the most fundamental requirements for livings, widely spread in nature (Plessis, 2017). Water is required for a variety of purposes, including drinking, cooking, washing clothing, bathing, irrigation, and hydroelectric power generation. Water is critical not only for meeting daily needs, but also for the ecosystem's long-term sustainability. Nepal is one of the wealthiest countries in the world in terms of water resources, accounting for more than 2.27 percent of global water resources (HEMS, 2015). Despite being one of the world's most water-rich countries, Nepal is ranked among the top five countries with the worst drinking water system (McPhillips, 2017). Although water scarcity and lack of sanitation affect the entire population, the effects are distinct and considerable in inaccessible remote sections of the country. As a result, water scarcity has emerged as a national concern that is intertwined with water pollution, food insecurity, and energy insecurity, slowing the gross domestic product (Panthi et al., 2018).

The varying geographical setting and of distance from water resource, and rural areas has made the expansion of service and facility distribution unfeasible. The majority of villages are located at the bottom of deep gullies and valleys, far higher up the streams and rivers, and the installation of water tanks in such settlements may be extremely expensive (Sharma et al., 2016). In Nepal's mid-hills, water resources have become increasingly scarce, posing a threat to rural people's livelihoods. During the dry months of the year, water for agricultural production and household purposes is a major concern in the mid-hills' areas. Villagers think that the drying up of springs in the area is caused by the decreased amount of rainfall over time, as well as the irregular of rainfall. For the growing population and modern lifestyle, more water is required (Wang et al., 2018). It has been a major issue not only in a particular area, but throughout the country.

Ramechhap is one of the districts in Nepal facing severe problems of water resources. Most of the land in this district is dry. The whole Ramechhap district is the drought-prone zone in Nepal. Drinking water sources are dried out by 60 percent out of which some are fully and some are partially dried up in the last decade. After the huge earthquake of 2015, most of the water source are disappeared. That caused out migration from the district. This problem has affected highly in the southern part of the district like Bethan, Rakathum, Pakarbas, Okhreni, Sukajur, Himganga, Deurali etc (Shrestha et al., 2015). Sukajur is one of the villages in the southern part of the district which has

a severe problems of water scarcity for domestic utilization of water.

Methods and Materials

Study area

The proposed study has conducted at Sukajor in Ramechhap district lies in Bagmati province of Nepal. Geographically, it is situated between 27°30'00" north latitude and 86°11' 00" east longitude. It has become one of the wards of (ward no.7) Ramechhap Municipality. The total area of the Ramechhap Municipality is 202.45 square kilometers and ward no.7 has 28.5 square kilometers area.

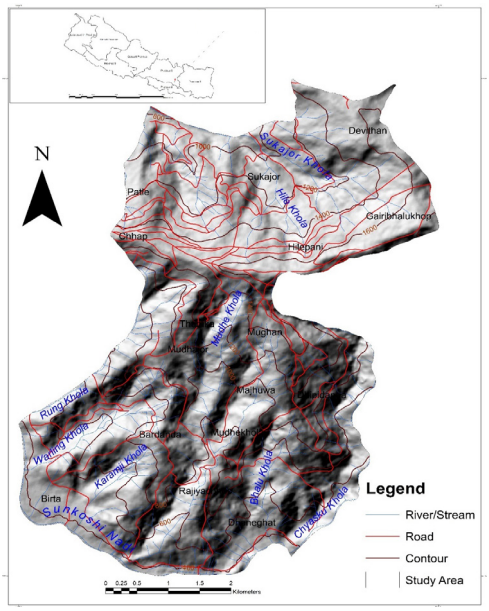

Figure 1. Location map of study area

Source: Survey Department, 1995

Data collection

For the primary data collection, both qualitative and quantitative data were collected using household survey, key informants' interview, focus group discussion. For the household survey, 60 random households were randomly selected representing all settlements in the study area. Similarly, four key informant interviews were also conducted with the senior citizens and ward representatives. For the focus group discussion, 3 FGDs were conducted. The FGD was organized in three different places. The number of participants in FGD ranged from 6 to 10 persons. The participants were women, men of different castes and various ages. The information from FGD and KII was checked against the GPS survey and spring inventory sheet information. Likewise, the information related to the effect of the earthquake 2015 on spring water was also collected. Similarly, for the mapping location of springs of the study area, hand GPS was used to track the location of springs. It was also measured the discharge of the springs.

Results and Discussion

The water resources in the study area is found to be directly affected by the climate change that has been observed or perceived by the local people which has affected in various sectors including agricultural system. Thus, some of the indicators based on climate and its impact in water resources in the study area is presented below:

Table 1. Climate change indicators

Variables	Trend	Indicator
Temperature	Increased	Less rainfall
		Warmer in summer
Rainfall	Decreased	Drying out of spring
		Shifting in timing of plantation and harvesting
		Drying of crops
		Land abandoned
Ground Water Availability	Decreased	Drying out of sources that has not been drying even in winter in the past
		More time to fetch water
		Disappearing source of water after 2015 earthquake
River/spring Flow	Decreased	Decrease half in water volume than past
		Problem in irrigation system
Agricultural production	Decreased	Use more chemical fertilizers
		Lack of irrigation
Drought	Increased	Less rainfall for long time
		Change in rainfall pattern
		Drying crops plants before the time

Source: Field survey, 2019

Thus, the effects of climate change like untimely rainfall, less rainfall, drying sources of water, shifting the time of plantation and harvesting of crops, appearing of hot water animals and birds, decrease in productivity has made the human life miserable.

Situation of water resources

Water volume situation of springs

There are 32 springs mapped in the study area of which 97% are perennial. Nearly 47% of springs originated from a tree root, 28% from tree and rock, 22 percentage from just soil and about 3% from the rock. Regarding land use, 37% of springs are on forest land, 36% springs are on bush/ grass land; about 3% are on agricultural land, and 21% are on barren land and 3% of sprigs are on swampy area. Out of the total 32 springs, 7 springs' water volume has decreased up to 25 percent, 20 springs water volume has decreased 25-50 percent and 5 springs water volume has decreased above 50 percent within the last decade. The situation of water volume of springs within the last 10 years is shown in the figure 2.

Spring by discharge rate

The discharge rate of springs is varied. There is no uniform distribution pattern of springs in terms of discharge rate and altitude. About 37% of springs' discharge rate is below 5 liters per minute (lpm). The percentage of small springs is higher compared to springs with higher discharge rates.

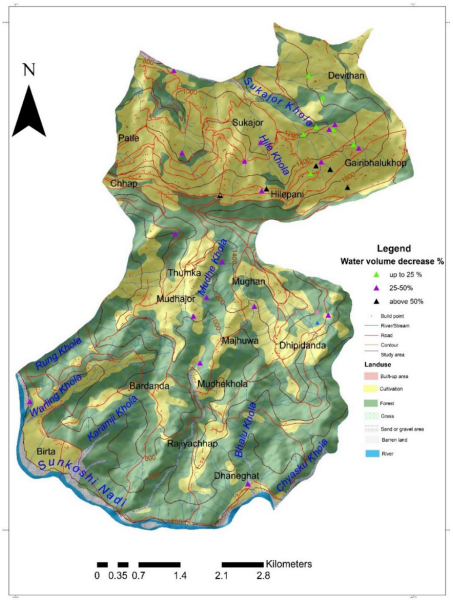

Figure 2. Water volume situation

Source: Field survey, 2019

Table 2. Discharge rate of springs

Discharge rate ((lpm)	No. of springs	Percentage
Below 5	12	37
5 to 10	7	22
10 to 50	7	22
50 above	2	6
No data	4	13
Total	32	100

Source: Field measurement, 2019

The Number of Springs by Elevation Out of these 32 springs, 6% are at an elevation of below 500 m, 9% springs, are at an elevation of between 500 and 1000 m, 66% springs are at an elevation between 1000m and 1500m and 19% springs are at an elevation above 1500m. In terms of altitude, most of the springs are in the altitude from 1000 to 1500 m.

The number of springs by served household

The springs are categorized on the number of households in which water is used for various purposes. Among the 32 springs, about 16% of springs serve up to 5 households. Similarly, 22% serve 6–10 households, 28% springs serve 11–20 households, 19% of springs serve 21–50 households, 9% of springs serve 51-100 and 6% of springs serve above 100 households. The number of springs according to the served household are shown in (Table 3).

Table 3. The number of springs hold by served house

Served household	Number of springs	Percentage
Up to 5	5	16
6 to 10	7	22
11 to 20	9	28
21 to 50	6	19
51 to 100	3	9
above 100	2	6
Total	32	100

Source: Field measurement, 2019

Drinking water demand and supply according to family size

It is found that demand and supply of water has been affected by family size. According to Family size the requirement of water demand has to be 35litrs/day for 1-3 family size but the supply is only 25litrs/day. The requirement of water for 4-7 family size is 75litrs/day but the

supply is only 55litrs/day. Similarly, the requirement of water for 8-10 family size is 100litrs/day but the supply is only 80litrs/day. The demand and supply are not matched. The table of drinking water supply and demand on basis of family size is given below.

Table 4. Drinking water demand and supply according to family size

Family size	1 to 3	4 to 7	8 to 10
Amount of Drinking water demand (Liters/day)	35	70	100
Amount of Drinking water supply(liters/day)	25	55	80

Source: Field survey, 2019

It seems that according to the purpose, the demand and supply of water is high for washing but the demand and supply is not matched with each other. The table of water demand and supply on basis of purpose is mentioned below:

Table 5. Total demand and supply of water according to purpose

Purpose	Supply of water amount (Liters/day)	Supply percent	Demand of water amount (Liters/day)	Demand percent
Drinking	2690	13.66	3610	9.28
Livestock	4118	20.92	6035	15.52
Washing	10545	53.57	22700	58.37
Sanitation	2330	11.83	6540	16.81
Total	19683	100	38885	100

Source: Field survey, 2019

Coping and adaptation to water scarcity

Water scarcity has been one of the major problems in the mid hill region of Nepal. According to Chapagain and Bhusal (2013), the decline in water sources (spring and streams) is of great concern in Upper Kaligandaki basin. In response, local people have set new community rules and regulations for irrigation use, construct new water infrastructure, gradually adopt new farming systems, adopt new irrigation methods on planning terrace, abandon less productive and land at distant. To tackle water shortage, people of the study area have adopted many coping strategies such as minimizing water usage, plantation when rainfall occur, only plantation near land from home, uses of lift water, involve in labor-based work and less animal husbandry. People of Bhalukhop, Hilepani, Dhipidada and Muhan are using spring water for drinking purpose only whereas they are using stream water, lift water and rain water for livestock feeding, washing and cleaning etc.

After the gradual drying out of different sources and reduction in volume of available sources, there had been a huge scarcity of water in this area. So, people in this area discussed about different alternatives to solve the problem. They have established lift water system in different places. They established Birta Lift Drinking Water System in 2014 for 68 households in Birta from Sunkoshi River. There was similar type of water problem in Bhalukhop too. They also

established Agaute Lift Drinking Water System in 2014 from Kirate Khola, Simle for 140 households. There was a huge Chhatiwane Lift Drinking Water System established for 800 households of Ramechhap municipality in 2018 from which the people of Dhipidada, Muhan, Hilepani and Bhalukhop of area caw use water from Chhatiwane lift. Furthermore, they have apply a practice of one

Figure 3. Hill tank distribution

Source: Field survey, 2019

Comparatively study of water scarcity in the past 15 years and present

Water scarcity problem was a few years before in Sukajor village and it is gradually increasing over the time. They had to walk on foot to collect water any time. A huge crowd of people used to come from different places in the winter season at the water sources like Muldharo, Khirabote and Akaledharo. There used to be conflict between the people during washing and bathing. There was no proper management of water in the night time. Water continuously flowed at night. Similarly, in the sources like Tallo Kafle Pani, Mathillo Kafle Pani, Sim, Kali Kuwa, people had to sink their pots in the pond which mate the water impure.

The water scarcity remains in the village but the problems are of different nature and they had adapted the coping strategies according to the problems. There is availability of water in each household but not sufficient. They get water for an hour in every three days even they pay monthly charge for operating lift system. An intake has been made in the source but the sources are not cleaned regularly. In addition, due to the development of infrastructure, earthquake and climate change the sources are gradually drying out every year.

Fewer bath, fewer wash and fewer rearing of livestock are the main consequence of insufficient. Now rain water collecting tank has stalled house (figure 4).

Figure 4. Rainwater harvesting tank

Similarly, to fulfill the increasing water demand, a deep boring of 100 cubic meter capacity is under construction which is shown in figure 5.

Figure 5. Deep boring under construction

Source: Field survey, 2019

Table 6. Problem faced and adaptation strategies to water scarcity

Purposes	Before 15 years		Now	
	Problem	Adaptation strategies	Problem	Adaptation strategies
Drinking	Travelling longer distance to fetch water	Used to walk early in the morning for water collection	Not enough water	Use lift water
	More waiting time specially dry season	Separate the time for water collection	No water for several days in the absence of electricity	Fetch water from far distance in absence of electricity
	Dirty water due to open sources	Used to clean water sources daily	Problems in cleaning the sources	Consumers themselves clean the sources when unable to drink
	Traditional storage systems	Used to keep all water pots in queue	More waiting time	Modern storage systems
	Used to collect water at an inconvenient time (early morning or night)	Minimize water usage	Only fixed quantity of water in fixed time	Sometimes travel longer distance to fulfill the insufficiency
Livestock feeding	Used to fetch water from distant for livestock	Ponds were dug to collect rain water	Not enough	To keep less domestic animals
	Waiting several hours in queue	Used to harvest rainwater	Spend more time	Harvest rain water
	Frequent conflict over water	Outdoor feeding system	Problems due to absence of electricity in lift system	Fetch water from distant sources in absence of electricity
Washing	Crowded for washing clothes in Saturday or holiday	Wash the clothes except Saturday and holiday	Not enough	Use lift water
	Used dirty water from the pond using bucket in absence of tap	Have to wait for some time for clean and clear water	Taps are made but less water	Collect rain water
Irrigation	Manually carry water from distant for vegetable	Used to collect of rain water	Waiting rainwater for plantation	Food purchase from market
	No irrigation facilities	Wait for rainfall	No irrigation facilities	Plantation of water resistant crops

Source: Field survey, 2019

Conclusion

Water is essential for life; water shortage is the major problem in the study area. The water resources are drying up rapidly mainly climate change. Most of the available sources are also of the traditional type and not properly managed. The study shows the importance and necessity of conservation of water resources and its proper distribution. This study area lies in leeward side. So, less rainfall occurs even in the rainy season. Due to the steep topographical condition, heavy runoff occurs, and there is less possibility of recharging groundwater.

Most of the people are involved in agriculture and animal husbandry but they have to import agricultural and animal products from other places to fulfill their requirements. People are searching for different alternatives and opportunities for getting rid of such problems.

Many attempts are done to tackle with the problems of water scarcity. People are compelled to face many problems due to water shortage. It is important to manage the available water resources. They must preserve and conserve on the presence of local participation as much as possible. People should be made aware of the migration and its effect. The present required demand and the supply conditions should be made known to them. They have to follow a suitable coping strategy for the related problem caused by water scarcity. Not only this, but the concerned authority of different levels of government should also make water available to the people.

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