IMPACT OF CLIMATE-INDUCED HAZARDS ON RURAL WATER SUPPLY FUNCTIONALITY - CASE NAWALPARASI

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ABSTRACT

Climate-induced hazards hinder the functionality and sustainability of water supply schemes in rural Nepal. As part of the Nawalparasi and Palpa Sustainable Water Supply and Sanitation Project, 80 users' committees of gravity-based water supply schemes, 73 Village Maintenance Workers and 1360 water users were interviewed to understand the frequency and impact of natural hazards on the functionality of water supply schemes. The study showed that especially climate-induced hazards, floods and landslides, affect the scheme functionality in the rainy season when the area faces extensive rainfall.

Based on a comprehensive case study conducted in Nawalparasi, the communities must often cope alone with the challenges without much support from the authorities. This has often led to delay and poor quality of repair works. In worst case, people have been left without safe drinking water for months. If not addressed immediately, climate-induced disasters have the tendency to turn into chronic problems. That is why, it is necessary that the support is close and easily accessible even for isolated communities. The newly elected local governments are well situated to provide timely support. Flexible funding mechanisms and technical support are needed to ensure water supply scheme functionality in long-term

KEYWORDS

Climate change, climate-induced hazard, flood, functionality, landslide, water supply

INTRODUCTION

The Nepalese water sector is known to suffer from functionality challenges. Although the water supply coverage has increased significantly in the last years to around 87 % in 2016, the functionality of the water supply systems has been frequently questioned. (SEIU, 2016). The Nationwide Coverage and Functionality Status of Water Supply and Sanitation in Nepal report from 2014 estimated that only about one fourth of the water supply schemes are functioning well, 36 % of schemes are in a need of minor repair and more than 39 % are in the need of major repair, rehabilitation or complete reconstruction. (NMIP, 2014). According to the Nepal Water Supply, Sanitation and Hygiene Sector Development Plan, reasons behind the functionality challenges are for example unclarity of ownership and management, poor planning and maintenance, environmental challenges and financial constraints (SEIU, 2015).

Nepal is very much affected by many natural hazards due to its challenging topography and weather patterns. Asian Disaster Reduction Center report on Nepal from 2014 states that Nepal is

ranked the 4th and 30th respectively in term of climate change and flood risk of all the countries in the world. Multiple hazards take place frequently in Nepal such as floods, landslides, fires, epidemics, and earthquakes. (ADRC, 2014).

Despite of the frequency of natural hazards, their impact on water supply functionality has been little studied. Nawalparasi and Palpa Districts Sustainable Water Supply and Sanitation project (NAPA WASH) 2014—2017, led by a Finnish non-governmental organization Waterfinns ry, studied the impact of natural hazards in the long-term functionality of water supply systems in Nepal. The study targeted gravity-based water supply schemes implemented during the Rural Water Supply a Sanitation Project Phases I, II and III (RWSSP), the first bilateral water and sanitation project between Finland and Nepal implemented between the years 1990 and 2005. The study sample consisted of 80 community-based water supply schemes in the hill and Inner-Terai areas of Nawalparasi and Palpa in the Western Development Region of Nepal. The study was planned and implemented in cooperation with the Nepalese company Centre for Appropriate Technology Nepal Pvt. Ltd. and received funding from the Ministry for Foreign Affairs of Finland and Maa- ja Vesitekniikan tuki ry. The objective of the NAPA WASH study was to assess factors that had had either negative or positive impacts on the long-term sustainability of rural water supply systems. This study looks in the impact of climate-induced hazard on the water supply functionality trough the following research questions:

- Do climate-induced hazards constitute a risk on the functionality of community-based rural water supply services in rural Nepal?
- Are communities able to cope with climate-induced hazards and what kind of support do they get to manage hazards and disasters?

CLIMATE-INDUCED HAZARDS AND DISASTERS IN NEPAL

Natural hazards are natural phenomena that potentially threat human society (Smith & Pentley, 2009). Climate-induced hazards originate in changes in climate such as in temperature or in precipitation. Climate-induced hazards include for instance droughts, heat waves and wildfires due to high temperatures and floods and landslides due to intensive rains. All societies and ecosystems are affected by the impacts of climate change and Nepal is considered being one of the most vulnerable countries to climate change in the world. The National Climate Change Impact Survey 2016 shows that between 1975 and 2005 in Nepal, the mean annual temperature has been increasing by 0.06 °C while the mean rainfall has been decreasing by 3.7 mm per month per decade (NPCS, 2016). Climate change is estimated to increase natural hazards in Nepal both in quantity and intensity including increased variability in precipitation patterns and water availability (NAPA, 2010). According to the Water, Sanitation and Hygiene Joint Sector Review, water will probably be the medium through which the climate change will have the most harmful effects (SEIU, 2014).

The National Climate Change Impact Survey 2016 shows that climate-induced hazards are very common in Nepal. According to the report, within the last 25 years, drought was observed as the top climate induced disaster by 86.1% of the interviewed 5,060 households followed by disease and insect (43.4%), hailstorms (32.5%) and floods (28.1%). The survey showed that within the last 25 years, 35.2 % of households had been impacted by landslides and 31.7 % by floods. Based

on the report, the most climate-vulnerable sectors of Nepal include agriculture, forestry, water and energy use, health and infrastructure. (NPCS, 2016). It is estimated that in Nepal, more than 1.9 million people are highly climate vulnerable and 10 million are increasingly at risk because of climate change (SEIU, 2014).

Disaster is the interface between a hazard and something of human value affected by the hazard (Blaikie et al., 1994). When hazards and disasters are considered, people tend to think of mega-scale events with large human and financial losses. Considering only large-scale events can cause misunderstandings when trying to analyze the big picture of disaster impacts. In a study by Shresta and Gaillard, data between the years 1990 and 2012 showed that the total number of recorded small and medium disastrous events over the studied years in Nepal was approximately 380 times greater than the number of large disasters in that period. What is more, the total estimated financial loss from the recorded small and medium disasters was about 2,000 times higher than from the large events. (Shrestha & Gaillard, 2015). Despite of the negative impact of these events, research and policy work has largely concentrated on the large disasters leaving smaller events unattended. Therefore, there is very little data available about the impact of small-scale natural events at the local level (Gaillard, 2016).

FUNCTIONALITY OF GRAVITY-BASED WATER SUPPLY SCHEMES

Most water supply schemes in rural Nepal are operated on a community-basis meaning that the water users are responsible for the everyday operation and maintenance of their own water supply system. The users are usually organized under a registered Water Users Committee (WUSC) which governs the scheme and has the right to collect water tariff from the users for scheme maintenance needs. Most schemes have also a trained Village Maintenance worker who has the responsibility to conduct any technical work needed to ensure the functionality of the scheme.

Most waters supply schemes in the rural hill areas of Nepal are gravity-based schemes. This is a very simple technology, in which the water flows down the pipeline on a gravity basis. If the water source is located above the water users, no pumping is required. The water source is mostly either a spring or a stream. In most cases, the scheme infrastructure consists of simple intake, collection and distribution chambers, reservoir tanks, pipelines, valves and tap stands.

In this analysis, scheme functionality was assessed through service level analysis which measures how well the scheme fulfills its requirements for water quantity, accessibility, water supply reliability, and water quality. Quantity-Accessibility-Reliability-Quality service level analysis is based on the World Health Organization Guidelines for Drinking Water Quality (WHO, 1997). The reference indicators are context specific. In this study, the Ministry of Physical Planning and Works Rural Water Supply and Sanitation National Policy 2004 criteria for drinking water service level was used as a basis for the analysis:

- Quantity: Water quantity for domestic use should be 45 litres per capita per day.
- Accessibility: All households should be able to fetch water within 15 minutes per round trip.

- Reliability: There will be few, if any, unscheduled outages, prompt repairs when breakdowns occur, minimum system downtime and little significant seasonal variation in water supply to users.
- Quality: Water quality should meet minimum World Health Organization standards.

METHODOLOGY

The research consists of both quantitative and qualitative part. The quantitative data collection targeted WUSCs, VMWs, Village Development Committee (VDC) officials and water user households of 80 water supply schemes in the hill and Inner-Terai areas of Nawalparasi and Palpa in Western Nepal. The quantitative data collection was done through structured interviews and it was conducted by Nepalese enumerators in Nawalparasi between 16.1.2015 and 5.2.2015 and in Palpa between 19.3.2015 and 10.4.2015. The 80 water supply schemes were located in 47 Village Development Committees. Per each scheme, 17 user households were interviewed. The final sample size is presented in Table 1.

Table 1. NAPA WASH study sample size

NAPA WASH	NAWALPARASI	PALPA	TOTAL
VDC	24	23	47
WUSC	40	40	80
VMW	39	34	73
HOUSEHOLD	680	680	1360

The quantitative data provides answers to questions such as what kinds of hazards have had impacts on the scheme functionality, how frequent have these hazards been and what kinds of impacts have they had on the water supply service functionality in the last 10 years.

To gain a better understanding of the perception of WUSCs in managing the hazards and disasters and maintaining their scheme functionality, a purposeful, multi-case sampling was selected for the qualitative data collection. The qualitative data collection targeted five WUSCs in Nawalparasi that based on the quantitative data reported experience in natural hazards causing harm on their water supply services. Naturally, WUSCs that had never faced any functionality challenges due to natural hazards could not give as information rich data about their capacities to cope with the phenomenon as communities that had experience in the issue. The qualitive research included interviews and observations that took place between 15.3.2015 and 8.4.2015.

The final sample included *Bisaltar Water Supply and Sanitation Scheme* in Devchuli Municipality, *Dhuwad Water Supply and Sanitation Scheme* in Dedgaun VDC, *Jousimajhuwa Water Supply and Sanitation Scheme* in Dedgaun VDC, *BahaKhola Water Supply and Sanitation Scheme* in Rakuwa VDC and *Mithukaram Water Supply and Sanitation Scheme* in Mithukaram VDC. Among the

sample VDCs and municipalities, the Devchuli Municipality is located in Inner-Terai and the rest are located in hills.

RESULTS

In the quantitative study, the WUSCs were asked to estimate the frequency that given climate-induced hazards had negatively impacted the functionality of their water supply schemes in the last 10 years. The results showed that especially landslides and flooding had caused harm on the water supply functionality in the study area (Figure 1). More than half of the WUSCs reported that landslides (68%) and flooding (54 %) had had a negative impact on the water supply functionality. In total, 23 % of WUSCs reported landslides and 20 % reported floods for causing harm more than 5 times in the last 10 years. These are high figures taken that the question considered only hazards that had caused harm on the water supply systems. Other hazards were not reported. Floods were reported more in Nawalparasi than Palpa and landslides were reported equally in both districts.

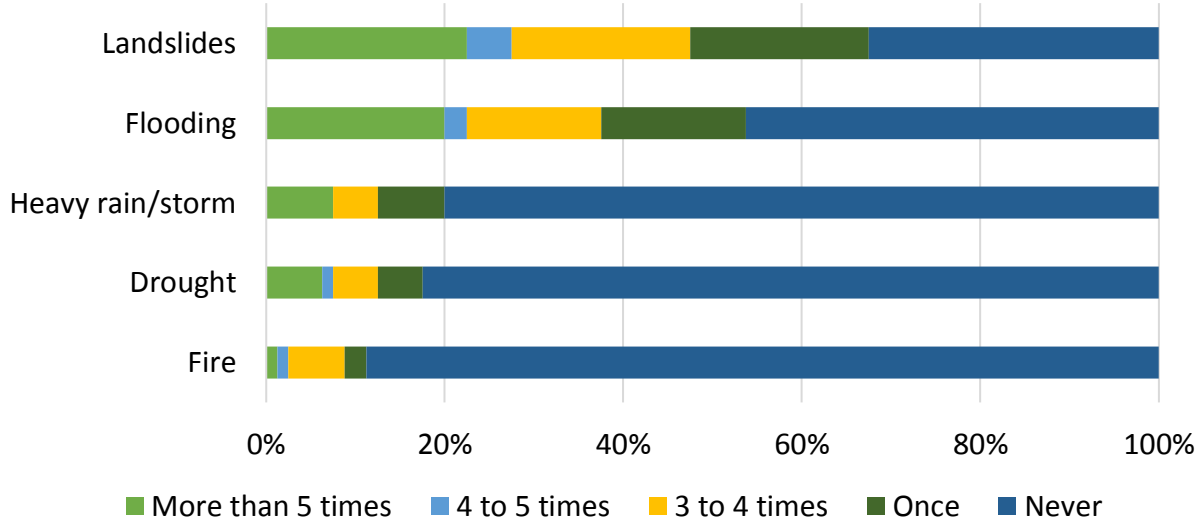

Figure 1. Frequency of hazards that had had a negative impact on water supply functionality in the last 10 years.

When asked about the impact of landslides on the water supply functionality, physical damage of scheme structures was reported in 93 % of cases, depletion of water flow in 20 % of cases and economic losses in 13 % of cases. Flooding on the other hand was reported to cause physical damage in 100 % of cases, depletion of water flow in 33 % of cases and economic losses in 23 % of cases. The impacts are connected: damage of the scheme structures can lead to depletion of water supply and to economic losses.

Interviews conducted in the five case locations in Nawalparasi support the findings. All the five WUSCs had experienced floods harming their water supply service functionality in the last 10 years. Based on the field assessment interviews, both landslides and floods occur mostly during the monsoon season, the period from July to September, when the area faces extensive rainfall.

The physical damage mostly means damage of the scheme infrastructure: dam intake, collection chamber, distribution chamber or pipelines. What is typical for both flooding and landslides is that they cause chronic problems: they tend to occur again each year.

Landslides and flooding have a negative impact on the service level indicators quantity, accessibility, reliability and quality. In addition to the damage of the scheme structures which naturally hinders the water supply quantity and reliability, based on the qualitative interviews, flood waters often bring plenty of mud and other substances into the water supply system. This worsens the water quality and can even block pipelines. If the scheme becomes dysfunctional, it means the water users need to go for alternative sources for their water which naturally affect the accessibility. Based on the quantitative data, only one fourth of the studied water supply schemes included any water treatment technology such as sedimentation tank or filters. This makes the schemes very much vulnerable to water quality changes especially in the rainy season when surface waters may enter the scheme. In theory, the water sources should always be protected in a way that no unwanted surface waters can enter. Based on the field observations, this is not often the case. All the five WUSCs reported suffering from water quality challenges and mentioned the monsoon rains being the reason for water quality changes. Entering surface waters predispose the scheme water also for bacteria which increases the risk of waterborne disease.

According to the theory of Shrestha and Gaillard, small-scale disasters may have significant importance to communities but for their size, they do not usually affect much attention beyond the people affected. Therefore, the affected groups are easily left to cope on their own. In case they do not have the means to protect themselves, the consequence might be that each disaster makes the community even more vulnerable to future disasters. (Shrestha & Gaillard, 2015). This theory applies well to the context of this study as during the field assessment, various examples were observed in which disaster impacts that had been left without proper response, will most likely contribute to new disasters again. For example, approximately two years before the study, the BahaKhola scheme transmission pipeline got completely blocked by mud and no water got through during the following six months. The problem was solved when the WUSC received a piece of high-density polyethylene pipeline from the VDC, dug out the blocked galvanized iron pipeline and installed the new pipeline on the ground surface. However, this solution is not very sustainable taken that it did not solve the initial problem - the lack of source protection that enables mud to enter the scheme when the area faces heavy rains. On the other hand, the new pipeline is even more prone to hazard impacts as it runs on the ground surface rather than underground.

The interviewed WUSC declared to suffer with both technical and financial constrains with keeping their schemes functional when facing harmful hazard events. Despite of the presence of VMWs, the quality of repair works left often space for improvement. During the field visits to the five case schemes, it was observed that broken pipelines were often repaired with cloths wrapped around leaking pipeline junctions or supported with wooden sticks. It is easy to estimate that these repair solutions are not long lasting and will probably contribute to future challenges. It was also observed that some VMWs were not proactively maintaining and protecting the schemes from potential disasters but taking actions only when problems occur. Only 19 % of WUSCs and 12 % of VMWs declared they had sufficient tools to repair schemes.

WUSCs have the right to collect water tariff from water users and 65 % of the studied WUSCs did so the average water tariff per household per month being 26 rupees. The collected money is used for paying for VMW services and for scheme maintenance. All the five sample WUSCs included

in the qualitative data collection, had been collecting revenues from water users at least at some point of the scheme lifetime and had also used this money to cover scheme repair expenses such as purchase of new pipeline and reconstruction of an intake. Based on the quantitative data, approximately in one third of the flooding cases and in one fourth of the landslide cases, WUSCs had needed to use economic resources to maintain the scheme functionality but only 21 % of WUSC reported that their current income was enough to cover all necessary operation and maintenance expenses.

In case of severe damage, the WUSCs must often search for external aid. In times of the NAPA WASH study, the possibilities included mostly VDC, District Development Committee (DDC), District Water Supply and Sanitation Division Office (DWSSDO) and District Soil Conservation Office (DSCO). In the inteviews, 62 % of the VDC officials reported having allocated at least some funds to water supply functionality in the previous year. Also, all the five case WUSCs had been able to receive support either from VDC, DDC, DWSSDO or DSCO during the scheme lifetime.

Despite of these positive examples, the WUSCs brought up common difficulties in receiving help after disasters events. All the WUSCs brought up the fact that even though there is the possibility to request for funding from district-level organizations through the VDC office, the process requires paying a visit in the district headquarters to request for support at the corresponding institutions. Four out of five of the case WUSCs were located far from the Nawalparasi district headquarters and travelling there would require both time and money. The distance is a problem is two ways: BahaKhola WUSC had requested for help when their pipelines was damaged by a landslide and as a consequence, DWSSDO had allocated them three pieces of six-meter-long galvanized iron pipe. By the time of the interview, the pieces were still at the district headquarters as the WUSC has no means to transport them to Rakuwa VDC.

Requesting financial support from higher tiers of administration can be a bureaucratic and time-consuming task for an isolated rural community with small resources In time of the study, each request was circulated through several tiers of administration until the decisions were taken on the central level. Due to the bureaucratic system, schemes that requested support this year, would most probably receive support only next year, in the case that they would fit in the budget. This is of course frustrating for water users who may need to wait months in uncertainty or even without drinking water supply. The WUSCs also had the experience that personal connections play a role in receiving support: without the right connections help is more difficult if not impossible to get. As there is often no budget for immediate needs, there is neither a way to repair the scheme immediately when problems arise. This naturally hinders the sustainability of the services.

DISCUSSION

Currently, Nepal is going through historical changes as governmental power is transferred from the central level to elected local units. This gives an unprecedented possibility to solve some of the challenges listed in this article: distant, hard-to-access authorities, bureaucratic and time-consuming budgeting cycle and the lack of timely technical and financial support to the rural communities in need. Municipalities are now governed by democratically elected bodies which

takes the decision making closer to people. This increases both the citizens' opportunities to influence the decision-making and the accountability of the local authorities to support the citizens. The reform can potentially improve the local governance capacity to provide more timely support and flexible funding mechanisms.

The NAPA WASH study showed that the communities need not only financial support but also technical and management support in order to maintain the functionality of their schemes. When the support is provided at the at the municipality level there is a chance that even the most isolated and deprived communities can access it. This would make it possible to respond to the acute repair challenges of schemes immediately before problems become chronic.

Municipalities have now the right to collect tax revenue and their improved financial status makes them capable to support communities financially. This is also a good momentum to establish innovative and flexible funding mechanisms between the Municipality, communities and the private sector. Municipalities should establish user friendly procedures and transparent criteria for requesting and receiving support. Currently, one of the challenges in establishing support mechanisms at the municipality level is the lack of skilful technical staff. It was a clear finding of the NAPA WASH study that many WUSCs are struggling in maintenance issues due to the lack of both skills and adequate tools. Municipalities should give the communities technical support to ensure that the schemes are both protected and repaired in an adequate manner to prevent any future disasters.

CONCLUSIONS

This article analysed the impact of climate-induced hazards on the functionality of community-based rural water supply services in Nepal, the abilities of the communities to maintain the scheme functionality against the hazards and the support the communities receive to manage the situation. The study showed that climate-induced hazards are common in Nepal and especially landslides and flooding cause harm on the water supply services during the monsoon season when the area faces extensive rainfall. These hazards contribute to physical damage of the scheme structures, worsening water quality due to flood waters as well as pipeline blockages and depletion of flow.

The study showed that the communities had been relatively successful in coping with disasters: all the five case WUSCs had been able to recover their schemes functional again. All the case WUSCs had also received support from authorities. The challenges found were the struggles in requesting for support from distant authorities, long wait before the support arrives and the lack of skills and resources in repairing and protecting the scheme in an adequate way to avoid future disasters. When a disastrous event occurs, the need for help is acute: drinking water is a basic need and a human right and that is why no community should remain without functional water supply for long.

It is predicted that the number of climate-induced disaster will increase in the coming years and water is one of the sectors it will affect most in Nepal. The same time, Nepal is going through historical changes as governmental and financial power is transferred from central level to elected local units. These changes have the potential to solve many challenges analysed in this report as the reform brings decision making and support closer to the communities. The municipalities must

establish transparent and flexible support systems to answer to the acute needs of communities and to ensure enough skilful staff that are available to give practical support to the communities. The NAPA WASH study showed that this far communities have been left too much alone in their struggles which has led to delayed action and poor quality of repair works. It is important that the support is available immediately after disaster events to prevent them from causing chronic problems.

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