Impact of Earthquake on Water Resources in Selected Earthquake Hit Areas

Adaptation Practices and Planning in Namobuddha Municipality, Kavre-palanchowk District

Final Report

Jalsrot Vikas Sanstha (JVS)/GWP Nepal
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Disclaimer

The findings, interpretations and conclusions expressed herein are those of the author(s) and do not necessarily reflect the views of the institutions.
Foreword

This research was part of Water and Climate Resilience Program (WACREP) activity of Jalsrot Vikas Sanstha (JVS)/GWP Nepal. JVS/GWP Nepal highly appreciates the contribution of the study team Mr. Somnath Paudel and Ms. Anju Air. JVS/GWP Nepal also acknowledges the contribution from Mr. Tejendra G.C. during the preparation of this publication.

Jalsrot Vikas Sanstha/GWP Nepal
Executive Summary

Earthquake has been notoriously devastating Nepal since time immemorial. Nepal is ranked 11th globally in terms of relative vulnerability to earthquake. The impacts of earthquake are more studied on physical, social and geographic sectors but impacts on water resources are less documented.

JVS/GWP Nepal evaluated visible impacts on water resources caused by the Gorkha earthquake in Dapcha-Kashikhand Municipality (Kavre-palanchowk district), Chandragiri, Dakshinkali Kirtipur Municipalities and Bagmati river (Kathmandu district) in 2016. The study confirmed that most of the ponds, stone spouts and springs were affected. Although, there lies other factors responsible for drying up of water sources, earthquake is equally responsible for impacts on water sources.

Recent study analyzed the adaptation strategies, plans and practices adopted by locals in Namobuddha Municipality (Previous Dapcha-Kashikhand Municipality). The main objective of the study was to identify the water focused adaptation planning/strategies and practices adopted at community and municipal level of Namobuddha Municipality, Kavre-palanchowk District. Focus Group Discussion (FGD), Key Informant's Interview (KII) and site visit were done to gather information on adaptation planning and practices. The study found that the community people have been adopting coping strategies to combat the impacts of water scarcity. However, at municipal level there has been planning and actions taking place. Environment Friendly Local Governance (EFLG) program, has been beneficial to address the water scarcity at local level in some parts of the municipality. Tole Level Organization (TLO) has been established as a sister organization of municipality, identifies the environmental issues of the area and reports to municipality. Likewise, installation of Rainwater harvesting plants, construction of plastic ponds and climate change issues have been prioritized by municipality.

The study concludes that there is socio-economic water scarcity in the area. It recommends that the water security in the areas can be achieved through installation of rainwater harvesting plants, restoration of traditional spouts, identification and conservation of recharge ponds etc.
**Acronyms**

B.S.- Bikram Samvat

DO- Dissolved Oxygen

DPCC- Daraune Pokhari Conservation Committee

EFLG- Environment Friendly Local Governance

FGD- Focus Group Discussion

GOs- Governmental Organizations

KII- Key Informant's Interview

LAPA- Local Adaptation Plan of Action

NAPA- National Adaptation Plan of Action

NCCSP- Nepal Climate Change Support Program

TLO- Tole Level Organization

VDC- Village Development Committee

WASH- Water Sanitation and Hygiene

WLO- Ward Level Organization

WUA- Water User's Association
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1. Introduction

A. Background

The Gorkha earthquake hit Nepal on April 25, 2015 severely affecting the lives, property and natural resources. However, the impacts on water resources were not properly documented. Previous studies have confirmed the impact of earthquake on water quality and quantity. In addition, it affects the local hydrological cycle of the area changing the hydrology for short to long term. Generally, the studies have confirmed qualitative and quantitative changes in rivers, dug wells, ponds, springs and stone spouts. Although, other factors such as climate change, urbanization, land-use pattern have also been responsible for alteration of qualitative and quantitative parameters of water sources, the cumulative impact of these have worsen the impact.

In this regard, some global studies have been relevant to cite. Among many, washing of silt and mixing of untreated sewer into water bodies increased the concentration of suspended sediment and caused impacts on water quality in the Canterbury Earthquake. The water bodies had low Dissolved Oxygen (DO) levels, high ammonia concentrations, and an accumulation of contaminant in riverbed sediments. Some qualitative changes such as the decreased concentration of DO observed in the areas affected by the Earthquake. Some springs stopped flowing, however many increased in rate of flow, and new springs were created. The short-term as well as long-term fluctuations in water quantity has been recorded in 2010-2011 in the Canterbury Earthquake, New Zealand (Potter et.al.2015). These ultimately impacts runoff, reduced level of ground water, increased rate of evaporation etc. Besides earthquake, natural disasters such as landslide, debris flow and drought has also been responsible for affecting the water resources in local region (Ghobarah et.al., 2006).

With these changes, the locals have been adapting with water quality and quantity since a long time. Adapting with water quality and quantity is the only option left behind. In general terms, adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their impacts. The adaptation may be planned or autonomous. Planned adaptation carry a vision and goal with some targets at local or national level. Planned adaptation requires the use of present and future information to review the suitability of current and planned practices, policies, and infrastructure (Füssel, 2007). Autonomous adaptation is defined as
adaptation that does not constitute a conscious response to climatic stimuli (Füssel, 2007). Autonomous adaptation comes with the costs and damages (Smit and Pilifosova, 2003). As locals tend to adapt to climatic changes very fast as they have to cope with. Coping with little knowledge or no knowledge at all can be dangerous and may jeopardize future adaptive actions. The main aim of the adaptation is to build robust and resilient communities with increased adaptive capacity of the affected people. Resilience, vulnerability and adaptive capacity are interrelated. The adaptive capacity is determined by the capacity of the local peoples to develop new coping techniques to combat (Engle, 2011). As illustrated in fig. 1, there are different other factors to identify adaptation process, with whom to adapt and what is the evaluating process of adaptation?

*Figure 1 Illustrative diagram of types of adaptation (Smit and Pilifosova, 2003)*
Kavre-palanchowk is one of the District hit by the Gorkha Earthquake with severe impacts on water sources. Past research by JVS/GWP Nepal in 2016 have found significant impact of the Earthquake on quality and quantity of water sources in the Namobuddha Municipality (previous Dapcha-Kashikhandha Municipality) of the District. The study confirmed that the locals have been affected by the water scarcity. The direct impact has been seen in agriculture, animal husbandry, social harmony and household water use. The locals have replaced the more water requirement crops with the lesser ones. Similarly, large mass domestic animals have been replaced by smaller ones. This has been ultimately affecting the economic conditions and livelihood of locals. Often, the limited water availability has been blamed for conflicts among the neighboring villages too.

This study analyzes water focused adaptation planning and practices at the Government and Community Level and identify the adaptation strategies with climate change and other disasters in the Namobuddha Municipality, Kavre-palanchowk District.

**B. Adaptation Strategies**

Adaptation strategies are important for adaptation and building adaptive capacity at the Community and the Government level reducing the vulnerability of the locals. These strategies can be:

A) **Building adaptive capacity** – To build adaptive capacity, creating the information such as research, data collecting and monitoring and awareness raising are crucial. The supportive social structures such as organizational development, working in partnership and institutions are other pillars to build adaptive capacity. Supportive governance such as regulations, legislations and guidance are also vital for delivering adaptation actions\(^1\) (Fig.2).

B) **Delivering adaptation actions** – These include range of actions helping to reduce vulnerability or to exploit opportunities. Adapting to climate change includes the practices such as crop diversification, irrigation, water management, disaster risk management and insurance. Such practices are undertaken by a range of public and private actors through policies,

\(^1\) [http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf](http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf) (retrieved on 10 October 2017)
infrastructures, technologies and behavioral change. These adaptation measures can be helpful to build adaptive capacity of the individuals and societies\(^2\).

![Diagram of climate and non-climate risks]

*Figure 2* Identifying Adaptation Options (Source: [http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf](http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf))

**C. Review of Adaptation at Local Level in Nepal**

Locals have been adapting to adverse climatic scenarios since ancient times knowingly and unknowingly. Since adaptation to climate change is an incremental process that can build upon a long history of previous adaption, there is the need to adapt much more rapidly because of the impact of human activities on climate (Burton, 2000). At national level, the adaptation to climate change in Nepal started with the formulation of National Adaptation Plan of Action (NAPA) in 2010. In line with NAPA, to implement its prioritized activities Local Adaptation Plan for Action (LAPA) has been adopted at local level. LAPAs poses pivotal role for local governments in planning and implementation of local adaptation activities for climate change induced impacts. LAPA has been implemented in 14 Districts of Far and Mid-Western Region of Nepal and has

\(^2\) [http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf](http://www.ukcip.org.uk/wp-content/PDFs/ID_Adapt_options.pdf) (retrieved on 10 October 2017)
been crucial for the climate change adaptation purposes. Within LAPA, the main adaptation activities are categorized in six thematic areas:

a) Human Health  
b) Agriculture, livestock and food security  
c) Alternative energy  
d) Climate induced hazards and infrastructure  
e) Forest management and biodiversity  
f) Human resources, capacity building and livelihood

Over a period of 2013-2016, Nepal Climate Change Support Program (NCCSP) has implemented more than 2,303 adaptation activities benefitting 600,000 vulnerable people with direct beneficiaries of 3,62,186 individuals. LAPA framework has been designed with extensive studies focusing on vulnerability of each households. LAPA has well-structured 7 steps envisaging bottom-up, inclusive, responsive and flexible approaches (Fig.3).

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D. Study Objectives:

The overall objective of the study is to identify the water focused present and future adaptation actions at local level.

The main objective of the study is to identify:

- water focused adaptation planning/strategies and practices adopted at community and municipal level, Namobuddha Municipality, Kavre-palanchowk District.
2. Methodology

a) Primary Information

I. Community Consultation:
The community consultation was done through Key Informant's Interview (KII) and Focus Group Discussion (FGD) in Ward Number 14 of the Namobuddha Municipality, Kavre-palanchowk District in early June 2017. Stakeholders consisting of representatives from Water Users Association (WUA), members from Women's Group, Youth Club and Chairman and other members of Daraune Pokhari Conservation Committee (DPCC) had been consulted to obtain information on adaptive measures at Community Level. The checklists were used comprising information on adaptation planning and practices being adopted at the Local Level.

II. Consultation with Municipality Officer:
The Municipality Officer was consulted to assess present and future adaptation planning and practices at municipality level.
b) Secondary Information:

The published reports, articles, papers on local level adaptation planning and practices have been reviewed for the study.

3. Study Area

The study was carried out at Namobuddha municipality of Kavre-palanchowk District. The District has an area of 1,396 sq. km. and a population of 381,937. Dhulikhel is the District headquarter. The literacy rate is 69.8% with 58.7% economically active population (CBS,2011). The total number of households are 72,846 and 85.5% of local people have safe drinking water facilities (CBS, 2011). Situated in mid-hilly area having subtropical climate with elevation range of 280m-3018m, the District also carries potential for internal tourism. The District is bordered to the East by Ramechhap and Dolakha, West by Kathmandu Valley, North by Sindhupalchowk and South by Sindhuli and Makawanpur. The Namobuddha Municipality is recently declared municipality in Kavre-palanchowk District. The study area comprises of five wards 2,6,7,8 and 9 from Daraune-Pokhari VDC. The Municipality has total population of 29,926 in eleven wards with 13,984 males and 15,942 females.

Figure 4. Gender Composition of Population in Namobuddha Municipality (CBS,2011)
Figure 5 Map of Nepal highlighting Kavre-palanchowk District

The sources of water in Kavre-palanchowk District has been categorized in Table 1 below.

Table 1 Sources of drinking water in Kavre-palanchowk District (CBS, 2011)

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Sources of water</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tap water</td>
<td>79.1</td>
</tr>
<tr>
<td>2</td>
<td>Tube well</td>
<td>0.27</td>
</tr>
<tr>
<td>3</td>
<td>Covered well</td>
<td>6.18</td>
</tr>
<tr>
<td>4</td>
<td>Uncovered well</td>
<td>6.45</td>
</tr>
<tr>
<td>5</td>
<td>Spout</td>
<td>5.90</td>
</tr>
<tr>
<td>6</td>
<td>River/stream</td>
<td>0.67</td>
</tr>
</tbody>
</table>
Kavre-palanchowk District has 79.1% of water supply from tap water while the large portion of locals still depends upon uncovered and covered well. The traditional water spouts are third largest source of drinking water in the District.

Figure 6 Map of Kavre-palanchowk District indicating Namobuddha Municipality
4. Findings and Discussion

Locals lack concrete plan to adapt with climate change and other disaster induced adversities. They are more reliant on short-term coping activities plummeting their vulnerability on long. The present adaptation scenarios are not enough to sustain water requirements in the District. The Municipality is under dire shortage of water supply for domestic and agricultural use. Some of the adaptation practices at community level in the Namobuddha Municipality of Kavrepalanchowk District has been categorized in Table 2.

A. Adaptation Planning and Practices at Community Level

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Adaptation Options</th>
<th>Description</th>
<th>Measures Being Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preventing losses incurred by scarcity of water resources</td>
<td>Take action to reduce the exposure to climate impacts</td>
<td>Some of the villagers have been lifting Rosi river water for drinking purpose but this is costly for them.</td>
</tr>
<tr>
<td>2</td>
<td>Tolerating losses induced by water scarcity</td>
<td>Accept losses where it is not possible or cost-effective to avoid them</td>
<td>The locals are accepting the water scarcity losses and compromising with daily water requirements.</td>
</tr>
<tr>
<td>3</td>
<td>Spreading or sharing losses</td>
<td>Distribute the burden of impacts over as larger region or population beyond those directly affected by the climate event</td>
<td>Sharing the losses has been one of the key adaptation strategies adopted by locals.</td>
</tr>
<tr>
<td>4</td>
<td>Changing use or activity</td>
<td>Switch of activity or resource use</td>
<td>The locals have been switching off their occupation due to scarce water resources. Locals have shifted towards less water requiring crops. Likewise, large domestic animals with high water requirements have been replaced by less water requiring animals. This has impacted local’s income and livelihood.</td>
</tr>
</tbody>
</table>
5
Changing location
Migrate to an area which is more suitable under the changed climate
None of the cases have been observed for internal or external migration due to shortage of water but locals informed that they may change the inhabiting place if the same situation prevails.

6
Restoration
Restore assets to their original condition following damage or modification due to climate/water scarcity
There have been some restoration activities observed in the area.

Adaptation options Adopted from Burton’s Classification of Adaptation (Burton, 1998)

The locals are supportive to adaptation activities in the area initiated by Municipality but they are lacking concrete plans to enhance water security. The locals have been coping with water scarcity by sharing and tolerating losses, lifting water from nearby rivers and compromising with water requirements. Meager progress has been achieved in restoration of dried ponds after the Earthquake contributing very less for water security of the area.

There are trainings and awareness raising programs such as Water, Sanitation and Hygiene (WASH) conducted at school level by local youth clubs.

B. Adaptation Planning and Practices at Municipal Level

The Namobuddha Municipality has planned adaptation activities to address environmental issues, climate change and other disaster induced water scarcity. Some of the activities are categorized below:

i) Supportive Social Structures (Organizational Development, Working in Partnership and Institutions): The Namobuddha Municipality has implemented Environment Friendly Local Governance (EFLG) program since last two years under its Environment Section. Installation of Rainwater harvesting plants and supply of pure drinking water is one of the water focused activities of EFLG. The Municipality has formed Tole Level Organization (TLO) and Ward Level Organization (WLO). TLO has been registered as a sister organization of the Municipality.
which helps to identify the environmental issues/problems of their vicinity. Environment Section of the Municipality plans and implements the activities to solve those problems.

**ii) Supportive Governance (Regulation, Legislation and Guidance):** The municipality has established Environment Disaster Management Fund to use in emergency situation. Municipality has spent nearly 35% of its total budget in the sector of Environment including water resources management in Fiscal Year of 2073/74 B.S. As per the main policy of municipality, it has planned to provide essential drinking water to all the people. Some of the major projects of the municipality are Sunkoshi Lifting, Rainwater Harvesting, Rosi Khola lifting, Dapcha Khola Dam construction and construction of one plastic pond in each house etc. The Municipality also supports Youth clubs and Non-governmental Organizations willing to contribute at local level to solve the water scarcity.

**iii) Offsetting Losses:** These includes spreading or sharing risks or losses through insurance or relief efforts. It goes through different development activities. Municipality plans the activities focused to prevent impacts or reducing risks as per the demand.

**iv) Exploiting Positive Opportunities:** The Namobuddha Municipality has started working on major activities such as large-scale drinking water, Rainwater harvesting, conservation of water at source, afforestation, awareness raising and formation of water user groups in the Municipal areas.

Daraune-pokhari conservation has been initiated at local level (Photos below). Daraune-pokhari is considered as the heart of water sources in the area. Locals believe that its conservation would release water in other sources also. During the field visit in June 2016, the pond had less water. One year later, water quantity in the pond has been increased.
Photos: Increased Level of water in Daraune Pond (Upper), less water (lower)
V) **Planned Adaptation (deliberate policy decisions) at Municipal Level:** It has been made mandatory to install Rainwater harvesting plant along with one plastic pond in each house while building new house, as the major policy of Municipality. Likewise, an inventory shall be prepared for water resources in the District.

C. Some Challenges

Water resource management techniques, especially those of Integrated Water Resource Management (IWRM), can be applied to adapt to hydrologic effects of climate change and additional uncertainties. However, the capacity to implement effective management practices is only possible with the coordination of implementing organizations and local community. Locals can be stewards of such projects and engage the community for achieving water secured society. In contrast, secluding them can sometimes cause adverse impacts on project.

Some other challenges, such as autonomous adaptation has been practiced by locals since long with little or no knowledge at all. It's crucial to identify it at an early stage. Adaptation without information may lead to mal-adaptation or other negative trade-off, information sharing on autonomous adaptation can minimize the potential loss. The sudden onset of climatic variables have imposed more pressure on locals to adapt locally with available information and resources. The data scarcity on current and future changes on climatic variables is another challenge for adaptation. Climatic data are necessary to formulate future adaption plans. Data unavailability can make adaptation plans ineffective.

Another challenge to formulate the adaptation plan is alteration of vulnerabilities over the period. The adaptation plans, often, have limited financial and technical capacities. The various needs of locals may not be addressed by such planning. Adaptation measures that have the desired result in terms of minimizing the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits are more successful.
5. Conclusion and Way Forward

The locals in the Namobuddha Municipality lacks long term adaptation planning to adapt with water scarcity in the area. However, community people are willing to support the projects intended to reduce the water scarcity. At municipal level, some plans, such as installing rainwater harvesting plants, constructing plastic ponds, have been made to address the water shortage. Yet, it has not covered most of the water scarce areas.

Some restored water sources are lacking proper conservation plans. For instance, the restored Daraune Pokhari (pond) has been eutrophicated with algal bloom. This has decreased the water quality of the pond. Besides, the large amount of municipality budget has been spent on reconstruction of houses damaged by earthquake. This has left a little space for water focused adaptation activities.

Furthermore, the practices adopted by locals to install rain water harvesting and restoration of traditional spouts needs more impetus from Governmental level, Non-governmental organization and other donor agencies. Likewise, improvement of existing water supply services is important to meet the water demands in municipality.

In Namobuddha Municipality, the water scarcity is due to changes in land-use, urbanization and increased demand of water. These are more like managerial problem. Strong institutional framework and coordination among community groups should ensure the conservation of water sources.
References


Annex

Checklist for Consultation with Municipal Officer

The main objective of the study was:

- to identify the water focused adaptation planning/strategies and practices adopted by community, Governmental/Non-governmental agencies.

A) Supportive Social structures (For e.g. Organizational Development, Working in Partnership and Institutions)

B) Supportive Governance (e.g. Regulation, Legislation and Guidance)

C) Offsetting losses by spreading or sharing risks or losses including:

  - Sharing costs of response
  - Insurance
  - Relief efforts

D) Preventing Effects or Reducing Risks

  - Building Resilience

E) Exploiting Positive Opportunities

  - Introduce new or develop previously limited activities or species

F) Accepting the impacts and bearing the losses

  - Planned Adaptation (deliberate policy decisions)
  - Autonomous Adaptation (adaptation plans taken by individual institutions)
  - Creating water collection and storage facilities Introducing new crop varieties/ Resource management tools/ infrastructures
## Checklist for Focus Group Discussion at Community Level

### List of Adaptation Practices at Community Level

<table>
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<td>Changing location</td>
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<td></td>
</tr>
<tr>
<td>Restoration</td>
<td>Restore assets to their original condition following damage or modification due to climate/water scarcity</td>
<td></td>
</tr>
</tbody>
</table>
List of FGD Participants

I. Mr. Khadga Shrestha
II. Mr. Krishna Lal Shrestha
III. Mr. Indra Bdr Lama
IV. Ms. Bhagwati Shrestha
V. Ms. Kalpana Humagai
VI. Mr. Jaman Singh Lama
VII. Mr. Hari Pd. Adhikari
VIII. Mr. Maheshwor Adhikari
IX. Ms. Ramila Adhikari
X. Mr. Pancha Lal Shrestha
XI. Mr. Kul Bdr Shrestha
XII. Mr. Mahanta Maharjan
XIII. Mr. Nani Ram Adhikari

Key Informant's Interview (KII):

Mr. Santosh Kafle- Environmental Officer, Namobuddha Municipality
Photographs

*Photos: Some glimpses of FGD held in Ward Number 14 of Namobuddha municipality*
Photos: Vegetation around Daraune Pokhari (pond), Namobuddha Municipality, Kavre-palanchowk