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TRANSFORMATION TOWARDS SUSTAINABLE
AND RESILIENT WASH SERVICES

Impact of climate change on WASH services: a case from Nepal

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Nepal is one of the most vulnerable countries to climate change, water-induced disasters and hydro-meteorological extreme events such as droughts, landslides and floods. A recent study conducted in Nepal on the impact of climate change on WASH revealed reduced yield, decreasing rainfall trend, change in rainfall pattern, increasing temperature, and high vulnerability water supply and sanitation schemes to risks. As per users' perception, yield of water sources reduced by 40% on average while analysis of secondary data revealed over 50% reduction in yield. This forced the communities to resort to different adaptive mechanisms including use of alternate/additional sources (28%), and introducing controlled water distribution mechanism (21%). Of the 49 schemes thoroughly assessed, 75% schemes have resorted to alternate sources to cope with the reduced yield. This paper will share the major findings from the study and highlight community led coping mechanisms to deal with climate induced changes.

Background

Nepal's mountainous and challenging topography and socio-economic conditions make it a highly vulnerable to natural hazards (i.e. chronic flooding, earthquakes, glacial lake outburst floods (GLOF), landslides) and is experiencing climatic changes. Based on the 2018 Inform Global Risk Index of the Inter-Agency Standing Committee (IASC) Reference Group on Risk, Early Warning and Preparedness, and the European Commission, Nepal is a country with a high (in a scale of very low, low, medium, high, very high) risk to humanitarian crises and disasters (INFORM, 2018). In terms of impact of climate change, Nepal is ranked as the fourth most vulnerable country (Maplecroft, 2011). According to the National Climate Change Impact Survey (2016), over 86 % of households surveyed reported experiencing drought in the past 25 years. Similarly, most of the household have observed change in the temperature as well as decrease in monsoon duration and winter rain while 84.6% of households reported that monsoon was delayed by 1 to 4 weeks. 57% observed delay in winter rain by one to four weeks (CBS, 2016). Data on temperature trends from 1971 to 2014 shows that the maximum temperature has risen at the rate of 0.056°C per year and pre-monsoon precipitation has reduced significantly by 0.74 mm per year in the high Himalayan region, and insignificant decrease in monsoon precipitation in majority of districts in central and eastern regions of the country and in other seasons, precipitation trends are insignificant in all physiographic region (DHM, 2016).

In the above context, UNICEF, WHO and OXFAM under the leadership of the Ministry of Water Supply and Sanitation jointly commissioned a study in 2017 to assess the impact of climate change on water, sanitation and hygiene services. This paper intends to present the summary of findings from this study and suggest measures to cope with the challenges induced by climate change.

Study objective and methodology

The main objective of the study is to assess the impact of climate change on Water supply, Sanitation and Hygiene (WASH) in Nepal and to propose appropriate climate adaptation measures for resilient WASH programming. The study was conducted in nine districts considering the representation of three ecological zones (Mountain, Terai and Hill) of Nepal. These districts included Mustang and Dolakha in mountainous zone, Achham, Bhaktapur, Dadeldhura and Jajarkot in hilly zone while Saptari, Dhanusa and Nawalparasi in Terai (plain) zone. It may be useful to mention that the word "Terai" in local language means "lands lying at the foot of a watershed" or "on the banks of a river; low ground flooded with water, valley, basin, marshy ground, marsh, swamp; meadow". The study used both primary and secondary data sources with quantitative and qualitative nature from the water supply schemes serving at least 50 households. The inventory of all qualifying schemes was prepared in close consultation with the District Water Sanitation and Hygiene Coordination Committee (DWASH-CC) of all nine districts. The process led to selection of 614 Water Supply and Sanitation (WSS) schemes. In addition, a total of 49 WSS schemes from nine districts (at least five WSS schemes per district) were identified for climate vulnerability and risk assessment based on the different set criteria such as population coverage, age of water scheme, hydro meteorological hazards, location, types of water source amongst others. The methodology for the climate vulnerability and risk assessment was adopted from the framework developed by the Ministry of Environment, Government of Nepal (MOE, 2016). The framework has been conceptualized on the basis of the Fifth Assessment Report on Climate Change. The climate risk at present situation at water supply scheme level has been assessed by assessing climate exposure, vulnerability, hazards and adaptive capacity. The primary data for vulnerability and risk assessment were collected by using participatory tools such as Focus Group Discussions (FGDs), Key Informant Interviews (KII), interaction with users during transect walk, hazard and risk mapping, historical timeline, seasonal calendar etc. from the selected 49 Water Supply and Sanitation Schemes. During the field data collection, android application based Kobo software system was used to inventory data which was transmitted online to the data server.

The meteorological data such as rainfall and temperature was obtained from different weather stations located in the study districts or nearby areas. Trend analysis was done for historical data observed during the past many decades. The climate vulnerability-risk assessment was carried out on the basis of water users' perception by considering multiples indicators which included i) hydro-climatic exposures (past climate trends and water yield changes at source), ii) hydro-meteorological hazards (floods, landslides, drought), iii) sensitivity of the schemes (physical, social, environmental) and iv) adaptive capacity of water users (technology, governance and knowledge, information & skills). Normalization of data was also used in this data by applying min-max method i.e., converting the data into dimensionless ratio in a scale of 0 to 1 by dividing the difference of a given value minus the minimum value with the difference of maximum and minimum value (data range). For certain indicators where normalization was not possible, rating method was used by categorizing them into a scale of 0 to 1. Data was also analysed using different indices such as climate vulnerability index, hydro-climatic exposure index, hydro-meteorological hazard index, sensitivity index, adaptive capacity index, and climate vulnerability and risk index. The definition of these indexes is available in the main report (UNICEF, WHO, and OXFAM, 2017).

Major findings

The major findings from the inventory of water supply and sanitation schemes, trend analysis of meteorological data (rainfall and temperature for the past 50 to 60 years), climate vulnerability and risk assessment, and users' perception etc. are presented in below sub-sections:

Inventory of schemes

The inventory of the water supply and sanitation schemes covered general features of the schemes, water quality parameters, Global Positioning System (GPS) location of sources, and yield measurement (flow rate) dry season. Below is the summary of basic information from the inventory analysis:

1. The study included 669 water supply schemes, out of which 55 schemes (8%) were found to be non-functional. Out of the remaining 614 functional schemes, 59% of the schemes (covering 75,576 households) was from hilly region followed by 32% (32, 822 households) from mountainous region and 9% (54,634 households) from Terai region (relatively plain areas).
2. In term of sources, 13 schemes (2%) used groundwater, 174 schemes (28%) fed by stream water, while 427 schemes (70%) were connected to spring sources.
3. The elevation of water schemes under study ranged from as low as 45 meter in Terai region to as high as 4,242 meter in the mountainous region.

4. The yield of stream sources ranged from 0.03 litre per second (lps) to 38 lps while for groundwater it ranged from 2 lps to 40 lps. For spring sources, it was from 0.01 lps to 10 lps. In case of very small yields, the communities were using alternate water sources available around the community.
5. Water quality test revealed compliance of pH level with national water quality standard by over 76%, arsenic level by 99% and iron level by 100%. Almost 80% of water sources were found to be free of faecal coliform (based on presence and absence method). This study show significant better results than found by other surveys previously. The advantage of this study was to have relatively a large representative sample size as compared to previous surveys.

Meteorological data

Rainfall and temperature trend

The results of trend analysis for rainfall data from a number of weather stations located in/or near to the study districts revealed significant decreasing trends ranging from 2.56 mm per year to 30.16 mm per year for some of the districts where the annual decrease was much greater than the national average. The rainfall data for other weather stations in the study districts showed insignificant increase of 0.33 mm to 2.43 mm per year. For one high altitude district, there were a remarkable increase of 11.2 mm per year. Analysis of data available for the last 30 years showed an increase of 0.01℃ to 0.04℃ per year for the annual minimum temperature trend. The results from the rainfall and temperature trend analysis are in full agreement with the perception of water schemes users in the study districts who reported decrease in rainfall and yield of water sources while increase in temperature (see below sub-section for detail).

User's perception of rainfall pattern and temperature change.

According to 88% of scheme users (540 of 614 schemes) the annual precipitation has decreased while 5% (31) users reported no change in annual rainfall and only 7 % (43) reported increase in annual rainfall trend. The decreasing trend of the annual rainfall perceived by the water user's committee has been supported by the annual total rainfall trend in the last decade (2006-2015) observed at the different meteorological stations in the districts. On average 59% of water users perceived that the seasonal rainfall duration has been decreased. Similarly, 84 % (516) of the users expressed annual temperature increased while 12% %(74) reported decrease in annual temperature and 4 % (24) reported stable temperature trend (no change in temperature).

Impact on WASH services

While measuring perception of users from the selected 614 schemes on various aspects, information was also captured regarding observed changes in the yield of water sources as compared to original yield when the schemes was first constructed and coping mechanisms to address the reduction of yield or drying out of sources, if any. The results revealed that 76% (in 467 schemes) of the users expressed decreased in water yield (on average 40% decrease) at source, 22% (in 135 schemes) users reported no change in water yield and only 2% (in 12 schemes) reported increase in water yield. The summary of coping mechanisms adopted by communities is shown graphically in Figure 1. As can be the seen from this figure, 28% (172) of the 614 schemes' users (or about 37% of schemes reported decrease in yield i.e. 172 of 467 schemes) have adopted alternate/additional sources (such as spring, stream, deep water boring, rain water harvesting) to supplement the existing sources while 21% have resorted to improved controlled water supply management (e.g., 4-5 hours/day supply instead of continuous supply), and rain water harvesting amongst others. On fourth of the users (23%) have not adopted any coping measures while only 5 percent users have built additional infrastructures like intake, reservoir tank, etc. to cope the situations. Out of 614 schemes inventoried, there are 171 (28%) schemes which did not have enough source yield to meet the demand of even the present population and some of the sources have dried out while others on the way to source drying up soon.

Decrease in water yield due to rainfall variability, decreased annual rainfall trend, and shortening of seasonal rainfall duration were found to be dominant factors for high hydro-climatic exposure index of the schemes in Hill and Terai Districts. Other factors such as increasing hot days and decreasing cold days also appeared to contribute to high exposure index value for the schemes located in the mountainous districts. The maximum rainfall duration with intense rainfall that triggered landslides was found to be four days in the study schemes, this damaged the scheme intakes in most of the cases. The minimum low flood depth perceived by the users was 1.5m in Paschim Pipra (Saptari District). In Terai, flood and inundation events were seen on annual basis while landslides and floods were observed in hilly region. Maximum drought period was reported to be 12 months in Birendra bazar (Saptari District) which caused a decrease of around 45% of the water while the shortest period was reported to be two months which had no change in water flow in Parasi.

Hydro-climatic hazards were found to be key factors adversely affecting the overall water supply schemes in the communities. For examples, increased frequency of landslides and erosion in the hill and mountain while increased duration and depth of riverine flood and inundation in Terai regions had severely impacted the intakes structures and pipeline network. Reservoir and treatment units were found to be less sensitive to hazard and climate variable as compared to intake structures and pipeline networks. Around 33% of the scheme intakes were highly sensitive at present. Intakes were mostly sensitive to flood disaster while the pipelines were mostly sensitive to landslides disasters. About 49% of the schemes pipelines were sensitive to flood, landslide and extreme temperature. Around 18% of the schemes were found to be highly sensitive to climate variable for sanitation and hygiene component.

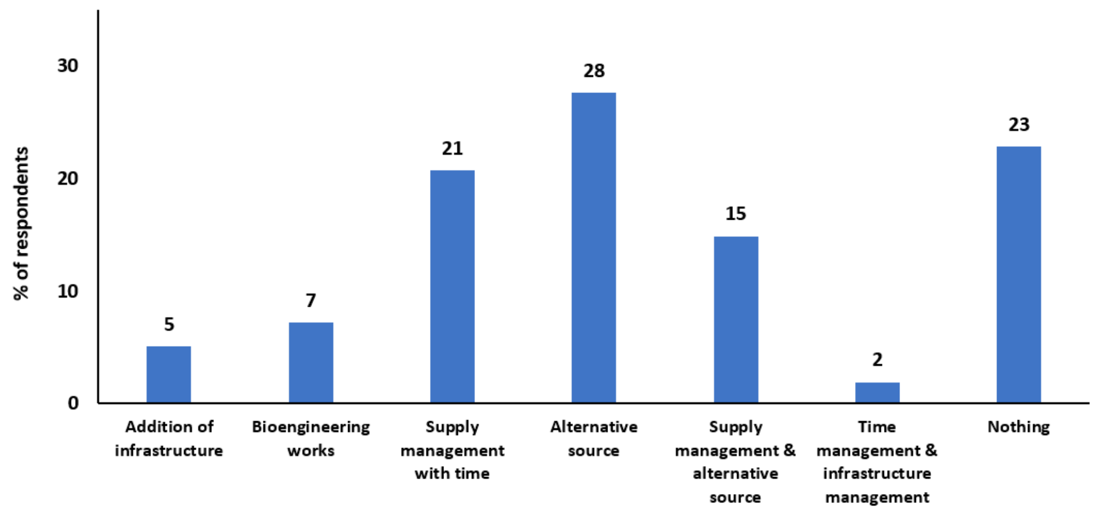

Figure 1. Coping mechanisms adopted by communities to address low yields reported

Similarly, physical, social and environmental sensitivity of water supply and sanitation schemes appears to contribute to high vulnerability of the schemes and thus further aggravating the impact of climate change. For example, water users have experienced increased sensitivity of water sources located in agricultural land to climate hazards and exposures as compared to the water source located in forests. The low water retention capacity, higher encroachment of the sources, and over exploitation of water for irrigation purposes have made agriculture land more sensitive to climate hazards and exposure as compared to forest areas where water retention capacity is relatively higher. In addition, human activities were also found to aggravate the impacts of climate change on the schemes. Anthropogenic causes such as road construction, grazing of domestic animals, deforestation, wildfire, illegal water tapping etc. have impacted both water quantity and quality. Grazing of domestic animals and easy access to wild animals around the source has degraded the water quality. The lowest value of adaptive capacity index of scheme was found to be correlated with weak governance and sanitation aspects. Inadequate women participation, weak linkage of management committees (of the scheme) with financial institutions and political networks were also contributing to low adaptive capacity index. Similarly lack of adaptation technology; limited access to knowledge, information and skills were associated with low value of adaptive index.

Coping mechanism of communities

The study identified users' adaptation practices under three broad categories of (i) governance, (ii) technology adaptation, and (iii) knowledge and skills of communities. Governance is all about power and authority of the management committees responsible for operation and management of water supply and sanitation schemes. Governance was measured using three sub-indicators related to linkage with financial institutions, women leadership, and involvement of members in social and political institutions. A good governance of water schemes was found to be one of the strong determinants of the effective coping mechanisms. For example, linkage of users' committee members with financial institutions and political networks was found to be strongly associated with functionality of schemes even during disasters. Availability of various technological options including structural and non-structural measures was found to be another coping mechanism to mitigate adverse impact of climate change. Resorting to alternative sources, adopting rain water harvesting, and water quality monitoring etc. were some of the technologies adopted by the users to ensure access to safe, well-functional and sustainable water supply schemes. Similarly, knowledge, information and skill of users' committees especially related to vulnerability risks and impact of climate changes on water schemes, and their adaptive capacity was found to be strong determinant for effective management and sustainability of water schemes. The results from detail analysis of adaptive capacity of communities from 49 schemes are summarized in Figure 2. As can be seen from this figure, 75% the schemes used alternative sources to cope with decreased yield. This figure also shows high level of women participation (87%) and prevalence of handwashing practices (96%) indicating a very good level of governance and knowledge and skills.

In order to cope with the adverse impact of climate change (reduced yields, drought, flood, delayed rains, temperature rise), communities have already incorporated a number of adaptative measures & practices with their own initiatives and resources for maintaining water supply and sanitation services. These practices include plantation, fencing around the intake, and diversion channel for the surface run-off, resorting to alternate water sources, rain water harvesting and recharging amongst others. The water users' group are also practicing time controlled water distribution system to cope with the decreased water yield to meet the minimum water demand of communities. Realization of low water yield of sources, in many instances, has led to careful and wise utilization of water. Likewise, other good practices include active participation of women and their role in water scheme management to create positive pressure to user's committee to take timely actions, hand washing practice with soap & water, water users linked with financial institutions, tapping of resources by taking benefits of personal involvements of committee members in political and social networks, budget allocation by water users for the schemes management amongst others. Some user's committees also mobilized funds through tariff collection for managing the water supply schemes.

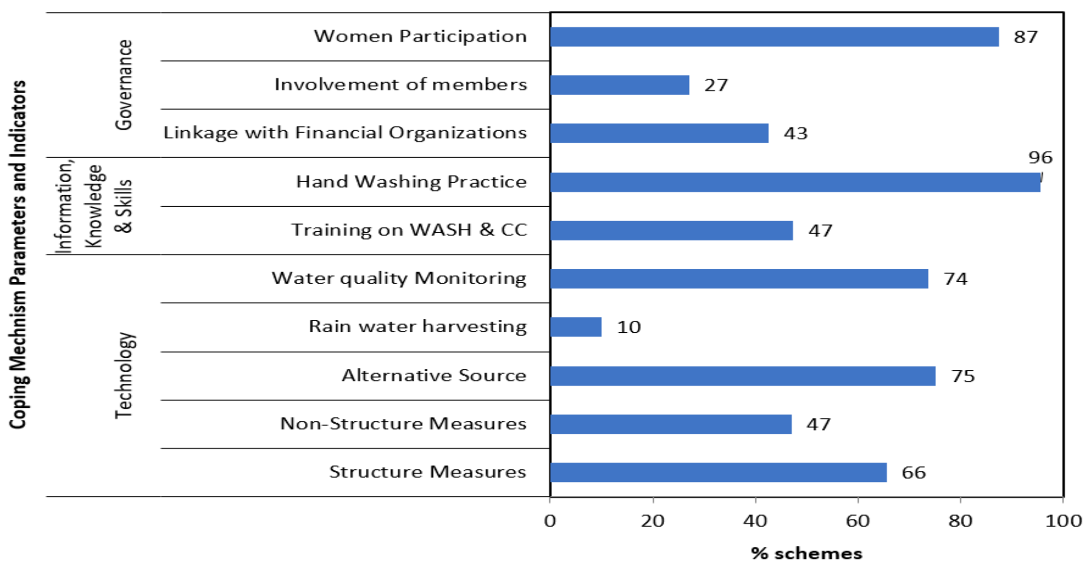

Figure 2. Adaptive capacity of communities from 49 schemes

Conclusion and recommendation

The findings from this study which are based on trend analysis of weather data of the Department of Hydrology and Meteorology for the past 45-60 years and perception of the users representing over 163,000 households (about 800,000 people) confirmed that the climate change has already affected the water supply and sanitation sector. Inventory analysis of 614 water supply and sanitation schemes revealed that 28 % of the schemes faced the challenge of insufficient water yield at source to meet the demand of the current population and some of the sources have dried out while others on the way to source drying up soon. 76% of users reported an reduction of 40% in yield of water sources while analysis of available secondary data on current yield to original yield revealed an average reduction of 50%. Reservoirs and treatment units were found to be less sensitive to hazard and climate change as compared to intake structures and pipeline network. Intake structures for around 33% of the schemes were classified to be highly sensitive mostly to flood. On the other hands pipeline network in 49% of schemes were found to be sensitive to flood, landslide and extreme temperature. Sanitation and Hygiene component was found to be highly sensitive to climate factors in 18% of the schemes.

Thorough analysis of 49 selected schemes revealed that communities in 75% the schemes used alternative sources to cope with decreased yield. Improved governance of users' committees (especially women participation, linkage with financial institutions and political networks), technological options available, and knowledge and skills of the users' committees were the major determinants for a good adaptive capacity and copying mechanism at the community level. However, there is a strong need to provide technical guidance and support to the communities to enhance their adaptive capacity. The 2017 August severe flooding (a consequence of climate change) in Terai region not only destroyed/damaged the water schemes but also affected household level sanitation facilities again indicating the need of climate adaptive and resilient water and sanitation structures (e.g., raise platform and toilets).

The study recommends mainstreaming disaster risk management and climate adaptive mitigation measures not only into policies, strategies, and plans; but also during the design and implementation of water supply and sanitation projects. Rain water harvesting, recharge of ground water resources, and effective water conservation and management should be promoted to address the issue of reduced yields of water sources. At the scheme/community level, the issues related to climatic and non-climatic factors affecting the functioning of water supply could be identified by conducting climate risk assessment to identify appropriate risk reduction measures as well as adaptation measures based on existing good practices. Regular monitoring of water yield and quality should be institutionalized, and behavioral change communication programmes need to prioritize the emerging issue of climate change and disaster risks.

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Note

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the government/organizations they work for.

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