Declining Water Resources and Environmental Degradation: A Case of the Thulokhola Watershed in the Nuwakot District of Nepal

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Declining water resources and environmental degradation: A case of the Thulokhola watershed in the Nuwakot district of Nepal

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Introduction

Climate change alters the hydrology of a watershed through changes on precipitation patterns, extreme rain events, increase on temperatures, degradation of forest and soil resources and drought conditions. Drought conditions create stress on agricultural crops, forests, drinking water supply for human and wildlife as well as water supply for industrial uses. Flooding destroys crops, infrastructures, private properties, and results in loss of life. Climate change impacts both the availability as well as the quality of water resources as extreme rain events tend to alter water infrastructures and pollute water sources.

In Nepal, climate change impacts include degradation of resource and ecosystem services, shrinking water storehouses, shorter winters with earlier snowmelt and natural hazards (Schild, 2007), as well as rise in mean maximum temperature and changes in the dates for the beginning and the end of the monsoons (Hua, 2009). All of these are major environmental concerns that affect water resources in Nepal. The changes in the reliability of stream flow, erratic monsoons, and flooding (Timsina, 2011) have been pronounced in recent years and adaptation to climate change has become a major issue in Nepal (Feed The Future, 2011). As a part of a larger study on livestock climate change adaptation in the mid-hills region of Nepal, the specific objectives of this study were to: (1) assess the status of water sources in the mid-hills region of Nepal, (2) assess farmers' perceptions and understanding about the impacts of climate change on water resources, and (3) identify adaptation measures that the local communities have undertaken for climate change adaption for water resources.

Materials and Methods

The Thulokhola watershed is located 2.5 km south of Devighat in the Nuwakot district of Nepal that drains northward into the Trishuli river. The elevation of the Thulokhola watershed extends from less than 440 m asl at the Trishuli river to 1,585 m asl, and for this study the watershed was divided into three elevations (lower <640 m asl, middle 640 – 1,150 m asl, upper 1,150 – 1,585 m asl). The watershed has a total area of 580 hectares and contains 359 households. Historical hydrological data with precipitation coming from the nearby Bidur station for the Thulokhola watershed, and discharge rates for two nearby rivers: the Tadi and Betrabati rivers, were obtained from the Department of Metrology, Government of Nepal. While the total annual precipitation from 1985 to 2000 fluctuated between 1,600 -2,500 mm/year, the total annual precipitation decreased steadily from about 2,573 mm in 2000 to 882 mm in 2009 (Fig. 1). Similarly, total annual discharge rate of the Tadi River which peaked in 1978 with 20,026 m3/s and again in 2003 with 16,712 m3/s dropped to 9,269 m3/s in 2009, the lowest year on record for both the rivers.

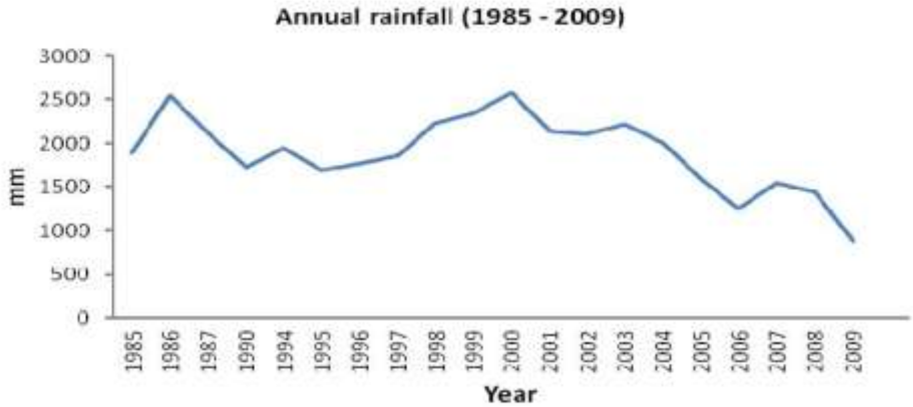

Fig. 1. Annual monthly rainfall in Nuwakot district of Nepal

Nine informal Community Livestock Groups (CLGs) were formed across the three elevations of the watershed in June 2011. The CLG members were invited to a workshop on July 3, 2011, where they were trained for water quality monitoring. Necessary materials for surface water quality monitoring were provided to the members from a portable LaMotte GREEN Water Monitoring Kit. Water quality monitoring started in July 2011 and ended in May 2012.

Six focus group meetings between the CLG focus groups and the interdisciplinary team of the scientists were conducted on January 3, 2012. In addition, a free style Participatory Rural Appraisal (PRA) was done in each of the three elevations on May 21-22, 2012. Surveys of water sources/springs and households in the Thulokhola watershed were done from May 17, 2012 to May 22, 2012. A total of 41 water sources in the three elevation levels were surveyed. Similarly, a total of 97 households were surveyed for a number of additional factors. For survey data, simple statistics such as mean, standard deviation, frequency and range were done in JMP 8.0. Focus group discussions and PRAs reports and information were gone through content analysis focusing on climate change exposure, sensitivity, and adaptive capacity.

Results and Discussion

Based on our water source survey results, 85% of the water sources have either dried up or have decreased water flow over the past 10-20 years in the Thulokhola watershed. Hydrogeologically, there are two main types of aquifers or flow systems, a regional and a local system in the watershed. The regional flow system is present in the foliated metamorphic rock that utilizes foliation and fractures as flow paths. The local flow system is present in the younger sediment and debris of the Pleistocene and Holocene deposits that is superimposed on the older rocks. There are three main types of springs related to these two major aquifer systems in the watershed: 1) those that flow from the foliated metamorphic rocks, 2) those coming from within the younger materials, and 3) those flowing from the contact between the two rock bodies. The most consistent and productive springs are from the third type whereas the smallest volume springs are from the first type. The springs that showed the greatest decrease in output over the last 10-20 years are those appear to come from the within the alluvium/colluviums younger materials (type 2 above). The springs that show no decrease over the same time frame come from the contact of the two rock units (type 3 above).

Confirming results from springs survey, the household survey results showed, on average, a household which was using five or more water sources 10 years ago has been using less than three water sources in recent years. Similar to the lower elevation (Fig. 2), a large number of respondents in the middle and the upper elevations reported that there is a severe decline in the flow of their water sources in recent years. Those water sources that once were perennial in nature have been turned into seasonal sources in recent years.

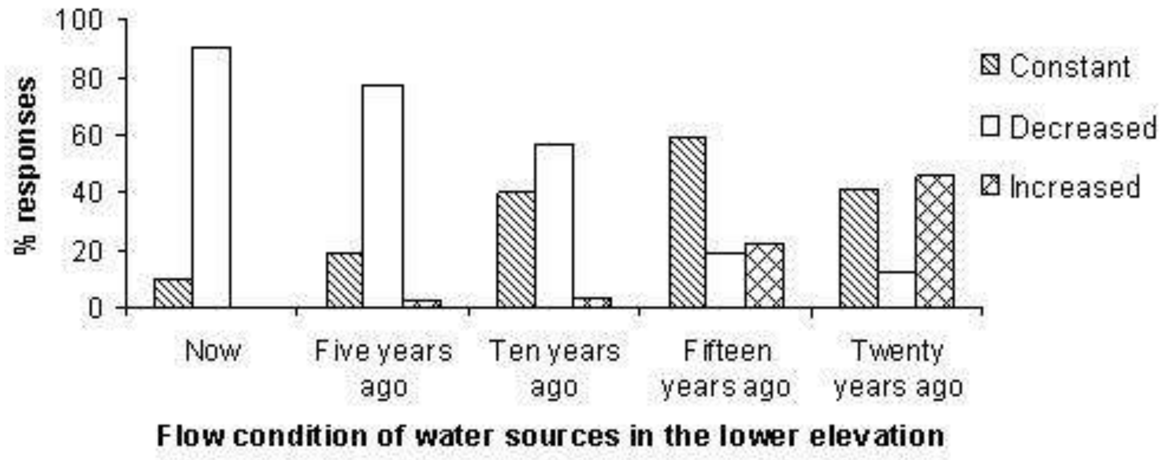

Fig. 2: Changes on the flow conditions of the water sources over the past 20 years in the lower elevation of the Thulokhola watershed, Nuwakot Nepal.

Water quality monitoring showed positive fecal coliform results, acceptable pH, and excellent DO conditions. Turbidity values were poor for July – September in the middle elevation, and July – October and February in the lower elevation. Nitrate values were poor August – October in the middle and the lower elevation. Similarly, phosphates values were poor July through October in the middle and the lower elevations. The higher level of phosphate and fecal coliform concentration is possibly due to inappropriate manure collection techniques in the watershed.

Based on the PRAs, five major climate change exposures among the Thulokhola watershed communities were: 1) drought, 2) declining crop productivity, 3) poor animal health, 4) drying-up water sources, and 5) the lack of fodder and forages. Drought conditions in recent years have taken a great toll on agricultural production in the Thulokhola watershed as farmers were unable to plant their crops in time which resulted in crop failures, poor harvest, and overall decline in agricultural productivity.

Conclusion

Climate change has severely impacted water resources in the mid-hills region of Nepal. Declining water sources in the region is a major concern for the local communities, agricultural production, and ecological integrity. The local communities have responded to this decline in water supply in various ways such as constructing water tanks at the sources, using pipes for drinking water supplies, diverting water from another spring, digging deeper wells, postponing or travelling far for washing clothes, or travelling further to fetching drinking water. In order to enhance water supplies and ensure ecological and environmental integrity of the watershed, specific initiatives such as reforestation, agroforestry intervention, conservation of surface runoff, protection of source water, and implementation of practices for groundwater recharge are suggested. While harnessing groundwater resources is a great possibility, it is necessary to characterize groundwater in terms of its availability, occurrence, local topography, rocks (water-bearing or nonwater-bearing), recharge characteristics, and groundwater flow for its development. It is also important to explore the possibility of artificial recharge of the water sources by creating ponds in the recharge zones filled with gravel and stone. Rainwater harvesting is another area to be explored for addressing water scarcity due to climate change impacts.

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