This book documents Dhulikhel's journey towards urban water security. It builds on about half a decade of collaboration between Southasia Institute of Advanced Studies (SIAS) and Dhulikhel municipality on working towards linking science, policy and practice on urban water management. It blends the perspectives of researchers, policy makers and practitioners and provides insights on climate adaptive and inclusive water governance relevant for emerging Himalayan towns.


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DHULIKHEL'S JOURNEY TOWARDS WATER SECURITY

# Dhulikhel's Journey towards Water Security

## INSIGHTS FOR POLICY AND PRACTICE


**EDITORS**
**DIL KHATRI**
**KAUSTUV RAJ NEUPANE**
**KAMAL DEVKOTA**

# Dhulikhel's Journey towards Water Security:

INSIGHTS FOR POLICY AND PRACTICE

**EDITORS**

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# Preface

This book is an outcome of the long-term collaboration between the Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality focusing on urban water security issues in Dhulikhel. Since early 2014, SIAS has been continuously involved in Dhulikhel through action research and dialogues focusing on urban water governance and management. The initial idea about the book originated in early 2020 when the researchers from SIAS and the Mayor of Dhulikhel were discussing on the documentation and sharing lessons from Dhulikhel. We then agreed to compile experiences and insights of researchers and practitioners involved in Dhulikhel's water management hoping that such compilation would be important for other towns of the Himalayas.

This book would not have been possible without the work of two important projects that SIAS carried out in Dhulikhel. We would like to acknowledge these projects namely 'The Political Economy of Water Security, Ecosystem Services and Livelihoods in the Himalaya (2014-2016)' from Ecosystem Services for Poverty Alleviation – ESPA program and 'Climate Adaptive and Equitable Water Management Strategies in Cities in South Asia (2016-2019)' from the International Development and Research Centre - IDRC. Further, support of Climate and Development and Knowledge Network - CDKN (2020) has also been valuable in synthesizing the lessons of earlier projects.

We also like to express our sincere gratitude towards Ashok Byanju - Mayor of Dhulikhel Municipality for his continuous support and encouragement for conducting research and local dialogues which provide important material for the book. We are indebted to Dr. Anushiya Shrestha, Dr. Bashundhara Bhattarai, Dr. Chandra Lal Pandey, and Dr. Dilli Prasad Poudel for their valuable comments on the chapters. Our thanks are due to the authors and reviewers of the chapters who volunteered their time despite their busy schedules. We also acknowledge the support from Gyanu Maskey for her tireless efforts in copy-editing role in this book. Finally, we would like to offer thanks to the people of Dhulikhel for sharing their valuable information and entertaining us as researchers.

February 10, 2021 **Editors**
Kathmandu, Nepal

# Foreword

## Knowledge co-production for urban water solutions

Scholars have written many volumes on the problems and scenarios of water insecurity across South Asia. These volumes contain tons of data and rich analyses of what is driving water insecurity and what could be the possible solutions to the water insecurity problem.

However, rarely there is an attempt to bring the knowledge of practitioners who are struggling to solve problems on the ground. On too many occasions, researchers also come down to cities and watersheds to collect data and test their hypotheses. This book "Dhulikhel's Journey towards Water Security: Insights for Policy and Practice" reverses these trends and sets a new example of how knowledge can be co-produced by a collaborative group of researchers, practitioners, and local leaders. It also sets a new example of a local research organisation working in partnership with local governments to jointly sponsor and publish the knowledge product that is proudly owned by local governments and communities.

Apparently, the story this book presents is a story of the struggle – I would not expect it to be an absolute success story. It outlines the struggles of Dhulikhel towards ensuring every resident of the town gets enough and good quality water all the time. The experiences capture the work of communities, local leaders, research groups, policymakers, and international development organisations over the past four decades. As a mountain town without its own watershed supplying water, Dhulikhel has done everything possible to ensure the supply of water to its rising population by integrating social, technological, and financial solutions.

The town is a popular hill-station situated about 30 Km east of Kathmandu and hosts the central campus of Kathmandu University and a nationally popular hospital. The municipality area is also expanding with an increasing number of residents coming under the central urban water supply grid. Evidence of climate change impact on various water sources of the town is also emerging. There have been at times conflicts between the upstream rural and the downstream urban communities

over the limited amount of water available. In such a context of rising demand, Dhulikhel has been able to develop a mix of institutional strategies to ensure water security – including community-based and local government-led initiatives. Regardless of past successes, its water future is marred by a number of challenges including rapid industrialisation and climate change.

This book compiles reflective and research-based accounts of the problems, solutions and lessons by combining the perspectives of researchers and practitioners. It provides invaluable lessons for similar towns in the mountain regions in the Himalayas. The honest reflections by practitioners of the ongoing challenges and policy gaps add significantly to the collective pool of wisdom around water security under changing climate. The book also offers important policy insights as to how local-level knowledge-based innovations can be supported by policies and international agencies.

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# 1

# Dhulikhel's Journey Towards Water Security: Insights for Policy and Practices

**Dil Khatri, Kaustuv Raj Neupane and Kamal Devkota**

## 1. INTRODUCTION

Lower Himalayan towns are facing growing challenge of water scarcity primarily because of rapid urbanization[1], intensifying impacts of climatic change and weak governance (Flörke et al., 2018). Dwellers of the expanding towns in Nepal are striving for basic water supply. For instance, the average per capita water consumption in Nepalese towns is dismally low compared to the global standard i.e. only about 35 to 55 Liters per Capita per Day (LPCD), compared to the WHO standards of 112 to 150 LPCD (MoUD, 2017). Reports suggests the decline of both quality and quantity of drinking water supply in all urban regions (see The Himalayan Times, 2018)[2]. For instance, a World Bank report shows the access to water by urban residents in Nepal is 90.9 % in 2015 (AD) which has declined from 95.5% in 1990. Three major reasons are attributed as causes of such a decline. First, expansion of urban areas by merging many rural villages into the adjoining cities.

1 Nepal is one among the ten least urbanized and fastest urbanizing countries in the world. In 2011, urban population constituted 17% of the total population in the country, which reached 18.2 % in 2014 (UN DESA, 2014) and 58.4% in 2017 (CBS, 2011). The annual urban growth rate in 2001 and 2011 were 6.5 and 4.9 respectively (CBS, 2011). Also, with the population density of 1961 per square km in 2018 (World Bank, 2018), Nepal comes under the five most populous countries in the South Asian region along with India, Pakistan, Bangladesh and Afghanistan (World Bank, 2019).

2 https://thehimalayantimes.com/nepal/ministry-rues-poor-investment-urban-infrastructure-housing/

Second, lower Himalayan towns are experiencing declining water flow reportedly because of the impact of climate change (Smadja et al., 2015). Third, studies also pointed out the persistent challenge of water governance (Bajracharya et al., 2015).

While growing water demand and declining water sources challenge urban water security, the Constitution of Nepal 2015 endorsed access to safe drinking water and sanitation as a fundamental right of the citizens. In line with this, the current periodic plan of Nepal (2019 – 24) aims to supply basic drinking water to all citizens and increase their access to safe drinking water. Local governments such as Dhulikhel are putting their efforts to provide basic water supply to town dwellers.

In this backdrop, this book aims to document the struggles of Dhulikhel towards urban water security which provides unique insights to other lower Himalayan towns. Dhulikhel is a popular hill-station situated at about 30 Km east from Kathmandu and has attracted both international and domestic tourists. In recent years, the water demand in Dhulikhel has sharply increased because of the influx of tourists and establishment of big institutions such as Kathmandu University and Dhulikhel hospital. Together, these add to the ever increasing demands for water for purposes beyond 'drinking' (Ojha et al., 2020b).

Dhulikhel municipality has taken diverse approaches for achieving water security including the experiences of being pioneer of community-based water management practices, skillfully negotiating with upstream communities for securing sustainable and reliable supply of water, developing diverse water management schemes for water security in rural parts of the town, extending partnership with research organizations for evidence-informed policy and actions, and taking new initiatives for sustainable water management. This book intends to document these experiences and lessons to inform local level policy and practices of water management in Nepal and beyond. Further, the book blends the perspectives of researchers and practitioners on water management and exposes some of the challenges of water security. Hence, this book can be a useful resource for national and international researchers and students, policy makers, practitioners, including local governments.

We build on the perspective that water security as not only physical access to water but also an outcome of process and politics that shape uneven access to and control of water resources. This means we see water security as political problem (Bakker and Morinville, 2013). The town of Dhulikhel is exemplary case for urban water security and it has rich experience and insights to offer. As we outline below, Dhulikhel case can provide major insights on the issues of community-based water management, process of (re)negotiation with and incentivizing upstream communities for sustainable water supply, negotiating large-scale projects with adjoining municipalities, challenges of addressing gender and equity issues, future scenario of water supply in the changing climate, and collaboration with research organizations for science-informed policy and innovations.

**Table 1**
**Overview of chapters**

| Chapter | Title | Author/s | Major focus of the chapter |
|---|---|---|---|
| 2 | Evolution of drinking water system in Dhulikhel: Trials and tribulations | Ashok Byanju, Kushal Pokharel and Kaustuv Raj Neupane | History of modern urban water management, initiation of community-based management and some recent initiatives. |
| 3 | Opportunities and challenges of the larger-scale water supply project: Insights from Kavre valley | Moti Ram Timalsina, Tikeshwari Joshi, Suchita Shrestha, Dilli Poudel and Dil Khatri | Struggle for water sources in Kavre Valley Integrated Water Supply Project (KVIWSP). |
| 4 | Upstream-downstream interdependencies and water security in Dhulikhel | Kaustuv Raj Neupane, Anushiya Shrestha and Tikeshwari Joshi | (Re)negotiations with upstream communities and incentivizing mechanisms. |
| 5 | Policy and institutional aspects of water management in Dhulikhel | Gyanu Maskey, Chandra Lal Pandey and Dil Khatri | Juxtaposes the Dhulikhel's journey of urban water management with the national policy and institutional contexts. |

| Chapter | Title | Author/s | Major focus of the chapter |
|---|---|---|---|
| 6 | Under the glass ceiling: limitations of women in urban water management systems | Rachana Upadhyaya and Suchita Shrestha | Gender and equity dimensions of water management in Dhulikhel. |
| 7 | Future climate stress on drinking water of Kavre Valley: A case of upper Roshi river | Anjit Gautam and Tikeshwari Joshi | Projection of climatic parameters and likely impact on water flow in Dhulikhel. |
| 8 | *Pani Chautari* as a tool for evidence-informed policy and practices: Experiences from Dhulikhel | Kamal Devkota, Gyanu Maskey and Dil Khatri | Experience and insights of a deliberative platform of *Pani Chautari* for promoting evidence-based planning and decision making. |
| 9 | Application of recharge ponds for water management: Explaining from nature based solution perspective | Suchita Shrestha, Kamal Devkota, Ngamindra Dahal and Kaustuv Raj Neupane | Technical innovations and nature-based solutions adopted by Dhulikhel municipality to revive its drying springs. |

The book chapters are logically organized in three distinct blocks: the past experiences, current initiatives and future direction towards water security. As shown in Table 1, the first chapter deals with the past experiences that documents the evolution of modern water management in Dhulikhel and initiation of community-based water management. The current dynamics of water management are captured into a number of chapters such as policy and institutional dynamics, a detail account of the negotiation with upstream communities, initiation of a large-scale water project for Kavre Valley and gender and equity related issues of water management. Remaining three chapters focus on the projection of future water supply in the changing climate, Dhulikhel's vision and initiatives towards ensuring sustainable and equitable water supply in future through science-informed stakeholder dialogue (*Pani Chautari*), and technical innovations and nature-based solutions.

## 2. DHULIKHEL'S JOURNEY TOWARDS URBAN WATER SECURITY

The second chapter (Byanju et al., 2021) navigates the history of urban water management system in Dhulikhel including the experiences of pioneering community-based water management. As the chapter outlines, the era of modern urban water management (i.e., supply of tap water) in Dhulikhel dates back to Rana period[3] when nine community taps were installed which were popularly known as Judha Dhara (named after the then Prime Minister Juddha Samsher Rana). Later in 1992, Dhulikhel initiated community-managed water management with the installation of German supported municipal water management system. In the endeavor towards establishing the first community-managed system, Dhulikhel negotiated with upstream communities of Bhumidanda for sustainable water provisioning with some incentives (detail of which is captured in another chapter). In the recent years, Dhulikhel has undertaken some new initiatives on urban water management to meet the mounting water demand caused by urban expansion and growing tourism and other business. Further, chapter also capture the recent dynamics that Dhulikhel has provided leadership towards developing a large-scale project of KVIWSP which covers three major towns located in Kavre Valley, namely Dhulikhel, Banepa and Panauti. The most recent initiative of Dhulikhel municipality as outlined in the chapter is a program of 'one house one tap' to ensure water security in rural areas which were included in the municipality after restructuring of the local governments in 2017. The municipal leadership has been fostering collaboration with diverse stakeholders including research organizations towards achieving sustainable water supply.

The third chapter (Timalsina et al., 2021) documents the experience of developing the large-scale inter-municipality water supply project called KVIWSP. The authors capture the context and process of developing the project and present the governing mechanism through which the project provisions water to different parts of the three municipalities. While the new project provides a cost-effective

3 Rana era, (1846–1951) in Nepal, the period during which control of the government laid in the hands of the Rana family.

solution to growing water problem of the towns, as the authors maintain, there are a mountain of challenges. The key challenges of such a large-scale project include: payback of loan to the donor (Asian Development Bank), governing mechanism including three municipalities and technical and management related challenges for effective functioning of the project. This chapter provides a clear message that while large scale projects are required for addressing increasing urban water demand in the lower Himalayan towns, we should also not undermine the importance of smaller scale community-based schemes which play a vital role in ensuring equitable and sustainable water supply. As Bidur's case suggests, the smaller schemes seemed to be more resilient during the time of crisis i.e. when the bigger system break due to climate-related extreme events such as flood and landslide (Ojha et al., 2020a).

The fourth chapter (Neupane et al., 2021) captures the struggle and strategies of Dhulikhel in negotiating with upstream communities to secure sustainable water supply. As the chapter documents, the socio-political relations and influence played a central role in securing and maintaining the water sharing agreement. Dhulikhel signed three subsequent agreements with the upstream communities at different times. These are: (i) agreement between then Dhulikhel and upstream Bhumidanda Village Panchayat in 1985 (ii) agreement between KVIWSP and Bhumidanda Village Development Committee in 2010 and (iii) agreement between Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC) and Bhumidanda Village Development Committee in 2011. In all these three agreements, Dhulikhel mobilized its political influences and social relations with upstream villages to (re)negotiate the agreements. These also involved financial incentives that Dhulikhel provided to the upstream communities that helped maintaining upstream-downstream relations. The relation between Dhulikhel and the upstream communities seems still delicate and Dhulikhel and upstream municipalities in Panauti are working for developing an institutional mechanism towards sustainable solution.

Chapter five (Maskey et al., 2021) examine the policy and institutional dynamics of water management in Dhulikhel where the authors explain the Dhulikhel's experience and struggle of

establishing and strengthening community-managed water management system juxtaposing with the national policy and institutional context. In doing so, the authors examine the evolution of water governance in Dhulikhel under three distinct political periods: Panchayat era, Democratic era and Federal Nepal. The major finding of the chapter is that Dhulikhel pioneered on community-managed water governance and has established itself as an exemplary case. Further, the federalism provided an opportunity for local government towards taking leadership in developing policy and institutional mechanisms for water security in Dhulikhel. The major institutional innovations that Dhulikhel has pioneered and provided successful examples are: community-based water governance; incentivizing and negotiating with upstream communities; and collaboration with wider stakeholders including research institutions towards sustainable urban water management.

Chapter six (Upadhaya and Shrestha, 2021) deals with an important and cross-cutting issue of gender and inclusion in local water governance. Authors have surfaced out the gender-related issues of water governing body capturing the key limitation of women for effective participation and engagement in water management. In doing so, the chapter narrates a story of a woman member of the committee focusing on how she experienced the hardship to nurture women's voice in the male dominated decision-making practices. Authors found that water-related polices have made a provision for women's participation in decision making bodies but the pre-existing patriarchal societal practices, stereotypical cultural expectations from women and entrenched biases against their capacity have limited the women's ability to influence decisions. The key insights from this chapter is that mainstreaming gender is a process, rather than a goal (Sandler 1997), therefore it is not an end in itself. It can be achieved only if women represent as an empowered group. It requires acknowledging and trusting their capacity as well as men in the executive to be more accepting of women's roles with a willingness to listen to a different voice.

Chapter seven (Gautam and Joshi, 2021) provides a projection of future scenario of water supply to the major water supply system of Kavre Valley Project. Based on the analysis of temperature and

precipitation data, the chapter uses 'abcd' hydrological modeling method and projects future water discharge in the Roshi River – the source of water for Dhulikhel and the adjoining municipalities. The result shows that there will be a slight increase in minimum temperature and the range of maximum temperature might be between 0.64°C to 1.91°C in different climate change scenarios. Further, it is projected that there will be a statistically negligible decrease in the mean annual precipitation in most of the time. Assessment of the future stream flow of the Roshi River shows that there will be slight increase up to maximum of 14 % in mean annual discharge in 2050. Seasonal discharge analysis shows that slight increase in the discharge in winter, monsoon and pre-monsoon but a very slight decrease in the post-monsoon season. However, no significant impact of climate change is detected in the future causing a deficit or extreme flows of the water source areas.

Chapter eight (Devkota et al., 2021) documents Dhulikhel's experience of partnering with a research organization on science-informed stakeholder dialogues and evidence informed policies and practices. Dhulikhel extended collaboration with the Southasia Institute of Advanced Studies (SIAS) and developed a tool called *Pani Chautari*. The *Pani Chautari* is described by authors as a process of evidence informed dialogue that starts from identifying policy issues, generating or consolidating credible knowledge for evidence-based policy making, evidence-informed dialogue among the key stakeholders, engagement with policy actors to translate the outcomes of dialogue into the specific policy documents and then translating that policy into practices for sustainable and equitable water management in the town. In fact, the tool of *Pani Chautari* was co-developed by Dhulikhel municipality and SIAS and the evidence-informed dialogue helped in identifying technical and managerial solutions to address the water management related problems faced by the town. The authors further detail out the process and outcomes of *Pani Chautari*. Authors claim that the key insights from *Pani Chautari* process can be useful for not only the municipalities across the lower Himalayan region but also to State and federal governments towards science-informed policy processes.

Finally, chapter nine (Shrestha et al., 2021) documents the Dhulikhel's recent experience of piloting water recharge ponds (and

trenches) for ensuring sustainable water management. As the chapter highlights, the key stakeholders in Dhulikhel realized the problem of declining water flow in local springs and worked with SIAS to pilot water recharge techniques. In this process, a series of water recharge ponds and contour trenches have been constructed with proven effectiveness towards improving the ground water recharge. The authors explain these techniques as Nature-based solutions towards sustainable water management and offer a framework through which municipalities can initiate similar solutions to address the local water-related problems. This chapter provides an important insight on how locally engaged action research (initiated by SIAS along with Dhulikhel municipality and other actors) can help developing a locally suitable nature-based solution to sustainable water management.

## 3. KEY LESSONS FOR POLICY AND PRACTICE

Such a rich experience of Dhulikhel towards achieving urban water security provides important lessons and insights for policy makers and practitioners. Not only can the municipalities in the lower Himalayan region be benefited from these insights but also governments (federal and provincial) can draw lessons. The key lessons and insights are summarized as following.

Community of Dhulikhel has struggled to develop the local water management system through securing financial resources to find the modern water supply system and negotiating with and incentivizing upstream communities. The political leadership and collective action of community of Dhulikhel seemed to have played important role in their achievements towards water security. As Byanju et al. (2021) document, community in Dhulikhel mobilized political network for securing German government funding to establish the first community-managed water management scheme in the country. Similarly, as Neupane et al. (2021) maintain, political network was mobilized in negotiating and sustaining the agreements with upstream communities. Such political commitments and leadership have also been demonstrated in recent initiatives such as Kavre Valley project and the ambitious program of 'one house one tap'.

The Kavre Valley seemed a promising and cost-effective project to provision water in three towns including Banepa and Panauti. However, such a large-scale project can have several technical and management challenges and may not resolve all water-related problems of Dhulikhel. Realizing this, Dhulikhel is moving towards diversifying the urban water management system i.e. combining large-scale projects alongside maintaining the existing community-based ones. The water-management strategies of Bidur Municipality offer important lessons on this. As Ojha et al. (2020a) document, Bidur has taken the approach to diversity and decentralize water management scheme. The small-scale community managed water schemes in Bidur proved to be more resilient in the time of crisis (such as earthquake, COVID-19, landslide, flooding) and crucial to ensure water access to poor and marginalized people.

One important insight from Dhulikhel for other municipalities is about negotiation with upstream communities. As Neupane et al. (2021) detail out, Dhulikhel has established relation with upstream communities involving negotiation and renegotiation of water sharing agreements. The important aspect of this relation is that while Dhulikhel provides financial incentive to upstream communities to support their development, the socio-political engagement played important role in reaching and sustaining the agreements at different times. Dhulikhel case also provide important insights to the wider Payments for Ecosystem Services (PES) debate that financial incentive alone is not sufficient to sustain upstream-downstream collaboration and that socio-political engagement plays pivotal role in such processes.

Dhulikhel pioneered in development and successful operation of community-based water management through managerial, technical, and financial capacity building of water users committee, which is now independently operating the water supply system to supply water to more than 2500 households. However, since the initiation of a large-scale inter-municipality water supply project, the existence of the once successful community-based management schemes is under question as the existing water user committees are supposed to be merged into the newly constituted water management board (Timalsina et al., 2021). This create the risk of the community-based institutions and system being subsumed into

the higher-level governance mechanism. This can pose threat to the existing and emerging small scale and community based schemes (Maskey et al., 2021). Further, as noted by Upadhaya and Shrestha (2021), local water governance institutions are also facing challenges in ensuring gender equality and social inclusion. Pre-existing patriarchal practices and prejudices constrain women's effective participation and their influences in making decisions on local institutions. Hence, there is a need for interventions to empower and nurture women leadership in local water governance. We further stress that the issue of exclusion and inequality exist across other forms of marginalization based on caste/ethnicity, class and geography and the local water governance institutions need to pay attention towards making water governance inclusive and equitable.

As reported by Gautam and Joshi (2021), climate change can pose further challenge to local water security. There is not only the risk of decrease in water flow because of variation on weather parameters in future, but there can also be the risk that climate-induced extreme events can jeopardize water supply system (see Ojha et al., 2020a). This reminds us to take account of climatic parameters and forecasts in water projects as this helps to build resilience against its possible impacts through enhanced institutional flexibility and make contingency planning to deal with potential climate-related risks.

Dhulikhel also ventured collaboration with diverse stakeholders including research organizations such as SIAS to achieve sustainable water management. Since last six years, a collaborative work with SIAS has helped Dhulikhel to practice evidence-informed dialogues towards resolving local water management related problems. As documented by Devkota et al. (2021), Dhulikhel initiated evidence-based policy and planning and co-developed an innovative tool for evidence-informed dialogue called *Pani Chautari*. The key insight of this initiative is that an evidence-informed dialogue can help to create innovation, foster collaboration and build capacity to address water-related problems.

One of such innovations that Dhulikhel developed and successfully implemented is water recharge system. As detailed out by Shrestha et al. (2021), the intervention on water recharge techniques such as

recharge pond and trenches were identified from series of discussions in *Pani Chautari* process. The recharge ponds and trenches have proven successful in increasing water discharge from the existing sources and steady spring discharge. The recharged ponds were effective and uptaken by locals and in the municipal planning due to its low cost and easy monitoring. For instance, 'one ward one pond program' has been included in fiscal year 2017/2018 plan.

## REFERENCES

Bajracharya, S.R., Maharjan, S.B., Shrestha, F., Guo, W., Liu, S., Immerzeel, W. and Shrestha, B., 2015. The glaciers of the Hindu Kush Himalayas: Current status and observed changes from the 1980s to 2010. *International Journal of Water Resources Development*, 31, pp.161–173. https://doi.org/ https://doi.org/10.1080/07900627.2015.1005731.

Bakker, K. and Morinville, C., 2013. The governance dimensions of water security: A review. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 371, p.20130116. https://doi.org/https://doi.org/10.1098/rsta.2013.0116.

Byanju, A., Pokharel, K. and Neupane, K.R., 2021. Evolution of drinking water system in Dhulikhel. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practices.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

CBS, 2011. *National population and housing census 2011.* National Report. National Planning Commison. Government of Nepal.

Devkota, K., Maskey, G. and Khatri, D., 2021. *Pani Chautari* as a tool for evidence-informed policy and practice: Experiences from Dhuliukhel. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

Flörke, M., Schneider, C. and McDonald, R.I., 2018. Water competition between cities and agriculture driven by climate change and urban growth. *Nature Sustainability,* 1, pp. 51–58. https://doi.org/10.1038/s41893-017-0006-8.

Gautam, A. and Joshi, T., 2021. Future climate stress on drinking water of Kavre Valley. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practices.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

Maskey, G., Pandey, C.L. and Khatri, D.B., 2021. Policy and institutional aspects of water management in Dhulikhel. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

Neupane, K.R., Shrestha, A. and Joshi, T., 2021. Upstream-downstream interdependencies and water security in Dhulikhel. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

MoUD, 2017. *National Urban Development Strategy 2017*, Government of Nepal, Ministry of Urban Development.

Ojha, H., Neupane, K.R., Khatri, D., Devkota, K., Maskey, G., Dahal, N., Joshi, T. and Kovacs, E.K., 2020a. Urban water security in South Asia: Crucial policy lessons from the Nepalese town of Bidur. *World Water Policy.* https://doi.org/https://doi.org/10.1002/wwp2.12041.

Ojha, H., Neupane, K.R., Pandey, C.L., Singh, V., Bajracharya, R. and Dahal, N., 2020b. Scarcity amidst plenty: Lower Himalayan cities struggling for water security. *Water*, 12(2), pp.567. https://doi.org/10.3390/W12020567.

Shrestha, S., Devkota, K., Dahal, N. and Neupane, K.R., 2021. Application of recharge ponds for water management: Explaining from nature based solution perspective. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.*

Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

Smadja, J., Aubriot, O., Puschiasis, O., Duplan, T., Grimaldi, J., Hugonnet, M. and Buchheit, P., 2015. Climate change and water resources in the Himalayas. Field study in four geographic units of the Koshi basin, Nepal. *Journal of Alpine Research| Revue de géographie alpine.*

Timalsina, M.R., Joshi, T., Shrestha, S., Poudel, D.P., and Khatri, D., 2021. Opportunities and challenges of the larger-scale water supply project: insights from Kavre valley. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

UN DESA, 2014. *World urbanization prospects, the 2011 revision.* Population Division, Department of Economic and Social Affairs, United Nations Secretariat.

Upadhaya, R. and Shrestha, S., 2021. Limitations of women in urban water management systems. In: D. Khatri, K.R. Neupane, K. Devkota, eds. 2021. *Dhulikhel's journey towards water security: Insights for policy and practice.* Southasia Institute of Advanced Studies (SIAS) and Dhulikhel Municipality, Kathmandu.

World Bank, 2018. Population density (people per Sq. Km of land area)- Nepal. [online] Available at <https://data.worldbank.org/indicator/EN.POP.DNST?locations=NP> [Accessed on December, 2020].

World Bank, 2019. Population, total- South Asia. [online] Available at <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=8S&most_recent_value_desc=true> [Accessed on December, 2020].

# 2

# Evolution of Drinking Water System in Dhulikhel: Trials and Tribulations

**Ashok Byanju, Kushal Pokharel and Kaustuv Raj Neupane**

## SUMMARY

*This chapter unfolds the fascinating story of struggles and triumphs of the evolution of Dhulikhel's attempts to secure urban water supply. The aim of the chapter is to familiarize the readers with the emergence and evolution of the community-based water resource governance system in Dhulikhel and reflect on the key insights that can be amplified to other municipalities adopting similar water governance system. The chapter elaborates on the relentless pursuits, obstacles and resolutions strategy adopted throughout the process of installing a reliable water supply system in Dhulikhel. This chapter is prepared based on personal observations and earlier experiences of water management and the current practice of the sitting Mayor of Dhulikhel who is the lead author in collaboration with SIAS researchers. Despite increasing challenges to water security amid growing population, expanding market and climate change, Dhulikhel is exploring innovative ways to manage water supply by integrating the concerns of the adjoining areas-peripheral or neighbourhood of Dhulikhel, Banepa and Panauti. Dhulikhel water management story reveals that with the provisioning of the right structure in place along with the inclusive decision making and transparent management practices, unprecedented achievements are possible.*

## 1. INTRODUCTION

The emergence of the drinking water system in organized settlements has its roots in the adoption of agrarian way of life leading to the formation of villages and cities. With traces of wells in Egypt and stone rainwater channels in Mesopotamia from 3000 BC (Juuti et al., 2007), the vitality of water for maintaining the livelihood in the early civilizations can be easily inferred. Over the years, rapid urbanization and high population growth coupled with ineffective water governance have exacerbated the problem of water insecurity. Many cities are grappling with the burgeoning challenge of water shortage (Biswas and Tortajada, 2010) further worsened by climate change. Rapidly growing cities in the Himalayan region are also bearing the brunt of this situation. With the population living in urban areas projected to move up to 60% by 2030, an uphill task lies ahead of these cities to ensure water security (Bajracharya et.al., 2019).

Against this backdrop, this chapter unravels the fascinating story of struggles and triumphs of a resilient water supply system in Dhulikhel- a small Himalayan town in central Nepal**.** The objective of this chapter is to familiarize the local policymakers and municipalities officials with the emergence and evolution of the community-based water resource governance system in Dhulikhel and reflect on the key insights that can be amplified to other communities adopting similar water governance system. Tracing the history of water supply in Dhulikhel, this chapter describes relentless pursuits, daunting obstacles and perseverant strategies undertaken for installing, improving and sustaining a reliable water supply system in this town.

This chapter is prepared based on personal observations and experiences of the engagement in water resource management for the last 25 years and current initiatives as sitting Mayor of Dhulikhel who is the lead author in collaboration with SIAS researchers. Besides, the chapter presents insights from a review of broad literature pertaining to the evolution of drinking water systems in organized settlements in addition to Dhulikhel.

The chapter comprises of six sections. Following this introduction, the second section narrates the history of the emergeence of Dhulikhel as a vibrant town. The next section discusses the relentless pursuits of Dhulikhel to pioneer community based water management. In the fourth section, the beginning of a modern decentralized water management practice has been dealt. The fifth section provides an overview of the recent initiatives including policy decisions taken by the Municipality towards strengthening the water supply system. Finally, we conclude by highlighting key messages and learnings.

## 2. DHULIKHEL AS AN ORGANIZED SETTLEMENT

The evolution of Dhulikhel dates back to 12th century evidenced by the inscription of Uma Maheshwar. Born out of the policy of then Malla king Ananda Dev Malla to establish a well-managed settlement in the areas outside of Kathmandu, Bhaktapur and Lalitpur, Dhulikhel was strategically conceived as an entry point of the east. Ancient stories are rife with the description of the religious people like the Bajracharya, Joshi and Karmacharya sent from Bhaktapur to Dhulikhel to establish the latter as a renowned place. In a bid to address the water demand of the local people, Gangamaharani[1] during the early Rana regime established *Raj Kulo*[2], as an important source for managing water demands of the community. For the effective management of *Raj Kulo*, one people was also authorized who would get a certain portion of rice collected from local community in recognition of his contribution.

However, the problem of water shortage wasn't fully addressed. Hence, Srinath Byanju on behalf of the community leaders met then Rana Prime Minister (PM) Juddha Shamsher and requested for finding a sustainable solution to manage the growing problem of water shortage. During his visit to Britain, PM Juddha Shamsher brought 9 standpipes out of which 7 were installed in Dhulikhel *Bazaar* to manage water supply. Popular by the name of Juddha

1 Ganga Maharanai was one of the wives of Janga Bahadur Rana who started the Rana Regime in Nepal and was the Prime Minister from 5 September 1846 – 1 August 1856

2 Ancient royal canal set up with an objective of ensuring smooth water supply and irrigation.

Dhara, this initiation marks a new stage in the development of modern water management in Dhulikhel.

The expansion of Dhulikhel trade up to Tibet and the east routes established Dhulikhel as a thriving market centre. Owing to this, pressure was exerted on the water supply system thereby calling for a need of an extended drinking water project. Additionally, population growth of the town posed a challenge to water supply. The problem was so severe that the residents didn't have water for flushing water-thrifty '*sulabh*' toilets which some of the residents were capable of building upon receiving training in India. Amid this scenario, the community leaders of Dhulikhel overheard the rumor of transferring the district headquarter from Dhulikhel to another town owing to severe water scarcity. In such a critical situation, a group of like-minded community leaders after intense discussions and deliberations found a remedy for the crisis. Out of their persistent effort, the Indian embassy in Nepal installed a water tank in Dhulikhel as early as 1982. Popularly known as the old water supply system, this project installed 27 public taps in the town (Tiwari, 2008). However, this could not adequately address the growing problem of water scarcity.

## 3. RELENTLESS COMMUNITY PURSUITS IN ESTABLISHING A WATER SUPPLY SYSTEM

The initiation of village Panchayat during 1980s and 90s towards the effective management and distribution of water supply is worth mentioning. During that period, the local administration requested the general public to use piped water only for drinking and manage washing and bathing activities by directly going to the river. To monitor the water usage, the Panchayat designated an individual who was popularly known as *Goofley* to function as a watchdog of the forest and water resources in Dhulikhel. Rules and regulations were formulated to ensure that people would go to fetch water for non-drinking purposes in rivers and the water for households would be used for drinking and cooking. *Goofley* was responsible for penalizing the offenders and making sure that the rules wouldn't be violated. He would keep a constant vigil on whether or not the locals violate the water rules and affect the water conservation.

With the passage of time, the dream of setting up a reliable drinking water supply system in Dhulikhel bore visible fruit under the leadership of some prominent community leaders namely Bel Prasad Shrestha, Hari Krishna Naseju, Shree Lal Makaju, Manik Lal, Bir Man Shrestha, Mishra lal Shrestha, Ram Chandra Ghinanju, Hari Krishna KC, Govinda KC, Ram Chandra Adhikari, Durga Prasad Shastri and Shailendra Kumar Upadhyaya among other. Dhulikhel also drew inspiration from neighboring cities like Bhaktapur where the German embassy had initiated 'Bhaktapur Development Project[3]' to promote organized settlement and sanitation. As per the agreement between the Nepal Government and the German government, the German project of developing sustainable cities was in full swing.

However, this was not an easy ride. Only after relentless pursuits of the community leaders with the strong support of the public, the accomplishment was possible. Amid looming water scarcity scenario in Dhulikhel with expanding population growth and rise of market centres, one of the then community leaders invited a German colleague to visit Dhulikhel and offer some useful suggestions for resolving the widespread water scarcity. Furthermore, a dedicated team of community leaders of that time directly approached a government representative from German embassy for help which infuriated the Nepal Government in the beginning. GTZ put two conditions to the community: to bring a request letter from the government, and to convert Dhulikhel Village Development Committee (VDC) into municipality. After several rounds of negotiations, the Nepal Government authority eventually consented to write a letter to the German government incorporating the voice of the Dhulikhel community. After that, the Germans came to visit the water source area and prepared a project design. Out of a tripartite agreement among the Government of Nepal, the German government and Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), the new drinking water project was successfully built in the 1987. Central to the project design was the idea that those who drink water should manage the system

3 This project began in 1974 with an aim of improving the living conditions of the people of Bhaktapur and restoring the historic city through improvement of infrastructure which included a sewage system, private access to water for individual households and street upgrading.

themselves. In this way, the project was modelled in the form of vesting the entire autonomy of operation and maintenance to the local community with technical support from the government and donor. The inherent nature of the project design called for strong community participation and mobilization of local resources for the sustainability of the water supply system. People of Dhulikhel have actively participated in various phases of the project ranging from planning, implementation to operation and maintenance. Some technical and financial support was also provided from Water Supply and Sanitation District Office and municipality during the implementation phase of the project. The government of Nepal handed over Dhulikhel Drinking Water Project to DDWSUC officially on the 7th July 1992. Such provision became instrumental in reaping rich dividends for the community and established Dhulikhel as a model town in community-based water resource management.

The evolution of Dhulikhel from a rural village to a municipal town is pretty intriguing. Once a district headquarter about to lose this status due to an acute water shortage, Dhulikhel rebounded into a vibrant city with the installation of an effective water supply system. To forge an agreement with the German Development Co-operation for water supply project, Dhulikhel required the status of a municipality. To meet this criterion, Dhulikhel had to acquire 0.4 million additional population which became possible only after integrating the surrounding Vajrayogini and Shrikhandapur village including some parts of Kavre. Demanding that Dhulikhel be declared as a municipality, Bal Krishna Byanju on behalf of the community leaders gave a formal letter to the town Panchayat. The then King Birendra declared Dhulikhel as new municipality in 1986 from the Far Western Development Region.

As per the tripartite agreement for the new project, the search for a water source area begun rapidly. A survey was done in the then Sasipani now Devitar and Kalanti Bhumidanda VDC regarding the feasibility of water source. Eventually, Kalanti Bhumidanda VDC was identified as a potent source area. Water from Saptakanya fall, from Kharkhola stream situated 13.5 km far located in Kharkhola Mahabharat Community Forest, in Kalanti Bhumidanda village was

brought to the town through gravity pipeline. The Kharkhola source is one of the tributaries of the Roshi river, which is a tributary of the Sunkoshi river. The then Dhulikhel leadership signed and entered into the first formal agreement with Kalanti Bhumidanda in 1985 to supply water to its inhabitants including the management of water sources at the upstream. As per the agreement, Dhulikhel agreed to construct a school, a bridge and provide health and educational facilities for the upstream inhabitants. The latest revision of the agreement in the early 2011 has increased the share of water supply for Dhulikhel further demanding its notable contributions to social and infrastructure development including conservation of the water source in upstream (Joshi et al., 2019). As of today, Dhulikhel has invested 10 million rupees for the socio-economic development of Bhumidanda as a strategic approach to sustain its water supply system. Beginning in 1989 as an integral part of Dhulikhel Development Project, Dhulikhel Water Supply Project was completed in 1994 (see Chapter 4 of this book by Neupane et al., 2021)

## 4. DAWN OF MODERN WATER MANAGEMENT PRACTICES

The emergence of Dhulikhel Drinking Water Supply Project (DDWSP) heralded a new trend in the Nepalese water management system. Unprecedented in the history of water governance in Nepal, DDWSP became the first drinking water supply project, implemented under the direct investment of the Government of Nepal with financial and technical assistance from the German Government, but operated as a community-based drinking water supply project. In the initial days, the water user committee (WUC) was set up as per decentralization act 1981 followed by Water Resource act 1992 which had provisions of community managed WUCs. Becoming a model of a self-governing institution, the DDWSP ushered a new era of decentralized water resource management in Nepal. The project was then handed over to Dhulikhel Drinking Water User Group- a pioneer community-based institution in decentralized water resource management. While the Government helped in its formation, the entire responsibility of

maintenance of water sources, strategies of water distribution, determination of water tariffs and conservation of source area was vested in the user group. The water user committee also collected 0.3 million as operation and maintenance funds from the local communities as per the agreement with German Technical Cooperation Agency (GTZ) to install the water supply project (Dhulikhel Case Study, nd).

As per this agreement, the pipes had to be purchased from Germany as the pipes available in Nepal and India were not sturdy enough for strong water pressure in the new system. However, the locals of Dhulikhel didn't want pipe to be laid through their lands. Moreover, the locals complained of high water tariff (Rs 35/month) compared to Rs 30/month in Kathmandu. But the Dhulikhel municipal authorities convinced the locals that they would get cleaner water for a longer period in return for paying fees to use water. By asking people to dedicate the price of half cup of tea per day for affording the cost, the municipality eventually succeeded in its objective. Interestingly, Dhulikhel also organized door to door campaigns to foster interaction with women who had major role for water management.

Inspired by the success of Dhulikhel water governance model, the Government of Nepal prioritized the community-based approach in its succeeding negotiations with donors and the local community related to water resource governance.

The introduction of a well-managed drinking water scheme created a multiplier effect in the social and economic life of Dhulikhel. Dhulikhel witnessed the establishment of a community hospital, several hotels including a university. Modern Dhulikhel boasts of a reputed national university, namely Kathmandu University in addition to 53 commercial hotels which are the lifeline of its tourism-based economy. The contribution of smooth water supply in the development of the town was visible. Over time, an increase in market demands and commercialization of the town along with expanding population posed a grave challenge for managing water supply in the town. Water supply to households drastically reduced from 24 hours a day to less than 2 hours a day owing to growing water demand (Devkota et al., 2018).

Since the GTZ project water supply targeted only the former Dhulikhel village, which was later designated as wards 2, 3, 4 and 5 of the municipality, a strong dissatisfaction was growing among the non-users of the project residing in other wards (Pokharel et al., 2019). In fact, the formal inauguration of the project was delayed due to reservations of people living in peripheral wards. As per the earlier agreement between then Dhulikhel water users committee and the disgruntled people, the residents outside the Bazaar area would be provided water by tapping local sources in the short run and alternative sources would be identified in the long run (Devkota et al., 2018). However, the agreement was not put in action by the concerned authority which aggravated the situation. In 2008, the non-users cut off water supply lines in Chaukot and Subba village and created water shortage in the wards 2, 3, 4 and 5 for two weeks. Contestations against the Dhulikhel water supply distribution system clearly manifested in the form of core-periphery divide (Pokharel et al., 2018) with the residents of wards in remote geographical regions denying equal access to the water supply system. While then core area- wards 2-5 received uninterrupted water supply, then wards 1, 6, 7, 8 and 9 had no access to water from the project. The original DDWSUC formed in 1992 did not include residents of the peripheral areas. Their exclusion in the committee intensified the grievances that population in the peripheral wards had due to unequal water distribution system. Furthermore, the conflict also emerged between users of old and new water systems – the former installed by Indian embassy and the latter by German embassy, people from Dhulikhel and surrounding municipalities, Panauti and Banepa. Amid this scenario, community leaders of Dhulikhel, Panauti and Banepa strongly felt the need for an integrated water management project to cater to the growing needs of the entire region. The growing circumstances demanded setting up a more encompassing water supply system to cater the water needs of the residents outside the bazaar area.

## 4.1. The ADB and Nepal government accord: contestations and resolution

Local leaders of Dhulikhel, Panauti and Banepa felt a greater need of setting up an extended water supply system with larger

pipes installed to siphon water from Roshi Khola and its tributaries. In 2010, Nepal government in collaboration with Asian Development Bank (ADB) started Secondary Towns Integrated Urban Environmental Improvement Project for supporting urban infrastructure development and strengthening municipal capacities of cities nearby Kathmandu. This agreement was inked between ADB and Town Development Fund incorporating municipalities of Dhulikhel, Panauti and Banepa. In late 2012, under the loan and grant assistance of ADB, Kavre Valley Integrated Water Supply Project (KVIWSP) was launched envisioning a provision of an independent board to oversee the new water supply system. The notion of an autonomous board marks a major shift in water governance. The board has the power to aquire, build, expand and rehabilitate service, formulate and implement policies. Water supply system will be operated by the Board under the leadership of the Mayor and water users do not have right to select their committee. With 35% loan from ADB and 50% grant, 15% of the total investment was collected from the local residents. As per the KVIWSP agreement, the upstream village will receive royalties from these water user municipalities for the development of schools and other infrastructures in the upstream water source village. ADB proposed a joint investment model with shared investments from Dhulikhel, Banepa and Panauti[4]. Moreover, ADB also agreed to invest in environment mitigation action plan, social resettlement, take corrective measures for resolving environmental issues and provide training for environmental management. While isolated investment would cost each of them 23 crores, the joint investment reduced it to 17 crores. However, Panauti initially rejected this offer primarily because of a serious threat emerging to its irrigation scheme from upstream area after providing water source for this project. In this scenario, relentless negotiations and meetings of like-minded community leaders ultimately resulted in an agreement for a joint investment model.

The project had to face many ups and downs before it finally came into operation. One of the major obstacles was the conflict between the people of Panauti and Chaukot area. Roshi Sarokar Samaj, a

4 One of the seven principalities under Bhaktapur of the then Saatgaon which included Dhulikhel, Banepa, Panauti, Nala, Saanga and Shrikhandapur.

community-based institution strongly rejected the idea of supplying water from Roshi watershed. They argued that supplying water from their village to other areas would adversely affect agriculture due to limited irrigation. Hence, the people of Panauti demanded free water supply as a compensation for providing a water source for this integrated water supply system.

Another aspect of the conflict was related to the acceptance of Ladkeshwar[5] as a reliable water source area. Since people living in this upper settlement generated more waste and the existing water contaminated, the viability of Ladkeshwar as water source area became debatable due to the high water treatment cost and greater risk to supply water for settlements nearby the river.

Amid this scenario, Banepa, Dhulikhel and Panauti finally agreed to bring water from the then Bhumidanda VDC, now part of Panauti Municipality by offering 75 lakhs Nepalese Rupees as compensation for development activities. Additionally, an understanding has been reached to pay yearly royalty to one of the wards, ward 6 in Panauti (after the water is supplied from this source).

97% of the work of KVIWSP has been completed so far. In December 2019, ADB handed over the project solely to Nepal Government. Kavre Valley Integrated Drinking Water Board comprising of Mayors of Banepa, Dhulikhel and Panauti, a representative from Water Supply Corporation, NGOs among others has been formulated to oversee the water supply system and explore further options for improving the water supply service in three municipalities.

Nevertheless, challenges still persist in the management of water supply. The issue of conserving water sources have significantly emerged. Decreasing rainfall and increasing stone mining activities in the watershed have further aggravated the problem (Shrestha et. al., 2020). In this scenario, a policy decision for source area conservation focusing on water recharge, forest conservation and environmental development has recently been reached. However, this project will not be supplying water to new annexed

5 Ladkeshwar is an upstream water source area geographically remote from the local community.

wards that has become part of Dhulikhel Municipality after administrative restructuration in 2017. So new initiatives have been taken by the Dhulikhel's current leadership.

## 5. RECENT INITIATIVES

### 5.1. Extension of water supply to new wards

While DDWSUC manages water in most parts of Dhulikhel, other small water users committees also exist in the town. In a bid to address the problem of water scarcity in Dhulikhel, various measures have been put forward after the last municipal election held in 2017. The vision of current municipal government is to make Dhulikhel a water secured town by achieving a target of 'One house one tap' by 2022.

Since 2018, Dhulikhel has been mapping available water resources and water supply projects in a bid to systematize water supply system and supply adequate drinking water with an overarching objective. At present, Dhulikhel municipality is getting the supply of drinking water from Dhulikhel Water Supply and Sanitation System which will be connected to Kavre Valley Integrated Water Supply System after the completion of the Project.

The survey design and execution of project's new initiatives under the program of one house one tap started from Fiscal Year (FY) 2018/19 and the municipality completed few projects facilitating around 700 households (HHs) with one house one tap water service. These projects were constructed in coordination with the user committees and handed over to these committees for the operation and maintenance under the municipal guidelines. Dhulikhel municipality aims operating 5 drinking water projects and extending the supply to 2000 HHs by the end of the current FY 2019/20.

The municipality is working on providing safe and adequate drinking water, especially in its extended area of wards 1, 2, 8, 9, 10, 11 and 12. Out of the 17 ongoing drinking water projects in Dhulikhel, 5 are deep boring projects supplying water to Kavre (ward 9), Batase

(ward 10), Saankhu and ward 11. the aim is to enhance the water access to 400 HHs in Kavre, 372 HHS in Batase and 480 HHS in ward 11 by the end of this fiscal year. Meanwhile, reconstruction of ancient wells, ponds and taps is high on the agenda. The policy and program of Dhulikhel municipality for FY 2018/20 clearly states that the program of 'one ward one pond' will be continued to preserve groundwater recharge and enhance the flow of water. Likewise, collection and storage of rainwater and its effective use by adopting suitable technology has been provisioned. Establishing recharge ponds in dry hill areas with the support of Southasia Institute of Advanced Studies (SIAS) and private sector are other important provisions included in the annual municipal program. In collaboration with World Wildlife Fund (WWF) and Kathmandu University, the Municipality intends to conduct research on the conservation of Roshi Watershed area and the potentiality of Jhiku Khola watershed (Dhulikhel Annual Policy and Program, 2019). In realization of SDG Goal 6: ensuring universal, safe and affordable drinking water, the municipality has endorsed 'one house one tap' policy and allocated NRs 3 billion for implementing this policy. As of today, ward no. 1 and Dhital gaun in ward 11 have successfully observed the implementation of water supply. The target is to include additional 2000 households in this system in the coming FY. Majority of settlements in these areas are on hilltops or hillside and depend on spring, well and stream for water. Lifting water from rivulets to these distant uphill settlements is tedious and costly.

## 5.2. Policy initiations

In 2018, the municipality successfully organized a local water conference in collaboration with SIAS, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Institute for Social and Environmental Transition in Nepal (ISET-Nepal), Municipal Association of Nepal. Dhulikhel got an opportunity to demonstrate its initiatives towards water management to wider audiences. This conference brought key stakeholders into a single platform where research findings, experiences and ideas and innovations on water management and governance were shared and debated. The conference also provided a deliberative platform to

dialogue among State and non-state actors. In the conference, the technical sessions provided platform to share research findings and innovations and the policy dialogues provided concrete feedback for future policies and actions pertaining to address the water management problems at different levels.

In addition, to foster science policy interactions among water users committees, local representatives, representatives from adjacent municipalities, researchers, academia and media among other stakeholders, Dhulikhel municipality has been leading the forum titled *Pani Chautari* (see Chapter 8 of this book by Devkota et al., 2021). In the recently held sixth series of Dhulikhel *Pani Chautari* (27 February 2020), local leaders, representatives from water user committees, representatives from upstream and downstream communities, representatives from neighboring municipalities among others, reflected on the roles and relationships of the upstream and downstream communities in relation to water management and the need for developing an institutional mechanism for collaborative activities for mutual benefits and sustainable water management. As the sitting Mayor of Dhulikhel, the lead author of this chapter proposed the formation of a 'water council' that is institutionally as well as technically capable and socially inclusive ensuring the representation of concerned stakeholders including upstream and downstream communities to deepen collaboration on resource conservation and sustainable water use between the two communities including other stakeholders. Urging the residents to bring attitudinal and behavioral changes regarding the utilization and conservation of water sources, Dhulikhel has sought strong community support in managing the increasing problem of water management in the region.

More importantly, the municipality is mulling over the integration of all drinking water user groups into a single institution within a ward and handover the water management responsibility to a Water Board in each wards. This is a fresh thinking in the policy innovation which aims at smooth management of the water supply.

## 6. CONCLUSION AND KEY MESSAGES

The growing Himalayan towns grappling with the challenges of water security can adopt the decentralized water governance with local autonomy and leadership to see the positive changes in the water supply system. Nevertheless, a dedicated community leadership putting the common interest at the centre can accomplish clear goals with due co-operation from the general public. Against the conventional practice of top-down, bureaucratic and centralized resource management structure, the success of Dhulikhel's water management stands out as a unique case. The resounding success of Dhulikhel Drinking Water Project is a testimony to the significance of a strong and dedicated local leadership backed by the community members. Forging strong partnerships among the users, municipality, central government agency and donor is also the lesson on offer. The capacity-building measures targeted towards local user committees became pivotal in garnering public trust and commitment for the grand success of the project. The general acceptance of the locals to pay the water tariffs and operate the project on their own despite some initial hiccups clearly indicates the significance of a vibrant and dynamic local leadership.

Dhulikhel water management story reveals that through provisioning of the right structure in place and transparent management practices, unprecedented achievements are possible. Evidenced by the Dhulikhel case, not only the local leaders but also the unflinching faith of the common people for making the community-based institutions has yielded a better result. Meanwhile, the power of relentless pursuit of negotiation to seal a deal in the best interest of the community has also become evident by the tireless effort made by the local community leaders from the early days to get a sustainable drinking water source in the town.

In this scenario, following are the key messages:

- **Decentralized water governance with local autonomy and leadership:** Dhulikhel implemented some innovative strategies with a community centered approach to resolve various forms of conflicts throughout the history of its drinking water management system. Intensifying discussion among community-based institutions and allowing different members

of the community to have a fair say in the pertinent matter of water management was a successful model. Likewise, the proactive leadership of local government in door to door interaction with women, representation of women in water user committee and the ambitious program of 'one house one tap' among others played a crucial role in developing ownership among the locals regarding the management of water.

- **Source area conservation and sustainable water use:** Growing rift between the upstream and downstream communities in Dhulikhel offers some useful lessons in terms of source area conservation and sustainable water use. Instead of short term financial compensation, sustained efforts and investment in watershed conservation of upstream communities will determine the fate of community based water resource governance. The important message is to develop harmonious relationship between water rich upstream villages and vibrant downstream urban centres. Managing wide-ranging concerns of upstream communities including socio-economic development and environmental sustainability will determine the fate of community based water governance model.

## REFERENCES

Bajracharya, R., Dahal, N., Neupane, K., Singh, V. and Habeeb, R., 2019. Urban water security challenges in the Nepal and Indian Himalaya in the context of climate change. *Resources and Environment*, 9 (1), pp.9-18. doi:10.5923/j.re.20190901.02.

Biswas, A. and Tortajada, C., 2010. Future water governance: Problems and perspectives. *International Journal of Water Resources Development*, 26, pp.129-139. 10.1080/07900627.2010.488853.

Case Study n.d. Dhulikhel Drinking Water Supply Project.

Devkota, K. and Neupane, K., 2018. Water governance in rapidly urbanizing small town: A case of Dhulikhel in Nepal. *Journal of Water Security, 4*. doi: https://doi.org/10.15544/jws.2018.002.

*Dhulikhel Annual Policy and Program*, 2019. Dhulikhel Municipality.

Joshi, T., Kovacs, E. and Neupane, K., 2019. Incentives for securing water in the Himalayan town. *New Angle: Nepal Journal of Social Science and Public Policy*, 6(1),j pp.1-20.

Juuti, P.S., Katko, T. and Vuorinen, H. eds., 2007. *Environmental history of water: Global view of community water supply and sanitation*, IWA Publishing. ISBN: 9781843391104.

Pokharel, K., Joshi, T., Adhikari, J. and Neupane, K., 2019. Water security in urban water governance: A case study of Dhulikhel municipality, Kavrepalanchowk, Nepal. *New Angle: Nepal Journal of Social Science and Public Policy,* 5 (1), pp.32-48.

Shrestha, A., Devkota, K. and Neupane, K., 2020. Upstream-downstream linkages for water management: Insights from Dhulikhel. *Spotlight Nepal*. Available at: https://www.spotlightnepal.com/2020/03/12/upstream-downstream-linkages-water-management-insights-dhulikhel.

Tiwari, B.N., 2008. *Pricing of water and sanitation: The Nepalese experience*. The Central Department of Economics, Tribhuvan University, Kathmandu, Nepal.

# 3

# Opportunities and Challenges of the Larger-Scale Water Supply Project: Insights from the Kavre Valley

**Moti Ram Timalsina, Tikeshwari Joshi, Suchita Shrestha, Dilli Prasad Poudel and Dil Khatri**

## SUMMARY

*This chapter documents the experience of the development of large-scale inter-municipality water supply project in Kavre valley, including three municipalities of Dhulikhel, Banepa and Panauti. The Kavre Valley Integrated Water Supply Project (KVIWSP) initiated in 2013 is about to complete and there are ongoing negotiations to agree on the governing mechanisms. While the new project provides a cost-effective solution to growing water problem of the towns, as the authors maintain, there are a mountain of challenges. As we argue in this chapter, there involves a daunting task of negotiating water sources with upstream community to ensure the reliable supply of water. Besides, other challenges related to the management of such a large-scale project include: payback of loan to the donor (Asian Development Bank), governing mechanism including three municipalities and technical and management related challenges for effective functioning of the project. This chapter signals a clear message that while large scale projects are required for addressing increasing urban water demand in the lower Himalayan towns, we should not undermine the importance of smaller scale community-based schemes which play a vital role in ensuring equitable and sustainable water supply.*

## 1. INTRODUCTION

Towns are not livable without ensuring reliable access to safe drinking water for the residents. Nevertheless, urbanizing areas in the Global South are having tough times managing water due to growing population, changing livelihood practices in tandem with climate change impacts (Manouseli et al., 2019). The experience of the rapidly growing hilly towns of Nepal is not different from other towns in the Himalayas (Bajracharya et al., 2019). As the existing water sources are depleting, these hilly towns are facing considerable challenge of meeting the increasing water demand. Estimate suggests that only about 87% population in urbanizing areas have access to municipal water supplies (DWSS, 2018). Consequently, the majority of poor people of both rural and urban areas are more likely to use the water from unimproved sources such as ponds, wells and streams, which may cause water borne diseases (Budhathoki, 2019).

Acknowledging water access as a basic human right, government of Nepal has given a top priority to water supply and sanitation services. Along with this line, large-scale water supply projects are being planned across the country with an intention to connect each household with pipe networks. However, such large infrastructure projects are not only costly and but also poses several social and environmental challenges (MWSS, 2016). Given the high investment and technical capacities needed, these projects are funded by external donors (Kovacs et al., 2019). Though the financial and technical (engineering) are the visible aspect of such large-scale water projects, significant effort is needed on invisible yet daunting task of the consensus building and negotiations on securing water within and between river basins before even visioning of such project. Securing water sources and maintaining the sustainable supply appears the key to such large-scale projects (Bhatta et al., 2014; Joshi et al., 2020).

This chapter presents an overview of individual as well as collective initiatives of the three municipalities – Dhulikhel, Banepa and Panauti of Kavre valley to develop consensus for the large-scale project and materialize it. While the large-scale projects are vital to

meet the growing water need of emerging towns, it involves daunting task of negotiations. There involved negotiations not only with upstream communities to serve the water sources but also among municipalities to agree on the governance mechanisms. As we elaborate in this chapter, large-scale projects have merits in terms of cost-effectiveness and reaching to larger populations, there involve mountain of challenges.

This chapter is based on the decade long knowledge and experience of the lead author who is district level journalist and the engagement and reflection of the researchers from Southasia Institute of Advanced Studies (SIAS) working on the issue of water security in Kavre Valley. The primary information was also collected through 14 key informant interviews with people involved in negotiating and implementing the project including mayors and deputy mayors of three municipalities, representatives of different water users' committees in the towns and the representatives from upstream community.

In the following sections, we captured the existing water management strategies of Dhulikhel, Banepa and Panauti municipalities and their struggle towards water security. In the section 3, we present the collective effort of these three municipalities in agreeing on the KVIWSP project and materializing it. This section also discusses the challenges and opportunities associated with the KVIWSP. Finally, we conclude the chapter indicating the ways forward.

## 2. WATER MANAGEMENT IN THREE TOWNS

Banepa, Panauti and Dhulikhel of Kavre valley are urbanising rapidly as a touristic, medical and educational hub. The valley comprises of three major towns i.e. Dhulikhel in the east, Banepa in the center and Panauti on the south. The land use map of Kavre valley shows that the settlement area has been increasing visibly.

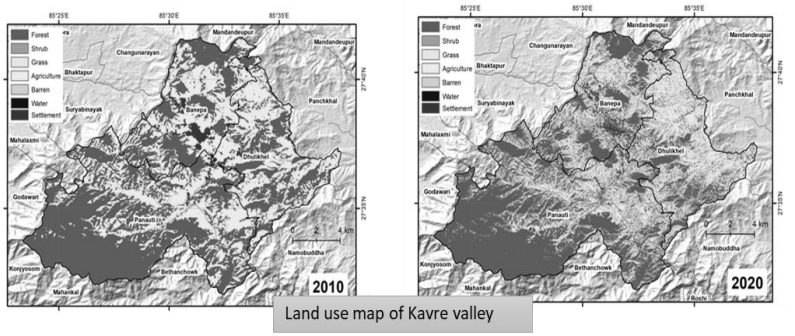


**Figure 1:** Land use map of Kavre valley

These towns were declared as municipalities at different years[1] and accordingly the development stages of water supply system within each municipality varies. However, all of them struggled to secure water supply.

Dhulikhel has troubling history of urban water management and in recent years (post-1990), it has been well-known for community-based water management. Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), has been managing water supply through the plant established with German Development agency (GTZ) support. Dhulikhel negotiated a water sharing agreement with the upstream village of Bhumedanda (currently under the Panauti Municipality) to ensure reliable water supply. History and struggle of Dhulikhel in urban water management is captured in the previous chapter (see Chapter 2 of this book by Byanju et al., 2021). Here we provide more attention on how Banepa and Panauti have been managing water supply.

The journey of water management of Banepa, in its initial phase, resembles that of Dhulikhel. It starts with the historic tap, Hari Amrit Dhara initiated by Hari Samsher, the community leader then in 1941. The town then stepped towards the first piped water supply system of Dhaneshwor Water supply project. Managed by Nepal Water Supply Cooperation (NWSC), the system relied on the water source located at Dhaneshwor Khola (MoUD, 2013). As the demand

1 Banepa, Dhulikhel, and Panauti were declared as municipalities in 1982, 1986 and 1997 respectively

grew over time, in the early 1970s, the local authority, i.e. Kavre District Panchayat, initiated the extension of the existing system. However, the extension was an arduous task, as it needed new water sources. The then Chairperson of Kavre District Panchayat, who was also an inhabitant of Banepa, along with other community leaders made significant efforts to build consensus with Devitar Panchayat (present ward no. 3 of Banepa) where the new source of water was identified. They made several rounds of meetings not only with the community of Sasipani village where the major source of water was located but also with other adjacent villages – Anekot and Jaisithok. The major concern of these upstream communities was to ensure their own irrigation needs. In 1972, with the assurance that the water will be diverted to Banepa without compromising the domestic and irrigation needs of Devitar, the community agreed to provide water to Banepa. This agreement led to the initiation of Sasipani Water Supply Project in 1972 that completed in 1976 with the support from the Department of Water Supply and Sewerage (DWSS).

Since Banepa was rapidly growing as a market center so the water supply was still inadequate to meet the increasing household and institutional demand. Community leaders made an effort in increasing the capacity of water supply system by adding alternate water source from Chandeswari. Later, when the water supply was again not enough, they approached Sasipani of Devitar village Panchayat for the second time to negotiate for getting additional water but this time local community denied providing water. One of the key informants stated:

> People from Devitar did not allow Banepa to take water as they wanted to secure their own needs. The community feared that providing additional water to Banepa might affect their irrigation system on which their livelihoods depend.

Exploration of other possible ways to increase the capacity of water supply continued. As an alternative source, local authorities attempted to extract groundwater but found it was not feasible as per the study of Japan International Cooperation Agency (JICA). Later, in 1993, in the quest of searching new source of water for potentially new water project with the support of JICA, the spring

located at Kalanti Bhumidanda was found potential. The then mayor of Banepa approached the chair of Kalanti Bhumidanda VDC for the support. However, Banepa was unable to secure the identified water source because of the refusal of VDC to provide water to Banepa owing to their own dependency on the water source and an existing water sharing agreement with Dhulikhel municipality.

The water management story of Panauti, a cultural town dominated with rural characteristics, differs from Banepa and Dhulikhel. Compared to these two municipalities, Panauti is richer in water resources as the Roshi and Punyamata rivers flow through its premises. However, Panauti also faced problem to secure water to town dwellers and as we learned, it has been primarily due to the lack of planning and financial resources.

The water supply system of Panauti, managed by NWSC, supplies water to households located in the *old Bazaar* area covering about 27% of the total population. The construction of this supply system was made possible by the financial contribution of Dhulikhel drinking water users committee as a compensation provided for using Panauti as route of water intake. The quantity and quality of water supplied by this system remained very poor (MoUD, 2013). In the wet season, water run only for a few hours and the situation becomes acute in the dry season when supply reduces to an hour every alternate day. As an effort to fulfill the unmet need of water, the town focused on small-scale water schemes. Other 58 small-scale water supply schemes and 40 spring sources remain scattered throughout the municipal area according to the availability and the need. For realizing such schemes, fund was leveraged from various sources. Small scale schemes of Subbagaun, Dhaneshwar, Bansaghari, Taukhal, Malpi, BhandariGaun and Pashtali were supported by Red Cross Society-Panauti, Dhulikhel Development Project and Rural Water Supply and Sanitation Fund Development Board.

Despite of the presence of multitude of supply systems, the lack of adequate supply of quality water drove the inhabitants to keep their eye open to an alternative water supply system. While exploring the reasons behind unsustainability of water supply in the town, one of key informants said:

> Limited investment in small scale and scattered water projects is the main reason that the communities are deprived of sustainable water supply. Water projects are initiated without having long term planning and without having adequate water sources meeting the growing demands.

The above water management cases of the three adjacent towns revealed that sustainable access to and use of water has always been a challenge. To keep up with the pace of increasing demand of water, all the three municipalities strived for an alternative source of water within and outside the administrative boundary to increase the water supply. Negotiating with upstream communities was the key challenge faced by Dhulikhel and Banepa whereas Panauti faced the problem of access to financial resources to build bigger sized water scheme. The experiences of the negotiation process gathered from the case study cities showed that a strong leadership with negotiation capacity is vital for reaching to an agreement.

The three municipalities of Kavre valley explored an opportunity of a large-scale drinking water project. Below, we elaborate the process through which the consensus among three municipalities were forged and the effort was made to negotiate with donors. The Kavre Valley Integrated Water Supply Project funded by Asian Development Bank (ADB) under the Secondary Towns Integrated Urban Environmental Improvement Project (STUEIP) is in the final stage of completion. While municipalities perceive this project as major breakthrough towards urban water security, as we highlight below, there also involves challenges ahead.

## 3. THE KAVRE VALLEY PROJECT

### 3.1. Initiation of the project

The hardships faced by three towns of the Kavre Valley in managing the growing water demands led them to explore a new water supply system in the early 2000s. Each town was in search of technical as well as financial support to enhance water supply as it was beyond the capacity of the town alone. In the meantime, in 2002, the GoN, in collaboration with ADB, initiated a project named Secondary Towns Integrated Urban Environmental Improvement Project

(STIUEIP) for supporting urban infrastructure development and strengthening municipal capacities of cities nearby Kathmandu Valley. All three municipalities of the Kavre valley approached the project to build a new water supply system and each proposed Roshi khola as the potential water source.

The Ministry of Urban Development prioritized those proposals and conducted a feasibility study with few criteria – adequacy of water, technical complexities, environmental and financial implication and operation and maintenance costs. In addition, the study report submitted in August 2007 also concluded that the Roshi Khola water source was feasible for the envisioned projects. Further, the report suggested a joint investment model which would be comparatively cost effective and environmentally friendly as municipalities are intending to extract water from the same source. The study reported NRs. 60 million differences between individual three projects and a joint project (the proposed total cost of three project summed NRs. 230 million). The ADB became ready to contribute 35% of the total investment as loan if joint investment is agreed. To deal with the ongoing negotiation process, a Kavre Valley Drinking Water Direction Committee was established in 2002[2] under the leadership of Dhulikhel.

The opportunity of realizing the dream project of all the municipalities was at the doorstep. However, Panauti municipality was not happy with the offer primarily because of two reasons. Firstly, the local community of Panauti feared losing their irrigation water. Secondly, the proposed modality of loan was not acceptable to Panauti. After series of discussions, Panauti accepted a joint investment model. The chairperson of the Kavre valley water supply management board stated:

> Series of meetings among community leaders, like-minded people of the community and the senior officials from the Ministry of Urban Development were organized. These meetings played a crucial role to bring Panauti municipality and its people to an agreement for a joint investment model.

2 Kavre Valley Water Supply Management Board was established in 2015 as per the Water Supply Management Board Act (2006). Since the establishment of this board, Dhulikhel has been leading the board and chairperson of this board is the present mayor of Dhulikhel.

After building consensus among three municipalities for a joint investment, Kavre Valley Drinking Water Direction Committee made a joint agreement with upstream community for securing water sources. The committee submitted the joint proposal supplemented with the joint agreement and the project– KVIWSP was approved. The procurement process started and was awarded to Chinese company Ningbo Ningshing International Inc. in December 2012. Subsequently, the project started in June 2013 with an estimated investment worth NRs.87 million. The financial support from the ADB (35 % loan), the Town Development Fund (TDF) of GoN (50 % as grant) and the remaining 15% from the residents of three municipalities was designed in 2010. The project was designed to divert 77.33 liter per second (liter/sec) of fresh water from tributaries of Roshi khola of then Bhumidanda and Kushadevi VDCs (current wards of Panauti municipality). The project targeted to supply 24 hours drinking water of national standard with an estimated 65-80 liters of water per day per person to an estimated population of 1,39,422 of three towns.

As the project is implemented, the independent Board of Directors (BoD) will oversee the management of the new water supply system. It will be the paradigm shift in the governance system of water management where the board under the leadership of the Mayor will operate the system. The board retain the power to formulate and implement policies and manage all the water related services.

KVIWSP is an integrated large-scale drinking water project where all three municipalities made a collective effort to get water from a single pipeline system with the logic that it will not only minimize the implementation cost, but also build social relationship, widen equal participation in management and operation, thereby reducing potential disputes on water sources. The joint effort demonstrates of how common understanding can be built amid differences in views, perceptions, interests and knowledge among the owners of multiple water sources. Similarly, the process of building solidarity between the municipal authorities and upstream communities has demonstrated an exemplary socio-political consensus and people-to-people connection in achieving water needs. Below, we elaborate the process of negotiation that helped materialize the project.

## 3.2. Negotiating water sources

Available documents such as meeting minutes, office records and consultations made with key informants showed that the project passed through obstacles and hectic negotiations with the different concerned groups of the water source communities in different time periods. For instance, *Roshi Khola Sthaniya Sarokar Samiti* (Roshi River Local Concern Committee), a concern group representing the community of Panauti put forward their concerns causing the obstacles during the designing phase of the project. The main concern of the group was that sharing water from the designated source to downstream municipal areas might adversely affect their own water use practices especially for irrigation in the dry seasons. The municipality authority and political leaders of three municipalities started a series of discussions with *Sarokar Samiti* leading to a mutual agreement in 2008. The recipient group agreed to allocate 40% of the total water of the project for Panauti only. In addition, they also agreed to support the community of Panauti to build lift irrigation as compensation.

The main negotiation with the upstream authority and community was done to secure water sources (Muldol, Sisha khani, Baira Mahadev, Gudgude and Khar), traditionally used by upstream communities. For this, the consensus building among communities was initiated by organizing meetings in a row by the representatives of three municipalities. During the negotiation process, Dhulikhel Municipality played a leading role. After series of two-way dialogues, they were able to make an agreement with the then upstream VDCs: Bhumidanda and Kushadevi in 2010. As per the agreement, the downstream municipalities need to contribute cash of NRs 13.5 million (7.5 million to Bhumidanda and NRs 6 million to Kushadevi) over the period of five years of project construction phase to the upstream communities in the lieu of their efforts in water source management. In addition, the downstream communities need to provide other in-kind support such as subsidy in health treatment at Dhulikhel Hospital, quota for scholarship at Kathmandu University, upgrade health facilities at upstream communities among others.

Nevertheless, reaching an agreement in a complex socio-economic as well as political context was not an easy process. While encountering the complexity that arose during the course of reaching an agreement, the chairperson of Kavre Valley Water Supply Management Board recalled as:

> Series of meetings with the officials and political party representatives at the community, VDCs (Bhumidanda and Kushadevi) and district levels were conducted. It took almost 7 months to build consensus with the upstream communities in order to have the agreement. After tedious discussions among and between community leaders and authority, the agreement was signed in the mid night at 2 a.m. of March 2010. You can imagine how intense was the discussion and how much efforts we might have put into this agreement process.

He further elaborated about the consensus building process as:

> From the beginning of the project, the involvement and cooperation of leaders of all political parties and representatives of local level authorities were instrumental in building consensus. We all political parties were united and we had a unified voice, as the project was the developmental needs of the people. Though, we might be from different political parties, in such people's projects, we had solidarity. Overall, for building consensus, leaders from all political parties of all levels were equally involved, nevertheless Dhulikhel played a leading role.

Evidences from our case showed that building consensus is crucial to have access to water sources located beyond the political boundary. However, bringing entire upstream communities in confidence during the course of implementing the project remained one of the greatest challenges. When negotiation team forged consensus in one group, the other group come with another demand. For example, in 2013, the traditional users of Roshi khola[3] particularly Bhumidanda VDC formed *Nagarik Sarokar Samaj*. Despite having an agreement in 2010 for providing water for the project, they denied and submitted 19- point demands halting the

3 People who have been using water for running traditional water mills and irrigation from generations.

project progress (GoN, 2014). They had fear that water abstraction from the source will adversely affect the water availability in their water mills and irrigation systems thereby affecting their livelihoods. While exploring how the consensus was built between the *Nagarik Sarokar Samaj* and the project, the coordinator of the Kavre Valley management board recalled as:

> The project organized several meetings among the members of Nagarik Sarokar Samaj, project officials, political leaders and municipal authorities. One to one discussion was made on the demands though some of the demands were already addressed by the project and some were beyond the capacity of the project. Finally, they allowed us to smoothen the project activities after making a seven -point agreement to address their demands.

However, the upstream community remained unhappy with their own community leaders because they felt the process of negotiation was not inclusive disregarding the concerns and voices of its people. During focus group discussion at upstream community, the respondent stated:

> The leaders of our community made agreements at mid-night without involving the wider community. They do not want to include community as such in the decision-making process of such an important issue. We are the one, who conserve natural resources including water but we are excluded in the decision-making process.

This implies that during such negotiations, top-level leadership of the communities get involved but it is not guaranteed that the wider voices of community is included.

At the present context, upstream water sources located at the then VDCs (Bhumidanda and Kushadevi) are now within the political boundary of Panauti municipality after the local level restructuring process in 2017. This has given an opportunity for Panauti Municipality to manage the possible future conflicts related to water source.

The above analyses showed planning, designing, building and operating large water infrastructure project is beyond the technical

and structural measures and depend upon the strong foundation of social cooperation among communities. In our case study, the joint efforts of three municipalities were very important in bringing the large-scale project into an operation. Series of political dialogues between and among the concerned stakeholders including community played an important tool of negotiation processes for resolving the concerns and conflicts emerged during various stages of the project. Therefore, to ensure adequate, inexpensive and sustainable supplies of water through large scale projects involving multiple interests of the multiple stakeholders need giving importance to social fabric and uphold the benefits of the source community.

## 3.3. Major challenges of the project

Despite of opportunities, the project suffered from several constraints. The series of delays due to dissatisfied traditional users of water source, the 2015 earthquake, and the economic blockade by India in 2015 created major hindrances for the project resulting in the overrun of the total project cost to NRs.112 million with a variance of 47.20%. Though, the project was expected to be completed by 2015, only 97% of its physical work was completed at the end 2019. More recently, COVID-19 pandemic has become another reason of the project delay which could again shoot up the project cost. As the project comes close to the completion, it is seen as solution to the mounting water demand. However, as we elaborate below, there remain challenges ahead in effectively governing the large-scale scheme.

**Paying back the loan:** KVIWSP differs from any of the earlier smaller schemes as it was built with loan support and there remain challenges to pay back the loan. Of the total budget, 35% is the loan from ADB and 15% is community contribution, other being grant from government of Nepal. According to the project agreement, the loan needs to be paid back within 20 years of time with 5% annual interest rate. For the municipal authorities with limited financial capacity amidst the growing developmental demands of the communities, paying back large chunk of loan within the given time period can be challenging. Further, as mentioned earlier, the cost

of project construction has been surged by 47% due to delays. This indicates an increase of proportionate loan amount as well. The increased loan amount has put additional burden to the municipalities.

**Sustainability of water sources:** The five water sources (Muldol, Sisha khani, Baira Mahadev, Gudgude and Khar) of the project are located about 16 km away from the Roshi khola with an uneven geographical terrain and muddy road. There are ongoing activities of extraction of stones, aggregates and minerals is on rise along the Roshi khola. More than two dozens of crusher industries along the riverside have been polluting the river by directly discharging the mine effluents including rocks which has even changed the flow of the river.[4] These activities are not only degrading water quality but also posing threat to the water sources. If no effective watershed conservation measures are taken, the water sources of the Kavre Valley project will remain under threat.

**Institutional challenges:** After the completion of the project, the responsibility of the existing executive committee of Kavre Valley Water Supply Management Board will end. This executive committee was established for the construction phase of the water scheme and will be handed over to the new governing body (water management board). The new governing body will be responsible for responsibilities such as developing water distribution mechanism and defining water tariff. The body will also have key role to play to maintain the relation with water source community. However, structure of such committee is yet to be finalized as no concrete decision at the Federal Ministry has been made for the formation of a new executive committee of the board.

**Disaster unpreparedness:** Roshi river which is a major water source of three municipalities witnesses flood and landslide risk during every monsoon season causing huge loss and damage of properties. The risk of flood and landslide is more intense during the monsoon (June-August) causing huge damage of properties (MoHA, 2020). For instance, in May 2020, water pipeline of Dhulikhel was damaged by a pre-monsoon flood of Kharkhola. Similarly, another

4 https://www.onlinekhabar.com/2018/05/680362

flood event of the Punyamata[5] during the monsoon of the same year also damaged the water pipeline of Dhulikhel. Because of damage to water pipelines caused by these flood events, the water supply system of Dhulikhel was cut off for few days. Such types of climatic disaster occurring every year could add financial burden to the project and bring sudden water crisis. Failing to introduce such disaster preparedness measures could result in huge loss of investment of KVIWSP in the future. In such cases, smaller schemes continued to work indicating more resilience during the time of crisis.

## 4. CONCLUSION AND WAY FORWARD

This chapter documented the experiences and joint effort of three municipalities of Kavre valley towards developing an inter-municipality large-scale water project as an attempt to meet growing urban water demand. We elaborated the negotiations of the municipalities with upstream communities to secure water sources for the new project.

We argued that the larger schemes inter-municipality projects are more feasible and achievable but there involves a lot of efforts to negotiate the water sources and in developing governing mechanism inclusive of all municipal authorities. The insights of this case are that the process of consensus building between municipal authorities and upstream communities is crucial and the political leadership with good negotiation skill is instrumental.

As the Kavre valley case shows, large-scale projects are the requirement of today's urbanizing trend and to provide solution to increasing water stress, however, there are a number of challenges to materialize and manage such projects ensuring equitable water provisioning. Other key challenges include the payback of loan to the donor, emerging conflicts, associated disasters affecting the infrastructure and inclusive governing mechanism. From this analysis, we conclude that while large scale projects are required for addressing increasing urban water demand in the lower Himalayan

5 Punyamata is one of the tributaries of Roshi khola. Punyamata river meets the Roshi khola in Panauti

towns, we should also not undermine the importance of smaller scale community-based schemes which play a vital role in ensuring equitable and sustainable water supply.

## REFERENCES

Bajracharya, R.M., Dahal, N., Neupane, K.R., Singh, V. and Habeeb, R., 2019. Urban water security challenges in Nepal and Indian Himalaya in the context of climate change. *Resources and Environment*, 9(1), pp.9-18, DOI: 10.5923/j.re.20190901.02.

Bhatta, L.D., van Oort, B.E.H., Rucevska, I. and Baral, H., 2014. Payment for ecosystem services: possible instrument for managing ecosystem services in Nepal. *International Journal of Biodiversity Science, Ecosystem Services & Management,* 10(4), pp.289-299.

Budhathoki, C.B., 2019. Water supply, sanitation and hygiene situation in Nepal: A review. *Journal of Health Promotion*, (7) pp.65-76 ISSN: 2631-2441.

DWSS, 2018. *Drinking water and sanitation status of Nepal: Factsheet.* Government of Nepal, Ministry of Water Supply and Sanitation. Department of Water Supply and Sewerage (DWSS), Environmental Sanitation Section.

Dhulikhel Drinking Water Supply and Sanitation Users' Committee, 2018. Annual Report.

GoN, 2014. *Addendum to the Initial Environmental Examination of Kavre Valley Integrated Water Supply Scheme.* Environmental Assessment Document. Nepal: Secondary Town Integrated Urban Environmental Improvement Project. https://www.adb.org/sites/default/files/project-document/150826/36188-023-iee-08.pdf.

Joshi, T., Kovacs, E.K., Neupane, K., 2020. Incentives for securing water in Himalayan town: A case from Dhulikhel. Nepal. *New Angle: Nepal Journal of Social Science and Public Policy,* 6(1), pp.1-20. https://doi.org/10.17863/CAM.48538.

Kovács, E.K., Ojha, H., Neupane, K.R., Niven, T., Agarwal, C., Chauhan, D., Dahal, N., Devkota, K., Guleriae, V., Joshi T., Natasha K., Michael, K.N., Pandey, A., Singh, N., Singh, V., Thadani, R., Vira, B., 2019. A political ecology of water and small-town urbanisation across the lower Himalayas. *Geoforum*, 107, pp.88-98.

Manouseli, D., Kayaga, M.S. and Kalawsky, R., 2019. Evaluating the effectiveness of residential water efficiency initiatives in England: Influencing factors and policy implications. *Water Resources Management,* 33, pp.2219–2238.

Ministry of Home Affairs (MoHA), 2020. *Monsoon preparedness plan 2020.* Government of Nepal, Ministry of Home Affairs, National Disaster Risk Reduction and Management Authority, Babarmahal, Kathmandu.

Ministry of Urban Development (MoUD), 2013. *Final report for environmental impact assessment (EIA) of Kavre Valley Integrated Water Supply Project (KVIWSP*). Ministry of Urban Development, Department of Urban Development and Building Construction, Secondary Towns Integrated Urban Environmental Improvement Project, Project Coordination office, Babarmahal, Kathmandu. https://www.adb.org/sites/default/files/project-document/81093/36188-023-eia.pdf.

Ministry of Water Supply and Sanitation (MWSS), 2016. *Water, sanitation and hygiene (WASH) sector status report 2016.* Sector Efficiency Improvement Unit, Ministry of Water Supply and Sanitation, Kathmandu.

# 4

# Upstream-Downstream Interdependencies and Water Security in Dhulikhel

**Kaustuv Raj Neupane, Anushiya Shrestha and Tikeshwari Joshi**

## SUMMARY

*Dhulikhel town relies on the upstream of Kalanti Bhumidanda for its water supply since the late 1980s and has been incentivizing the upstream community through formal agreements. In this chapter, we document these agreements and underlying negotiation processes. Our findings and reflections are based on qualitative research including in-depth interviews, focus group discussions, and review of agreement documents, conducted between 2014 and 2020. Findings show that rather than valuation of environmental services and benefits, socially embedded norms associated with water and socio-political relationships played important role in succeeding and sustaining the water-sharing agreements with upstream communities. Besides, the incentive model has changed over time from social benefits and material support to monetary inputs as the social values associated with water have eroded while the economic benefits of water have become an attraction. Dhulikhel-Bhumidanda case depicts negotiation processes need to carefully identify and involve the affected actors and ensure that mechanisms for mobilizing monetary incentives are transparent. In lack of attention to these details, incentives, as in this case, can backfire as a cause of conflict rather than flourish upstream-downstream relationships. Involving different water users in the dialogues and decision-making processes can help internalize and institutionalize the upstream-downstream inter-dependencies and contribute to making both, villages and towns water secure.*

## 1. INTRODUCTION

The increasing water stress is leading contestations and conflict over water sources (Falkenmark, 1992). Such cases of conflict and contestations are increasingly common in urban areas as growing water demands outrun the supply from traditional water sources located within their administrative jurisdiction. Many of such water-stressed towns have tapped water from distant sources and augmented their water supply (Celio, Scott, and Giordano, 2010). Traditionally, such water-sharing mechanisms materialized through informal negotiations and mutual understanding (Upreti, 1999). However, over time, such practices often become a contentious issue between the water provider, upstream and the water user, downstream communities. Water Aid (2012) reported a steady decline of local sources compelling local communities to cut supply to some traditional water users, which resulted in conflicts between drinking, irrigation, and other water user groups.

Payment for Environmental Services (PES) schemes emerged as a conflict-resolution instrument in solving downstream–upstream conflicts (Kosoy et al., 2007). PES schemes in watershed gained popularity between 2002 and 2008 (Porras et al., 2013). The PES[1] is defined as a free-market-based approach designed to conserve the environment, in which the users of ecosystem services (ES) pay producers (or managers) to adopt (or maintain) environment-friendly regimes to ensure the long-term supply of such services (Wunder, 2005). However, PES schemes remain criticized for the commodification of nature by narrowing down of ecosystem complexity to individual and distinguishable 'services' and single value systems which do not recognize ecological, social, or spiritual values as separate from an income dimension (Kosoy and Corbera, 2010). Given that watershed resources are needed for human survival and that watershed governance is dependent on social institutions and evolving knowledge systems, proponents of PES have stressed the application of PES for enhancing mutual benefits

1 A PES scheme depends upon a number of criteria. It is described by: (1) a voluntary transaction, in which (2) a well-defined land use likely to secure that service is (3) bought by a (minimum of one) ES buyer from (4) a (minimum of one) ES provider if (5) the ES provider secures ES provision (conditionality).

in managing watersheds (Kolinjivadi, Adamowski and Kosoy, 2014; Tacconi, 2012).

Muradian et al. (2010) defined PES as 'a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land-use decisions with the social interest in the management of natural resources and considered any scheme where economic transfers play a role in facilitating the coordination between participants either that meet market transaction nature or not is a PES scheme'. They stress on the need to pay special attention to social embeddedness in administering and analyzing PES schemes in developing countries. For instance, in Bolivia, besides providing material support, water schemes were built on pre-existing social norms and promoted through social embeddedness rather than environmental support (Grillos, 2017). Social norms are informal rules derived from social systems that prescribe what behavior is expected, allowed, or sanctioned in particular circumstances (Kinzig et al., 2013). The concept of social embeddedness recognizes that any economic activity depends upon the social context in which it takes place and the interpersonal relationships and social ties (Cui and Liu, 2018).

Dhulikhel, a hilltop town in Nepal provides a striking example of water-related negotiations that involve incentivizing the water-rich upstream community, explicitly by providing economic incentives, and implicitly by mobilizing socio-political position and interpersonal relations (Joshi et al., 2019). Until 1987, Dhulikhel residents depended on local springs located in its *Thulo Ban* (big forest) (for detailed history, see Chapter 2 of this book by Byanju et al., 2021). Attempting to improve water supply in Dhulikhel town, in 1985, Dhulikhel Village Panchayat made the first agreement with Bhumidanda Village Panchayat. Following the agreement, in 1987, a Dhulikhel water supply project started based on a Roshi watershed. Roshi watershed lies in the Kalanti Bhumidanda Village Development Committee (VDC), referred to as Bhumidanda after this (since 2017 it belongs to Panauti Municipality). The primary source of this water supply project is the Saptakanya fall of Kharkhola, a stream originating from the Kharkhola Mahabharat Community Forest of the Roshi watershed.

Over the past three decades, Dhulikhel municipality made two more agreements for diversion of water to the Dhulikhel town; in 2010 and 2011 (for a summary of the agreements, see Table 1). In this chapter, we elaborate these three agreements and underlying negotiation processes with a focus on the influences of social embeddedness in reaching and sustaining negotiations and water-sharing agreements between the upstream and downstream communities. Our analysis shows that Dhulikhel made perseverant efforts in bringing the upstream communities into a series of negotiations and sustaining the water-sharing agreements through material and non-material contributions. Besides, Dhulikhel as the district headquarter and the district hub of education and health services made upstream community dependent on Dhulikhel. This dependency on Dhulikhel and embedded socio-political power made Dhulikhel able to negotiate with upstream communities and secure water for its residents.

Evidence and reflections we present in this chapter are based on interactions and observations made during qualitative field research conducted between 2014 and 2020. We also collected and reviewed the three agreement documents, interviewed farmers (5), water mill operators (7) in the upstream community, and the agreement signatories of both, upstream and downstream communities. Additionally, we organized focus group discussion (2) with Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC).

Following this introduction, the second section narrates the history of the negotiations. The second section is further divided into three sub-sections elaborating on the agreements of 1985, 2010, and 2011. For each of the agreements, we explain (a) why the agreement was required (b) the process of negotiation, and (c) analyze how social-political relations played role in making negotiation and agreement successful. Finally, we conclude by highlighting key messages and insights, and policy recommendations.

**Table 1**
**Agreements and incentives between upstream Bhumidanda and downstream Dhulikhel**

| Agreements | Upstream Signatories | Downstream Signatories | Water Supply Area in downstream | Incentives to the upstream community |
|---|---|---|---|---|
| The first Agreement, July 27, 1985<br>Tap water from Khar Khola at Bhumidanda and supply Dhulikhel | Bhumidanda VDC – Pradhanpancha | Chair of Dhulikhel Development Board | Dhulikhel Village Panchayat (ward no 2, 3, 4, and 5 of Dhulikhel Municipality) | Constructed school building and paid more than NPR 1 crore on ad hoc basis till 2011 for different development projects in the upstream area |
| The second Agreement, March 12, 2010<br>Tap water from Roshi river and its tributaries at Bhumidanda and Kushadevi VDC for KVIWSP | Bhumidanda VDC-VDC secretary and local political leaders | KVIWSP –political leaders of 7 major parties from Kavre valley | Dhulikhel ward no 1, 6, 7, 8, 9 and Banepa and Panauti Municipality | NPR 75 lakh in over five-year period, and subsidies in treatment at Dhulikhel Hospital and support in upgrading health post building scholarships at Kathmandu University. |
| The third Revised agreement,<br>May 08, 2011<br>Enlarge water intake at the tap from Khar | Bhumidanda VDC Secretary in presence of three members of All Party Mechanism | Dhulikhel drinking water user committee in presence of representatives of Kathmandu | 2, 3, 4 and 5 and few parts of ward no 1, 6, 7, 8, and 9 of Dhulikhel Municipality | NPR 8 lakh for VDC and NPR 2 lakh for school teachers and NPR 36000 for forest steward annually, provide a discount |

## 2. HISTORY OF WATER NEGOTIATIONS BETWEEN DHULIKHEL AND BHUMIDANDA

This section of the chapter provides details of the three agreements made between Dhulikhel and upstream community Bhumidanda Village from the 1980s to 2011. It also draws key messages of each of the agreements and shows how social relationship and support was a key factor in materializing these water-sharing agreements.

### 2.1. The first agreement, 1985

Severe water shortages led some local leaders of Dhulikhel to negotiate with the upstream Bhumidanda community for water sources and with potential donors for funding a water supply scheme in the early 1980s. The local leadership consisted of the Chief of the then Dhulikhel Village Panchayat and Dhulikhel Development Board (DDB), a community-based organization formed for the overall development of Dhulikhel. Bhumidanda community, led by their Village chief, agreed to allow Dhulikhel to withdraw water through a 6-inch pipe on the condition that Dhulikhel would provide them the financial support they needed for constructing a school building. The upstream community demanded the construction as the building of the only primary school in this community was washed away by a flood in 1981.

Our interviewees who took part in the negotiation process during this first agreement explained that the socio-cultural norm of sharing water as a 'social good' that everyone should have access to contributed in making this bilateral agreement successful. Additional factor to this was the inter-personal relations between the community leaders of these two communities. According to the then president of Bhumidanda Village Panchayat (interviewed in 2015):

> Chairman of Kavre District Panchayat - the district headquarter, who is my friend, requested us to provide water for Dhulikhel residents who were suffering from water scarcity. In response, we requested them to construct our local school building as it was damaged by a huge flood of the Roshi River in 1981. The Pradhan

> Pancha[2] agreed to the conditions we put forward, and accordingly, as per the decision of the Village Council, we decided to allow them to take water and establish a new water supply system.

Bhumidanda Village Panchayat discussed the proposal in a wider citizen forum and, recognizing the severity of the water crisis in Dhulikhel, agreed to provide water to the latter. The elected Pradhanpancha, the Village head of Bhumidanda, and the chief of Dhulikhel Development Board on behalf of the downstream community signed this non-expiring five-point agreement on July 27, 1985 (see Figure 1). Point two of this first agreement mentions the construction of the school building as:

> With an objective of improving the education status of Bhumidanda Village Panchayat immediately, Dhulikhel Development Board will develop a blueprint and estimate cost for the financial support for the construction of a primary school building of Bhumidanda.

**Figure 1** Exchange of agreement document between Dhulikhel town and Bhumidanda (*Photo source:* DDWSUC)

2 Pradhan Pancha were the village head in the Panchyat Period.

The key message of the first agreement is that the inter-personnel relations between community leaders along with material support (for the school building) were the key factors in making the agreement possible. The social relationship was established as Dhulikhel was the district headquarter, which the people of Bhumidanda had to visit to get state services such as citizenship, land ownership registration, and electricity connection. Also, important was the role of the facilitator, who was a common friend of both community leaders and facilitated in building the mutual trust needed for the agreement. Similarly, the social norm regarding water as a social good and sharing water as a spiritual deed (Devkota and Neupane, 2018) was a crucial factor underlying this agreement.

Following the first agreement, Dhulikhel Panchayat explored an organization that could support them in developing a water supply system. Although GTZ agreed to support, Dhulikhel needed to 'upgrade' itself into a municipality to qualify for this support. This was achieved by incorporating some adjoining rural villages (Bajrayogini, Srikhandapur Village Panchayat, and some parts of Kavre Village Panchayat) in 1986. However, the proposed water supply project was designed for Dhulikhel Village Panchayat only, referred to as the 'core settlement' excluding the annexed surrounding villages (for detailed history, see Chapter 2 of this book by Byanju et al., 2021).

## 2.2. The second agreement, 2010

In the following decade, both Dhulikhel and Bhumidanda settlements expanded, their socio-economic contexts changed, and water demands soared with increasing urbanization and growing tourism-based economy. Kathmandu University, Dhulikhel Hospital, and several hotels were established in Dhulikhel. In Bhumidanda, the shift from traditional farming system to more intensive agriculture practices increased irrigation water use.

While the core settlement of Dhulikhel, which comprised of wards 2, 3, 4 and 5 of Dhulikhel Municipality had adequate water supply, peripheral wards (ward no 1, 6, 7, 8, 9) of the municipality remained excluded. The residents of these wards continued protesting,

demanding for the water supply. In 2006, there was a huge protest during which the protestors broke the intake pipeline of the Dhulikhel water supply system. This stopped water supply to Dhulikhel town for a week. After this demonstration, Dhulikhel Municipality explored options for new water supply projects. Subsequently, a new project called the Kavre Valley Integrated Drinking Water Supply Project (KVIWSP), funded by the Asian Development Bank (ADB) was designed (For details about KVIWSP, see chapter 3 of this book by Timalsina et al., 2021).

To arrange the water source for KVIWSP and enable its construction, a new 9-points agreement was signed with the upstream community of Bhumidanda on March 12, 2010. VDC secretary and six local political leaders (two from each Nepali Congress, Unified Maoist and Leninist and Unified Communist (Maoist) Party of Nepal) of Bhumidanda VDC signed the agreement on behalf of the upstream community. On behalf of the Kavre Valley, the political leaders of seven major political parties along with Chief executive officers of Banepa, Dhulikhel, and Panuati municipalities as the invitees signed the agreement. During this period, the country did not have elected local representatives and the government authorized the VDC secretary, a civil servant, to take over the roles of the local government. Local leaders of different political parties, through All-Party Mechanisms (APM)[3], had significant influences in making resource-related decisions and were active in these negotiations between upstream and downstream communities that happened over a period of nine months.

This agreement offered new incentives to the upstream: cash amounting to a total of NPR 75 lakh over five years, subsidies in treatment at Dhulikhel Hospital, contributions in upgrading their health post building, and scholarships at Kathmandu University[4]. Although the agreement also entitled Bhumidanda VDC to an undeclared percentage of annual royalty collected upon operation of the project, this is yet come into practice as the project operation

3 In absence of local elected governed in 2008-2012, the government introduced All Party Mechanism (APM) to make consensus-based decisions at the local level. APM members represented different parties on a one-party-one-representative basis.

4 KVIWSP has signed agreement with Kusha Devi VDC for additional water sources and has paid NPR 60 lakh

has not started. This agreement was made as a single time agreement that does not need renewal. The decision 1 of the agreement document (2010) mentions the payment mechanisms as follows:

> In response to the demands of Bhumidanda VDC concerning the operation of Kavre Valley Integrated Drinking Water Project, Banepa, Panauti, and Dhulikhel Municipalities agreed to provide a grant of fifteen lakh rupees (five lakh from each municipality) to Bhumidanda VDC annually. This shall continue for five fiscal years and a total sum of seventy-five lakh rupees.

Water Resource Act (1992) of Nepal sets a priority order for water uses, drinking and domestic uses being the priority, followed by irrigation, agriculture uses, hydroelectricity and other various uses in the priority order. As per the above-mentioned agreement, Bhumidanda communities have the '*prior* rights' and the diversion of water for Kavre Valley cannot hamper their existing water uses such as irrigation and water mill operation. In case the water source volume decreases, the amount of water diverted to Dhulikhel will be curtailed to reduce the consequent loss of water-based livelihoods options for the upstream communities. Although the Bhumidanda communities complain that "the decision for the entire village was made by involving only a few people" (FGD, 2015), the local leaders of Bhumidanda argue they had no option except signing the agreement because of the repeated 'requests' of the district-level political leaders.

Although the upstream residents are satisfied with the amount of money paid to them, both, the incentive providers and receivers opined the coordination between the VDC authority, local political leaders, and affected people in the allocation and use of the funds and services was weak. For instance, the downstream community illustrated, "we have provided water pipes for proper water distribution in the upstream region, but it remains unused. It is the duty of the upstream community to lay that pipe" (Vice-chairperson, DDWSUC, 2015).

Bhumidanda has two micro watersheds: Roshi catchment and Kalanti water catchment, which meet in the downstream (Panauti)

as the Roshi River. The agreement does not lay any condition on how these upstream communities should use the funds. This has, however, allowed the upstream leaders to divert the fund to sectors and areas not affected by the water supply project. Many residents in Bhumidanda argue that the incentive fund should be used only for the Roshi catchment. One of the residents interviewed in 2016 mentioned that, "Dhulikhel has given an incentive amount but our leaders have used it for development activities in areas that are not impacted by the water supply projects."

All these factors have led to forming a protest group in the upstream community to oppose these ongoing activities. Local people from Bhumidanda also painted the walls with protest slogans such as: "Do not ask only water with us, give us development", "irrigation and water mills cannot be finished by diverting water' and 'water cannot be sold".

The key message of the second agreement is that the negotiations process and the resulting PES-oriented agreement were strongly influenced by the pre-existing social connections between the political leaders, and embedded unequal power positions at the district, municipal, and within the village level. These agreements were made at a higher political level and the water user groups of the upstream communities, despite being affected by the water supply projects, were neither included nor well-represented in the negotiation processes. Hence, the decisions lacked attention to their stake, including those regarding mobilization of the incentives. While the agreement has provided the upstream community immediate benefits, they suspect that the political leaders had hidden interests and therefore did not involve the affected water user groups in the negotiation processes. Additionally, they are dissatisfied with the ongoing haphazard mobilization of the incentive fund. Growing grievances among the water users are resulting in conflicts among the water provider communities and contestations against the sharing of water for the water supply projects. Moreover, the use of the incentive fund has been limited to improving the access to the basic services which the upstream communities lacked. Hence, the valuation and sustenance of environmental services, a major component of PES, has not been a primary focus in this water-sharing agreement.

## 2.3 Revised agreement, 2011

The DDWSUC was facing increasing challenge to run the water scheme. On one hand, water demand was increasing. On the other hand, people from upstream area of Bhumidanda were demanding redefinition of the earlier agreement and some additional payments. Without taking into account the agreement of 2010, in 2011, DDWSUC inked a new agreement to increase the water supply immediately and to establish a regular payment mechanism. The president of DDWSUC reported (interviewed in 2015):

> Upstream people used to come to us demanding money for development activities; we had already paid them nearly 1 crore Nepalese rupees on an ad hoc basis. So, we thought to formalize the payment mechanism to make it more transparent and clearer.

Responding to the request of the DDWSUC to forge consensus on the demand and supply of water, the then mayor of the Dhulikhel Municipality and the then DDC chairperson had started a dialogue with the then VDC chairperson of Bhumidanda already in 2000. In order to bring the actors into a constructive dialogue, the chairperson of DDWSUC was actively involved in the negotiation process. The manager of the DDWSUC recalled:

> During the negotiations, representatives from the Kathmandu University (KU) and Dhulikhel Hospital facilitated the discussions between the communities. The Vice-Chancellor of KU himself was involved in the negotiation process. Their facilitation helped to end the negotiation with fruitful decisions.

Upstream Bhumidanda community actively participated in the negotiation process. They were represented by local leaders of different political parties and other local institutions. After several dialogues, an addendum to the first agreement of 1985 was signed in 2011. The revised agreement laid ground for increasing the volume of water that Dhulikhel could intake for Dhulikhel drinking water supply. It also established a mechanism for a regular payment to the upstream community.

DDWSUC and upstream Bhumidanda signed a new nine-point agreement on May 8, 2011. The document states:

> This contract is held between Dhulikhel Drinking Water Users Committee (first-party) and Bhumidanda VDC (second Party) [...] after a series of discussions between the representatives from Dhulikhel Drinking Water Users Committee and Bhumidanda to repair and increase the volume of water being tapped (as per the agreement between Dhulikhel Village Panchayat and Bhumidanda Village Panchayat on 27 July 1987) from Sapta Kanya spring of Khar Khola forest from Kavre district Bhumidanda VDC ward no.3 under German project by Dhulikhel Drinking Water Users Committee to Dhulikhel Municipality.

VDC secretary of Bhumidanda, on behalf of the upstream community, signed the agreement in the presence of three leaders from representatives of All-Party Mechanism (political leaders belonging to UCPN (Maoist), Nepali Congress, and CPN (UML). The president of DDWSUC signed the agreement in the presence of the chairperson of the district water resource committee, chief executive officer of Dhulikhel Municipality, representative of Kathmandu University and Dhulikhel Hospital.

According to the agreement, DDWSUC will financially support the upstream community, mainly for their school and forest management. Every year, DDWSUC will pay a sum of NPR 800,000 to the upstream VDC and NPR 20000 for the school at the upstream. Dhulikhel also agreed to increase the payment being given for the salary of a forest guard to NPR 36,000 per annum. Similarly, it was agreed that the Kathmandu University will plan and implement activities for upgrading education standards at Bhumidanda. Dhulikhel Hospital also agreed to provide discounts on the treatment costs for the poor and vulnerable population of Bhumidanda. Further, Dhulikhel Hospital will support Bhumidanda in improving its health sector.

Dhulikhel has regularly paid the agreed-upon amount annually. Dhulikhel Hospital is also providing a discount for medical treatment at the Hospital and Kathmandu University provisioned scholarship at an intermediate level for people of Bhumidanda.

However, the upstream stakeholders were dissatisfied because of continued poor transparency in the disbursement of the incentive fund and questioned the accountability of upstream local political leaders. Consequently, the upstream community obstructed DDWSUC in increasing the water intake to a 10-inch pipe (from the existing 6-inch water pipe), which hindered the full implementation of the project. The smoldering grievances have resulted in growing opposition against the new agreements.

Similar to the above-discussed first and the second agreements, the key lesson of this agreement is that the social relations and embedded power positions have strong influences on the water-sharing agreements. However, the social values associated with water continue degenerating. Rather the negotiating parties prefer and prioritize monetary and social incentives as the desired way out to materialize water-sharing agreements. This shift can be related to a general trend of growing demands for local schemes based on the payment for environmental services. For instance, Nepalese city Dhankuta has recently established a PES mechanism led by the Municipality for Nibuwa Khola Watershed conservation (Aryal et al., 2019). Similarly, in Baglung Municipality, the drinking water users committee had paid 18 lakh to the upstream forest users committee (Acharya and Khatri, 2013). In the agreement for the KVIWSP, the committed monetary and social incentives seem to have heated protracted debates and heightened the expectations of the upstream service provider community. This agreement also shows that the involvement of powerful local institutions, in this case, Kathmandu University and Dhulikhel Hospital, added credibility in dialogue, taking these prolonged negotiations into an agreement. Support in developing the health and education sector of Bhumidanda as per their commitment will be crucial in sustaining the agreements amid growing distrust against the local leadership and objections to the agreements.

## 3. CONCLUSION AND WAY FORWARD

This chapter delved into the details of water-sharing agreements between Dhulikhel Municipality and the upstream Bhumidanda VDC, with a focus on the influences of social embeddedness in the

negotiations and agreements for securing water in Dhulikhel. Analysis of the Dhulikhel-Bhumidanda case shows the social norms that, until the past few decades, motivated people to come into water-sharing agreements have become weak against the growingly popular, payment-driven 'mutually beneficial' mechanism. Sharing of resources for immediate economic incentives, a practice influenced by the idea of Payment for Ecosystem Services (PES), has become a key factor in making water-related negotiations successful. Nevertheless, pre-existing social relations and embedded social, political, and institutional privileges continue to facilitate and stimulate the dialogues between negotiating parties.

According to Muradian et al. (2010), this intermingling of economic incentives and socio-political relations in resource-related negotiations is a major criterion of PES. Dhulikhel-Bhumidanda water-sharing agreements and the underlying process showcase intersection of social norms, values, and socio-political relations where material supports are a continuous and evolving process. Socio-political relations, the economic ability to pay for accessing water resources, and the perseverance to continue dialogues enabled Dhulikhel to overcome its water scarcity and regain its socioeconomic and political vibrancy. Although debates and dissatisfaction against the mobilization of funds exist, sharing of the water resource has increased the pace of socio-economic development in Bhumidanda. What remains largely neglected in this reciprocal relationship is the valuation of environmental services despite that conservation of water sources is vital for the real success of these agreements and sustainability of the water supply systems. As elaborated in the above sections, these agreements are not free from conflicts and controversies. One of the reasons for this is the changing social norms from one that attributed social and spiritual value to water to one that urges to draw maximum economic benefits from water.

The second major cause of contestations seen is the weak representation of the affected community in the negotiation process and lack of attention for developing a strong mechanism for mobilizing and monitoring the incentive funds. In addition, whether the revenue generated by the water governing body should be shared

with the water source owning upstream communities remains unanswered in applying PES schemes in Nepal (Bhatta et al., 2014). Moreover, as seen in this case of Dhulikhel-Bhumidanda, transparent mobilization of the incentive fund has been a conflicting issue rather than the incentive amount. In such a situation, additional incentive, if not properly managed can proliferate the simmering conflict.

In these scenarios of inter-dependencies of Dhulikhel and Bhumidanda for water and development, we draw the following key messages:

1. Social relations and embedded power positions strongly influence water-sharing agreements. Social values associated with water have weakened while monetary and material incentives that have become crucial for succeeding and sustaining the water-sharing agreements. Nonetheless, a pure market-based practice involving sharing of revenue or royalty can add distrust and complicate the negotiations resulting in breaching of agreements. Monetary incentives do not ensure socio-economic development and watershed conservation at the upstream nor do these ensure sustained water supply for downstream water users. Socio-political relationships when mobilized along with institutionalized participatory and transparent monetary and material support mechanisms for the development of the upstream community, help in making negotiations for water successful and sustaining the water supply system.

2. Addressing the growing dissatisfactions, reinforcing good relations between upstream water-rich villages and downstream urban centers as well as clear mechanisms for mobilizing incentives remain crucial, not only for sustaining these water supply systems but for the socio-economic development of both communities. Identification of affected actors and their participation in the institutional mechanism can help to sustain symbiotic relationships between different water user groups in both upstream and downstream communities. Such an institutional entity must be formally authorized, institutionally, and technically capable, and socially inclusive. Such

internalization and institutionalization of the inter-dependencies of different local government units will be increasingly important in managing water, mutual development, and for making both villages and towns water secure.

## REFERENCES

Acharya, S., Khatri, D.B., 2013. Paymnet for watershed services as a tool to resolve drinking water problem of municiplaities: A case of Baglung Municipality. In: International Conference on Forests, People and Climate: Changing Paradigm Pokhara Nepal. pp.284-296.

Aryal, K., Bhatta, L.D., Thapa, P.S., Ranabhat, S., Neupane, N., Joshi, J., Shrestha, K., Shrestha, A.B., 2019. Payment for ecosystem services: Could it be sustainable financing mechanism for watershed services in Nepal? *Green Finance,* 1, p.221.

Bhatta, L.D., Van Oort, B.E.H., Rucevska, I., Baral, H., 2014. Payment for ecosystem services: Possible instrument for managing ecosystem services in Nepal. *International Journal of Biodiversity Science, Ecosystem Services and Management,* 10(4), pp.289–299. https://doi.org/10.1080/21513732.2014.973908.

Celio, M., Scott, C.A., Giordano, M., 2010. Urban-agricultural water appropriation: The Hyderabad, India Case. *The Geographical Journa*l, *176*(1), pp.39-57. https://doi.org/10.2307/25621861.

Cui, F., Liu, G., 2018. Global value chains and production networks: Case studies of Siemens and Huawei. Academic Press.

Devkota, K., Neupane, K.R., 2018. Water governance in rapidly urbanising small town : A case of Dhulikhel in Nepal. *Journal of Water Security,* 4. https://doi.org/ 10.15544/jws.2018.002 WATER.

Falkenmark, M., 1992. Water scarcity generates environmental stress and potential conflicts. *Water, Development and the Environment*, 279.

Government of Nepal, 1992. *Water Resource Act 1992*, Ministry of Water Supply and Sanitation, Singh Durbar, Kathmandu.

Grillos, T., 2017. Economic vs non-material incentives for participation in an in-kind payments for ecosystem services program in Bolivia. *Ecological Economics*, 131, pp.178-190. https://doi.org/10.1016/j.ecolecon.2016. 08.010

Joshi, T., Kovacs, E.K., Neupane, K.R., 2019. Incentives for securing water in a Himalayan town: A case from Dhulikhel, Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 6, pp.1-20.

Kinzig, A.P., Ehrlich, P.R., Alston, L.J., Arrow, K., Barrett, S., Buchman, T.G., Daily, G.C., Levin, B., Levin, S., Oppenheimer, M., 2013. Social norms and global environmental challenges: The complex interaction of behaviors, values, and policy. *BioScience*, 63, pp.164–175.

Kolinjivadi, V., Adamowski, J., Kosoy, N., 2014. Recasting payments for ecosystem services (PES) in water resource management: A novel institutional approach. *Ecosystem Services*, 10, pp.144-154. https://doi.org/10.1016/ j.ecoser.2014.08.008.

Kosoy, N., Corbera, E., 2010. Payments for ecosystem services as commodity fetishism. *Ecological Economics,* 69, pp.1228-1236. https://doi.org/10.1016/j.ecolecon. 2009.11.002.

Kosoy, N., Martinez-Tuna, M., Muradian, R., Martinez-Alier, J., 2007. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. *Ecological Economics*, 61, pp.446-455. https://doi.org/10.1016/j.ecolecon. 2006.03.016.

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*, 69, pp.1202-1208. https://doi.org/10.1016/j.ecolecon. 2009.11.006.

Porras, I., Aylward, B., Dengel, J., 2013. *Monitoring payments for watershed services schemes in developing countries.* International Institute for Environment and Development.

Tacconi, L., 2012. Redefining payments for environmental services. *Ecological Economics,* 73, pp.29-36. https://doi.org/10.1016/j.ecolecon.2011.09.028 Upreti, B.R., 1999. Managing local conflicts over water resources: A case study from Nepal. Network Paper - AgriculturaL Research and Extension Network 1–6.

WaterAid in Nepal, 2012. Water source conflict in Nepal : A right to water perspective. Lalitpur, Nepal.

Wunder, S., 2005. *Payments for environmental services: Some nuts and bolts,* CIFOR Occasional Paper Series 42. Indonesia.

# 5

# Policy and Institutional Aspects of Water Management in Dhulikhel

**Gyanu Maskey, Chandra Lal Pandey and Dil Khatri**

## SUMMARY

*Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), a community-based water management organization has been known for its reliable and good quality drinking water supply system since 1991. Growing population, haphazard urbanization, changing socio-politico-economic contexts, and impacts of climate change have posed new challenges to the local institutions to manage water. DDWSUC along with other water-related institutions have made their efforts to extend its services and manage water sustainably. However, the policy and institutional aspects of water management at the higher level have implications for local efforts towards achieving water security. This chapter unravels the struggle of Dhulikhel on securing water juxtaposing with the national policy and institutional contexts in three distinct political periods: during Panchayat, post 1990s democratic period and Federal Nepal. We find that the policies governing water management had emerged during the Panchayat period but lacked coherent institutional arrangements. In the post 1990 democratic system, the decentralization of power and authorities to local levels created spaces for local water management institutions. Further, Federalism in 2015 provided local government the authority to develop policy and institutional mechanisms and initiate external collaboration for ensuring water security. However, there remain challenges with regard to developing capacity of local water management bodies and other stakeholders. The chapter offers important lessons from Dhulikhel to other municipalities specifically on community-based water management, maintaining relations with upstream communities, and stakeholder engagement.*

## 1. INTRODUCTION

Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), served as an exemplary institution to initiate community-based water management practice since 1990s. It was known for quality and reliable supply. However, DDWSUC is facing the unprecedented pressure due to the accelerating water demand. On one hand, rapidly expanding urban settlements and growing population with significant floating population of tourists in Dhulikhel accelerate water demand. On the other hand, the water supply is decreasing due to impacts of climate change. The Roshi River watershed area, that supplies water to three municipalities in Kavre valley including Dhulikhel, is experiencing diminished precipitation pattern and stream flow, with increasing dry spells and decreasing wet spells (Dahal et al., 2019). In this situation, the water management institution is functioning on its limit and is struggling to fulfill the water demand. Recent studies have identified a huge gap between the supply and demand of water in the town. For example, the current water supply has been 1.8 MLD compared to the demand of 3.9 MLD[1]. In part, such a high demand of water is because of a large number of floating populations and businesses.[2]

Policy and institutional arrangements at higher levels play a vital role to cope with the growing problem of water insecurity. Yet, problem also lies with the provisioning of multiple and overlapping institutions and policy arrangements hampering the efficient and equitable urban water management systems (Maskey et al., 2020, Pandey et al., 2019, Ojha et al., 2020a). So, there remain unresolved puzzle, why local level institutional response is limited despite of policy and institutional mechanisms at place in higher levels (Cullet and Gupta, 2009). As we argue, this is largely because of weak institutional capacity and lack of robust system of water planning and governance at local level, as is evident in Dhulikhel (Ojha et al.,

1 Interview on May 24, 2020, Manager and Technical Chief of DDWSUC.

2 Calculation carried out by Chandra Lal Pandey (May 2020) based on WHO recommendation of 130 LPCD water for Nepalese cities × 32162 (CBS 2011 population estimation and the Municipal population data, 2017) as resident populations without considering the floating population and business water requirements.

2020a). In this context, this chapter unravels the experience of Dhulikhel drawing attention to policy and institutional context of water governance in Nepal.

The chapter draws from the qualitative research approach in which the insights are drawn through in-depth interviews, transect walks, participatory observations and water forums *(Pani Chautari)*[3]. Altogether, 15 in-depth interviews were conducted, and the authors participated in six water forums and Drinking water general assembly. Secondary sources including journal articles with specific research in Dhulikhel and other relevant articles, policy documents focusing on water management, annual reports and municipal plans were reviewed. The history of water-related institutional and policy aspects was traced from literature review and in-depth interviews with key informants and their relations in Dhulikhel's context was linked. In the following sections, we analyse the water management related institutions and policies in three distinct timeframes- during Panchayat, development after 1990s as Democratic era and after Federalization. The initiatives the city has taken and the vision the city has adopted have salient features to inform policy and institutional aspects of water management to other cities of the Himalayan region.

## 2. WATER INSTITUTIONS AND POLICIES IN NEPAL

Nepal has long experience of traditional and community managed water management practices such as *Raj kulos* (irrigation canal), stone spouts, ponds, wells and lakes. Nepal's Five-Year Plan (1956-61) initiated modern planning and development of public water supply and sanitation in Nepal. The Water Supply and Sewerage Board, established in 1973 under the 1957 Development Board Act, was followed in 1985 by the establishment of the Water Supply and Sewerage Corporation under the Corporation Act of 1965. The Department of Water Supply and Sewerage (DWSS) was established in 1972 for the management and maintenance responsibilities. One of the important developments was the establishment of Nepal Water

3 Water forum is a common platform with relevant stakeholders for discussion on water related issues and identifying the solutions, linked to traditional practice of gathering people informally for discussing social issues.

Supply Corporation (NWSC) in 1990 which was responsible for drinking water supply.

Nepal's political transformations towards inclusive democracy since the early 1990s devolved power locally compared to the rigid centralized model of Panchayat system. It provided the freedom to citizens to raise their voices and concern through multiple ways and the major water-related legislations were formulated in this period.

The 1990 political change marked an important policy departure towards decentralized water governance. The Water Resources Act[4] was formulated in 1992. This Act vests ownership of water in the State and provisions user rights through licensing process. The Act also set the priority in utilizing the water resources with Drinking Water having the first priority regarding utilization of water resources. Water Resources Regulation (WRR) 1993 and Drinking Water Regulation (DWR) 1998 are the two relevant regulations for drinking water that were issued under this Act. These regulations govern the Drinking Water User Associations, drinking water quality and drinking water supplies. Drinking Water Regulation (DWR) 1998 regulates the use of drinking water via different management systems: Corporate bodies, Water Users Associations and Individuals. In the case of community managed systems, Water Resources Regulation (1993) provisioned the District Water Resources Committee (DWRC) headed by the Chief District Officer to register the water user committees while tapping water from a particular source. The enactment of Local Self-Governance Act in 1999, provisioned power to the local government units to prepare, construct and maintain drinking water projects for the supply of drinking water to the communities.

Another major departure in institutional arrangement was introduced with the formulation of Water Supply Management Board Act (2006). This act provisions Water Supply Management Board as an autonomous body that can own, build, expand and finance the infrastructure that is required for drinking water services in Nepal. It can manage the service system within one or more than one municipality, being operated by any government body or Corporation.

4 Water Resource Act is the main legislation for drinking water.

There has been further progressive development in policies and institutions in the recent five years. The promulgation of Constitution of Nepal (2015) has added a new dimension to local governance from the perspective of local autonomy. The 2015 Constitution adopted federal governance, with three tiers governance system i.e., Federal, Provincial and Local. The Constitution envisions policy regarding the conservation, management and use of natural resources. It has provided the scheme of distribution of power among the Federal, Province and Local levels; devolved power and resources to the federal level and given autonomy for the local institutions. It also mandates the federal government to conserve water resources and develop policy and standards for multi water uses, and provincial government to manage water resources within their provincial jurisdiction.

The federal restructuring has empowered the local governments and opened window of opportunities for effective management of water resources. The opportunities lie with the authority provided to the local governments for developing required water and sanitation Acts and Policies for water management and sanitation within their jurisdiction. However, despite having many institutional and policy making provisions in three levels of government, there still lie an array of challenges for urban water security.

Further development includes Local Government Operation Act (LGOA 2017) that replaced Local Self- Governance Act (1999). LGOA (2017) provides the legal framework for local government to operate and provides authority to the local government to prepare legislations related to drinking water. The sectoral policies, particularly developed after 2015 under the Federal structure [National Urban Development Strategy (NUDS 2017), LGOA (2017) and National Adaption Plan (NAP)] are found progressive regarding sectoral linkages while the sectoral policies prior to this were not effectively interlinked and had disconnected themes of urban-water-climate issues (Maskey et al., 2020).

In the following section, we discuss the context how different institutions emerged in the water management regime in Dhulikhel and the challenges they are going through.

## 3. EVIDENCE AND ANALYSIS

In this section, we present the analysis of the water management related institutions and policies of Dhulikhel in three distinct timeframes. Firstly, we discuss about the institutional arrangements and policies in managing water during the time of Panchayat. Next, we discuss the development after 1990s and water management challenges, in relation to the development of policy and institutional mechanisms in democratic context. And lastly, we focus on development after new local government and discuss the federal policy reform and the state of ambiguity.

### Dhulikhel's struggle in water management in relation to higher level policy and institutional dynamics

#### Panchayat era

During the Panchayat period, a single party-political system was functional under the direct rule of the Monarch. The Village Panchayat Act 1961 gave judicial power to the Village Panchayats (village councils) and were authorized to exercise powers to hear cases relating to encroachment of water outlet, embankment of water resources and irrigation water and others. Village Panchayat also functioned as decision making authority with its involvement in negotiation process for bringing water to Dhulikhel from Bhumidanda. In Dhulikhel, the head of the village was led by the Pradhan Pancha, elected Chairperson of the Village Panchayat. The monitoring of the water usage was also done by an individual mobilized by the Panchayat (see Chapter 2 of this book by Byanju et al., 2021). Prior to 1982, Dhulikhel did not have any systematic water management system while people were dependent on the natural water sources. The first tap water supply in Dhulikhel started through Judha Dhara (1932-1945).

In 1982, the Indian Embassy in Nepal funded the first water project with 27 public taps for Dhulikhel initiating the history of water institutions (Tiwari, 2008). This was known as old water supply system in Dhulikhel. The initiative of 1982 was small in scale and was not able to serve water matching the demand of the time.

Realizing the problem of water rationing, Government of Nepal and Dhulikhel community worked jointly to acquire the support of German Government for the drinking water project to tap water from Kalanti Bhumidanda (For detail about German funded project, see Chapter 2 of this book by Byanju et al., 2021). The project implementation phase began in 1987 and the project was completed in 1991. During the time, Pradhanpanch of Kalanti Bhumidanda Village Panchayat on behalf of upstream community signed the agreement with Pradhanpanch of Dhulikhel Village Panchayat in 1985 (for detail about the negotiation with upstream communities, see Chapter 4 of this book by Neupane et al., 2021) to allow Dhulikhel to tap water from Khar Khola, a tributary of Roshi River (Joshi et al., 2020).

## Democratic era

The post 1990 decentralization policies opened space for wider range of institutions in water resource management such as the community groups, local government and private sector, including non-governmental organizations. Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC) was formed under the provision of Decentralization Act 1981 and later under Water Resource Act 1992, as required for implementing the GTZ project. Both Dhulikhel Drinking Water project and the old drinking water project were handed over to DDWSUC in 1991 and 1993 respectively. DDWSUC was formed in ad hoc bases initially[5] but after its successful tenure completion in July 1993, first election of the users committee was organized. DDWSUC then continued exercising its democratic process of forming elected user committee. By 2000s, it was a well-established local community-based water management institution and functioned as a responsible local institution for meeting the local demands of drinking water.

The merging of Village Development Committees in 2014 for making Dhulikhel a larger municipality (Pokharel et al., 2018) increased the households and population of the municipality. Further, growing

5 The ad hoc committee was formed to acquire necessary land, supervise construction, help in policy formulation, set up office, take over the project after completion and hold election of the users committee. Source: Dhulikhel Drinking Water Supply Project Document, Case study

urbanization and tourism activities led to increase in water demand. With this, DDWSUC could not provide water services to all the wards of the municipality and its focus remained at the core of city only representing previous wards 2, 3, 4 and 5. DDWSUC could supply water for only seven hours per day in the core while the peripheral areas received daily water supply for less than three hours or even merely 15 minutes (Pandey and Bajracharya, 2017).

Dhulikhel experienced continued struggles in negotiating with upstream Bhumidanda with the adding up of demands and the grievances of local users manifested in different forms (see Chapter 4 of this book by Neupane et al., 2021). People from upstream communities formed Local Concern Committee demanding for inclusive decision making. Likewise, people from outside core Dhulikhel formed Struggle Committee claiming equitable water distribution; and Roshi Khola Concern Group represented local people from downstream raising their compensation demands. Due to inadequate policy framework for upstream-downstream cooperation for securing water in urban areas, Dhulikhel faced continuous challenge of recognition and renegotiation with upstream communities. Often there were contestations. Several meetings and negotiations were conducted and informal agreements with the upstream communities were made to secure water supply.

The socio-political change in the country also affected the negotiation process between the upstream and downstream communities. The agreement process in 1985 was smooth process and the demand from the upstream communities was limited to construction of a school building. But the second negotiation process took nearly 11 years, reaching to an agreement in 2011. With the introduction of multi-party-political system, the negotiation process became chaotic involving a number of actors. The tenure of the local bodies expired in 2002. In absence of elected local bodies until 2017, the overall administrative and development activities at the grassroots level, were handed over to the central government bureaucrats.[6] During this transitional period, APM (All

6 In the local political vacuum situation after 2002, APM members representing the major political parties at the local levels held the de facto authority for facilitating the local level decisions.

Party Mechanism) were firmly in place. The political leaders of APM took over the local level decision-making practices and were the actors involved in these agreements. APM from upstream played a significant role in negotiation process (see Chapter 4 of this book by Neupane et al., 2021). In the downstream Dhulikhel, Kathmandu University and Dhulikhel Hospital also took over the mediating role and DDWSUC, a well-established local institution was active in the process. In summary, Dhulikhel entered into the formal agreement with upstream with its first agreement in 1985, next in 2010 and third in 2011 bringing together upstream and downstream parties.

The claims and voices of the civil society organizations and upstream communities have led to positive outcomes such as support to upstream communities. A short-term cash-based incentive with NPR one million per year with an increment of NPR 100,000 in every five years was established to support the upstream community. Dhulikhel also supports water mills and irrigation canals in the upstream area. The vociferous claims and voices with better bargaining capacity of upstream communities were possible due to the change in socio-political contexts in the country (Joshi et al., 2020).

The institutional change in water management was introduced with the idea of Water Board in 2006. The implementation of ADB funded Kavre Valley Integrated Water Supply Project (KVIWSP) formed Kavre Valley Integrated Water Supply Board as per the provision in Drinking Water Supply Management Board Act (2006). It envisioned that the existing Water Users Associations, like DDWSUC in Dhulikhel; and Nepal Water Supply Corporation (NWSC) in Banepa and Panauti, would be merged gradually into newly formulated water board. Dhulikhel municipality is interested in bringing DDWSUC and other key water institutions under Dhulikhel Water Board. However, whether the institutions like DDWSUC in Dhulikhel and NWSC in Banepa and Panauti, which enjoyed full autonomy of water management and financial matters, accept the proposal of the municipality is yet to be seen. It is also perceived as a conflict between the Ministries at the federal level. NWSC is under Ministry of Water Supply and Sanitation and KVIWSP Board is under Ministry of Urban Development. The shifting responsibilities among the existing and emerging water institutions has become the standard operation procedure for now (Pandey et al., 2019).

## Development after federalization

The Constitution of Nepal (2015) and introduction of Local Government Operation Act (LGOA 2017) have empowered the local government of Dhulikhel with specific powers, including the management of the water resources within its jurisdiction. The local government units were fulfilled by democratizing practices of local election in 2017, which ended nearly two-decade long vacuum in local governments (Acharya, 2018). In line with the Nepal's Constitutional (2015) mandates, Dhulikhel also experienced enabling environment to engage people in promoting the participation of local people and rejuvenating local level democratic institutions such as DDWSUC. Local government in Dhulikhel is now responsible to formulate and approve the plans and promulgate laws on managing water resource.

After 2017 local elections, the local government has developed ambitious plan for securing water adopting the concept of 'one house one tap' within municipal jurisdiction and extended its engagement with diverse actors (see Chapter 2 of this book by Byanju et al., 2021) The municipality has extended its partnership and collaboration with various national and international organizations such as Southasia Institute of Advanced Studies (SIAS), Federal Government, Drinking Water Department, World Wildlife Fund (WWF) and Kathmandu University (KU). To increase the coverage of water supply system in all the wards of the municipality, Dhulikhel municipality has been engaging with various actors, including Panauti and Banepa municipalities to expedite the Kavre Valley Integrated Water Supply Scheme.

The new political context with the elected local representatives has provided municipality the space to lead and facilitate some innovative informal institutional practices and collaborative approaches for securing water. For instance, Dhulikhel municipality has taken the initiative to forge collaboration with research organization by organizing Water Forum to create space for dialogue amongst the key water stakeholders (see Chapter 8 of this book by Devkota et al., 2021). Such an informal platform is evolving and attempting to institutionalize informal institutional collaborative platform or discussion and collective decision-making practices.

One of the concrete actions through the water forum was the decision to construct Climate Adaptive Recharge Ponds — fusion of indigenous knowledge with modern science — for water source conservation. Dhulikhel is also affiliated to global network 'Cities with Nature' and others. Dhulikhel municipality has moved forward formulating municipal strategies as Local Drinking Water Act. In terms of institutional mechanism, Dhulikhel opts for establishing 'Water Council' as an inclusive institutional structure. The council is intended to deal with water related issues of upstream and downstream communities and maintain amicable relations between them. But the idea of Water Council is yet to be finalized, formed and operated.

Despite engagement in multiple efforts to enhance the municipal capacity for urban water management, Dhulikhel is still facing a number of challenges in making itself a water secure city. The major challenges include: the disconnection between ageing infrastructure built for small number of populations to serve the core city, which are wards 2, 3, 4, and 5 only; manifold increase in the urban population and expansion of the jurisdiction of municipality covering rural areas. The water institutions also lack understanding of the changing dynamics due to socio-economic changes and climate change.

Moreover, the major institutional challenge is posed by newly declared Water Board which intend to subsume the existing community institutions. The development of the idea of water board in 2006 has not yet materialized and is still under the state of confusion. Water board has envisioned bigger scale and higher-level mechanisms, but the relations between the existing water management institutions and user committees like NWSC and DDWSUC and newly introduced water board lack clarity. How the existing water institutions will function under the leadership of the municipality is a matter of concern in the situation where the user committees and NWSC are reluctant to function together.

The newly envisioned local platforms like water council and water board may contribute to overcome the competing roles and responsibilities of existing water management institutions and the municipality and address the water issues; but they are also likely to become hostage of duplication. Such institutional interventions

need to envision the implications of formation of multiple institutions as they may instead create confusions and dilute the efficient integrated approach of achieving urban water security.

In summary, despite devolution of power and authority at the local level, the early stage of local government in Dhulikhel, like other municipalities, is facing multiple challenges such as insufficient technical capacity, lack of infrastructure and human resources, limited knowledge and skills in promulgating local laws. There are also confusions and lack of clarity in roles and responsibilities among the three tiers of government in terms of delineation of power and jurisdiction for managing water, and formulation of laws and human resource and budget. Such a lack of collaboration between the three tiers of government amid limited capacity of new local government is posing constraints to manage water sustainably in Dhulikhel.

## 4. CONCLUSIONS AND WAYS FORWARD

The city of Dhulikhel faces growing water scarcity with increasing gaps between water demand and supply, and servicing of quantity and quality water. This chapter discussed the experience of Dhulikhel juxtaposing the policy and institutional context of water governance in Nepal. In doing so, the chapter analyzed the water management related institutions and policies in three distinct timeframes- during Panchayat era, Democratic era and after Federalization. By doing this, the chapter stress for the importance of water related institutions in effective water governance amid the impact of increasing population, urbanization and climate change.

Firstly, during the Panchayat period, although the policies governing water management had emerged, there lacked coherent institutional arrangements. Most of the water-related problems were handled by the governing bodies and the drinking water mega projects were implemented in absence of clear institutional mechanisms.

Secondly, after reintroduction of the democratic system in 1990, the decentralization of power and authorities to local levels opened up spaces for local water management institutions. Institution like DDWSUC was established and operate in order for meeting local

water needs adopting democratic decision-making. DDWSUC has performed its functions of urban water management successfully since 1990s to recent time. However, it has encountered a number of challenges in meeting supply and demand of water in Dhulikhel fueled by rapid urbanization and declining water flow.

Thirdly, with the development of ADB funded Kavre Valley project, process has initiated to form new institutional mechanism of Water Board. There remains confusion about the future of existing community-based institution of DDWSUC. In Dhulikhel, KVIWSP is progressing smoothly and is expected to be completed by 2022. The idea of Water Board is also meant for governing a range of small-scale water supply projects in rural part of Dhulikhel. The new institutional mechanism, however, may invite contestation and confusion, new challenge of local water management.

Fourthly, with adoption of federal structure, the local government of Dhulikhel became empowered to manage water within its jurisdiction. More devolution after Federalism provided local government bodies even more opportunity to forge collaboration with diverse organizations. It is working towards water security with the ambitious goal of 'one house one tap' within the municipal jurisdiction, which after restructuring has expanded including a few new village development committees.

With the devolution of policy-making authority at the local level, Dhulikhel has initiated formulating municipal legislations as Water Resource Utilisation Act (endorsed in February 2020). However, some of these are beyond the realm of local policy and are guided by federal policy, for instance, the provision of Water Board. Moreover, there are some challenges associated with the new federal structure. At the early stages of the local government, there remain ambiguities about roles and responsibilities across three levels of governments, which may affect Dhulikhel's ambition of achieving water security.

Despite these challenges, prospect to harness the authority provided by the Nepal's Constitution (2015) and Local Government Operation Act (2017) lies with Dhulikhel municipality and all other municipalities of Nepal. We offer below some suggestions for Dhulikhel and the sound practices here can offer learnings to other municipalities

- As managing its expanded services seems beyond the capacity of DDWSUC, Dhulikhel municipality can diversify its water management mechanisms making it accountable to the users. Ojha et al. (2020b) offer valuable insights from Bidur on how small-scale water supply systems and community-based water supply schemes serve as safety net during the time of disaster (crisis). Learning through these practices, Dhulikhel and other municipalities should set priority in considering the conservation of local water sources and valuing the small-scale community managed water schemes along with the large-scale water projects.

- Dhulikhel needs to develop local water policy that can transform the local water management and governance towards more equitable and sustainable water supply across municipal jurisdiction. The idea of Water Board can provide broader governing mechanism but we should not forget the history of existing institutions such as DDWSUC. Further, future governing mechanism such as Water Board should also ensure the inclusive membership with women representation (see Chapter 6 of this book by Upadhaya and Shrestha, 2021).

- Municipality needs to continuously engage with the stakeholders through dialogues such as *Pani Chautari* for engaging with evidence-based policy making. Replication of *Pani Chautari* discussion in Dharan and Diktel offers learnings to other municipalities to promote such forums for dealing with water related issues and opting for solutions.

## REFERENCES

Acharya, K.K., 2018. Local governance restructuring in Nepal: From government to governmentality. *Dhaulagiri Journal of Sociology and Anthropology*, 12, pp.37-49.

Cullet, P. & Gupta, J., 2009. India: Evolution of water law and policy. *The evolution of the law and politics of water.* Springer.

Dahal, N., Shrestha, U., Tuitui, A. & Ojha, H., 2019. Temporal changes in precipitation and temperature and their implications on the streamflow of Rosi River, Central Nepal. *Climate,* 7**,** 3.

Joshi, T., Kovacs, E. & Neupane, K., 2020. Incentives for securing water in a Himalayan Town: A case from Dhulikhel, Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 6(1), pp.66-85.

Maskey, G., Pandey, C.L. & Shrestha, K.K., 2020. Securing water in the rapidly urbanising global South: Insights from critical analysis of 'sectoral policies' in Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 6(1), pp.9-31.

Ojha, H., Neupane, K.R., Pandey, C.L., Singh, V., Bajracharya, R. & Dahal, N. 2020a. Scarcity amidst plenty: Lower Himalayan cities struggling for water security. *Water,* 12**,** p.567.

Ojha, H., Neupane, K.R., Khatri, D., Devkota, K., Maskey, G., Dahal, N., Joshi, T. & Kovacs, E.K., 2020. Urban water security in South Asia: Crucial policy lessons from the Nepalese town of Bidur. *World Water Policy.*

Pandey, C.L. & Bajracharya, R.M., 2017. Climate adaptive water management practices in small and midsized cities of Nepal: Case studies of Dharan and Dhulikhel. *Sustainability: The Journal of Record,* 10**,** pp.300-307.

Pandey, C.L., Maskey, G., Devkota, K. & Ojha, H., 2019. Investigating the institutional landscape for urban water security in Nepal. *Sustainability: The Journal of Record,* 12**,** pp.173-181.

Pokharel, K., Joshi, T., Adhikari, J. & Neupane, K.R., 2019. Water security in urban water governance: A case study of Dhulikhel municipality, Kavrepalanchowk, Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 5(1), pp.32-48.

# 6

# Under the Glass Ceiling: Limitations of Women in Urban Water Management Systems

Rachana Upadhyaya and Suchita Shrestha

## SUMMARY

*Despite being in the foothills of Himalayas, rampant water shortage has been a legacy of Nepalese communities, both in hills and Terai. More recently, there has been a concentrated effort from both government and non-government agencies to ease the water shortages through alternative water supply projects, both in communal and municipal level. Albeit the government mandates for a gender friendly and inclusive management committee, such has not been the practice. The crucial role of women as both primary users and managers has been recognized to an extent through affirmative actions which require women's representation within water governance entities, nevertheless, women's role within such committees are constrained by patriarchal societal structure. This chapter presents a case of women's representation in water management systems in Dhulikhel to understand the challenges faced by women in meaningful participation in water sector management. In this particular case, we have traced how women enter such committees, what roles they are assigned to and how their marginalization is perpetuated with an aim to illustrate how such committees function as a microcosm of patriarchal practices. With the stories of women within the Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), we draw out the constrains for transformative roles women can play and then based on their experience, make recommendation that the intervention on women's participation should focus more than just on policy reforms.*

## 1. INTRODUCTION

With a slight limp, Shrestha slowly makes her way towards the Dhulikhel Municipality office. Having waited for few hours, we stand outside the gate of the office, while she with a bad knee walks uphill towards us. When we meet, with an apology she lets us know the societal[1] and topographical[2] situation that constraints her everyday movement. In the course of our research, this scene of first meeting- Shrestha taking small steps on a steep road to reach the municipality office, has become a visual metaphor for the challenges women are confronted with, to hold a public position. In this chapter, placing our case within Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC), we try to explore these factors impeding women's stake in local level community managed water governance systems.

DDWSUC is a fully autonomous body which provides water to 92 percent of the households in Dhulikhel (Parajuli, 2018). It is one of the oldest water management systems managed by the local community in Nepal. Following a tripartite agreement between the Government of Nepal (GoN), Dhulikhel municipality and the then ad hoc user's committee, the drinking water project was started in 1987 and completed in 1991 with the technical and financial support of GIZ. The drinking water project was officially handed over to the community in 1992. It was the same year when for the first-time women's central role in water management was acknowledged by international community through 'Dublin Principles' at the International Conference on Water and Environment in Dublin. The Dublin Principles or also known as 'Dublin Statement on Water and Sustainable Development' was adopted by the United Nations Conference on Environment and Development (UNCED) later that year.[3] The intent of the policy was to recognize the major role women play on a daily basis to supply, use and manage water and their need to be involved in all phases of water management projects, which includes implementation and also decision making (Sitraz, 1993). DDWSUC, unaware of these global developments but

1 As a mother/mother-in-law, she performs the majority of the household chores, so that her daughter-in-law can work in an office.

2 Dhulikhel is a hilly town with gently sloping hills with settlements along the ridges.

3 The complete Dublin statement can be read at: https://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html

presumably with the same intent, ensured women's representation in the first users committee formed through election in 1993. There were two women in the first elected committee. Shrestha was one of them. Now, as the deputy-chairperson, she was one of the first female members of DDWSUC.

Nevertheless, the essence of Dublin Principles - women's stake in implementation and decision making in water management project, exists but with a limitation, in the present DDWSUC. In the span of 27 years, Shrestha, who started as a member, is working as the vice-chair at present. Despite her position, she considers her say in the decision making has not changed considerably as it has always been "*bare minimum*"[4]. Shrestha and Clement (2019) consider the underlying cause for this limitation women face on decision making on water management project despite government's affirmative action, as the 'masculine nature of the institutions'. They further argue that this 'masculinity' has persevered through 'masculine discourse, norms and culture' (ibid).

The trajectory of Shrestha's growth within the DDWSUC is reflective of the policy provisions placed in by the government to ensure women's engagement in water management. Over the years, it has changed from mere representation of women to mandatory positions in vital posts, within such committees. The DDWSUC that started with two female members out of 11, now has six females within the committee of 14. The crucial role of women as both primary users and managers has been reflected, to an extent in policies and in institutional arrangements for the management of water sector. The Drinking Water Rules of 1998 sets a legal requirement of at least 33 percent women in water users committee (HMG, 1998). Both the development pundits and the scholars emphasize the need for women's stake on decision making bodies in water management not only to reduce gender inequality by giving voice to women but also to improve water management systems. There are ample examples around the world that underscore the effectiveness of women's participation in water management. A World Bank Report back in 1995 that analyzed 122 water projects concluded that the project with women were 6/7 times more effective compared to those that

4 Key Informant Interview (KII) on 16.05.2019

did not have women in the management committee. With such evidences of success abound, women's number within water project grew steadily over the years. But these remain incomplete successes as challenges for women within water committees remains, that Agarwal (2001) has succinctly put as 'participatory exclusion', a situation where women participate but do not have any influence/stake over decision being made.

In this chapter, we make an attempt to document the gendered experiences of women in DDWSUC and the constraints they face for equitable participation. This observation and analysis is a result of a primarily qualitative research. Apart from experiences of women being a part of what they call a male-dominated committee, an attempt has been made to thoroughly review the water-policies through a gender-lens to understand the gradual evolution of policies and what exists currently to facilitate women's active engagement in water management systems. The water policies examined have consequences beyond Dhulikhel, however, the aim is to understand policy landscape and opportunities it presents for women's participation in water management systems. The findings presented in the form of thematic analysis in the sections that follow are primarily from Key Informant Interviews (3 KIIs), Focus Group Discussion (1 FGD) and Water Forum[5] (1 focused on gender but the insights were drawn from 6 water forums organized and a water conference in Dhulikhel). Apart from these tools, the continuous engagement in Dhulikhel through different activities has helped the authors to gain an insight to the workings of the DDWSUC and the role women play within.

To draw a conclusion on how and why women's engagement is limited within water management committee can be a daunting task within a scope of a single study.[6] As multifarious reasons have been already identified; from women's limitation as a result of socio-

5 Water Forum (locally called as *Pani Chautari*) is an informal platform created by SIAS along with Dhulikhel municipality where stakeholders come together and discuss on water related problems and explore solutions. It is a unique practice of engaging with research users at local level so as to create impact from on-going research.

6 During the study, only women from the sitting committee were spoken to and the experiences of previous members could differ from this analysis. Further, within the scope of this study, analysis was limited to the experience of women vis-à-vis men within the same committee and hence lacks an intersectional understanding or differing experiences of women.

cultural factors that shape how female and male perform in a community (Sultana, 2009), disparity in land ownership and the limitation thus created in participation (Crow, 2001) to inconsistent policy provisions from the government (Bhattarai et.al, 2020). Nevertheless, at the end of this chapter, we have tried to draw a conlusion on what DDWSUC women consider as the constraints they faced to engage in a meaningful way. Based on our findings, we have drawn some recommendations on how women can be meaningfully engaged in water-management committees, not only for effective service delivery, but also for the transformative role of such deliberated participation for gender equality in the wider society.

## 2. WOMEN IN WATER RELATED POLICIES

Despite their inherent limitation on bringing about gender transformative changes in the society, water policies have been very crucial in ensuring women's representation in water management/ governance systems. The table below summarizes the key aspects of the major water related policies along with its gender provisions.

With the Water Resource Act of 1992 to the draft Drinking Water and Sanitation Bill of 2019, the idea of inclusion of women in water resource management has gone through a considerable change. The Drinking Water Policy of 1998 was the first document that mandated women's representation and but was limited to mere numeric representation. In subsequent policies for the next decade, the representation was redefined as 'meaningful participation' (HMG, 2004) to gender balanced decision making (GoN, 2014). During the course of the study, while speaking to women in Dhuikhel, we found that the policy changes have not translated in a greater extent to practice. In the sections after the Table 1, we attempt to explain the underlying causes.

**Table 1**
**Gender analysis of water related policies**

| Policies | Key Concept | Gender sensitivity |
|---|---|---|
| **Water Resource Act (2049), 1992** | provisions for the formation of Water User Associations (WUA) where a group of individuals come together to collectively use the water source | Silent about gender and social inclusion<br>There is no mention of what the composition of such users associations should be in terms of representation of women and people from marginalized communities. |
| **Water Resource Regulation, 1993** | The regulation decrees the provision of various committees such as District Water Resources Committee (DWRC), Water Resources Utilization Investigation Committee and Water Tariff Fixation Commission (ETFC), to facilitate effective supply of water to the consumers | There is no reservation policy provision for the representation of women within these committees. |
| **Drinking Water Regulation (2055), 1998** | In the chapter 2, 'Establishment and Registration of Consumer Organization', of the Drinking Water Regulations 1998, states that the composition of the nine member executive committee of the consumer organization should at least include two women as members. | The Regulation, however, does not mention if the women thus included in the committee should also hold a vital post |

| Policies | Key Concept | Gender sensitivity |
|---|---|---|
| **National Water Supply Sector Policy and Regulation, 1998** | The regulation mention six points where GESI has been integrated:<br>1. During the feasibility study of the project, analysis of gender-related labour contribution and benefit will be made.<br>2. Consultation with local organizations representing women and women's rights will be taken care of during project design.<br>3. Discussion on importance of women participation in the project will be made among male and female users to enhance mutual understanding of the roles of men and women.<br>4. Training programs to empower women.<br>5. Local organizations will be strengthened to work on gender equity.<br>6. Officers & volunteers implementing water programs will be encouraged to undertake gender analysis during the implementation. | |
| **Water Resources Strategy, 2002** | To encourage women's participation in all aspects of water supply planning, management, installation and operation and maintenance. | Emphasise on balanced gender participation |

| Policies | Key Concept | Gender sensitivity |
|---|---|---|
| **Rural Water Supply and Sanitation National Policy (2004) and Rural Water Supply and Santation Strategy (2004)** | Mentions, "participation of gender, caste and disadvantaged ethnic groups will be made essential to all decision making processes regarding water supply and sanitation services.<br>Ensures quota of 30% women in water user committees | Emphasis on "meaningful participation" not only in the operation and maintenance of water supply and sanitation infrastructures, but also in local planning and budgeting and service delivery |
| **National Water Plan, 2005** | It has recommended the inclusion of women in integrated river basin water management (e.g., involvement of women in river bank protection, conservation of watershed, operation and management of irrigation systems, in electricity distribution programmes, etc.)<br>Equity, Gender and Social Inclusion has been kept as one of the five guiding principle of NWP implementation | |
| **Water Supply Management Board Act (2063) 2006** | The act under its second chapter, 'Establishment, functions, duties and powers of the Board', mentions the provision on formation of management board. It entails that will have seven members, namely, i) the mayor of the geographical area of the board, ii) a representative of the Ministry of Physical Planning, | The act does not mandate a women representative but mentions that the 'priority will be given to women, to the extent available' (GoN, 2006) |

| Policies | Key Concept | Gender sensitivity |
|---|---|---|
| | iv) chairperson of the local chamber of commerce, v) chairperson of local user's associations, vi) a person nominated by the committee from within the local NGOs, vii) an expert in the field of water supply and sanitation nominated by the committee. It is only within the clause (vi) of the membership criteria, participation of women in mentioned. | |
| **National Urban Water Supply and Sanitation Sector Policy, 2009** | Ensures participation of women and the vulnerable groups at decision making at all practical levels<br>Women's participation will be emphasized in all aspects of water supply and sanitation planning, implementation, management, operation and maintenance.<br>In addition, it has been mentioned that men will be encouraged through proper education and awareness programs for effective management of water supply and sanitation at household levels | |
| **National Sanitation and Hygiene Master Plan, 2011** | It expressed its commitment to GESI through GESI responsive objectives: i) to help ensure equity, inclusion and sustainability through participatory planning process; and ii) to develop a mechanism for ensuring | GESI responsive in its provisions and practice<br>Fair gender balance |

| Policies | Key Concept | Gender sensitivity |
|---|---|---|
| **National Water Supply and Sanitation Sector Policy, 2014** | It has a separate section (4.2) under " Gender Equity and Social Inclusion" heading | Emphasis on participatory and transparent planning with meaningful participation of key stakeholders at local and district levels<br>Gender sensitive indicators in designing water plans, including the need for a gender-balanced decision-making team. |
| **Draft Drinking-Water and Sanitation Bill, 2019** | Has recognized the problem of lack of access of water sources to marginalized community and lack of sufficient women participation<br>Assure about the participatory method of decision making and women and marginalized community inclusion in water resource management at all the levels. | 1/3rd representation of women/men in water users committee<br>The study of impact on women during the implementation of any water resource projects and developing strategies to mitigate any negative impacts<br>Increasing access of water for women so that they can utilize their time for education and other capacity building |

## 2.1. Add women and stir

Shrestha recalls the early days when their water woes were addressed through the new drinking water project and the ad hoc committee was preparing to form the first elected users committee. When she recounts the history to us, she constantly uses the word 'they'. 'They' were the men who made the drinking water project possible. She says, "At first, they wanted only one woman in the users committee and later agreed for two". [7] What Shrestha retold here is a summary of the story of women's inclusion. Women's representation was simply as a face/emblem in an already formed functional group that is added to make the committee 'inclusive'. After more than two decades, Manisha (pseudonym), another user committee member we interviewed succinctly summarizes how the same practice has been continued:

> We usually are not part of the activities of the committee unless they want to show how inclusive the user committee is. In that case, they come to our door steps in motorbikes so that we can be showcased in the program (ibid).

Women's participation is used as fixtures to create an imagery of inclusion.

Just 'add women and stir', phrase used by Charlotte Bunch (as cited in Harding, 1995) to criticize the approach where women are 'added' more to fill the gender quota than actually addressing any structural issues that limits/hinders women's engagement. While quotas have their usefulness in taking women to spaces denied (Udas, 2006), they do not address the structural barriers. An apt example is presented by one of our interviewees who in the following quote mentions how the pre-requisites to be a committee member or the member of the general assembly, which is the apex body of DDWSUC that elects the working committee, is limiting. One of the interviewees reported (interviewed in 2019):

> Land ownership or house ownership is a prerequisite for water line connection [through DDWSUC] and also to be a member of

7 Based on Focus Group Discussion (FGD) on 30.04.2019

> the users committee and to vote for the working committee selection. 1 tap 1 vote provision has been established for the selection of the working committee. In absence of land or house owner, which is mostly men, female member or other member of the household is not eligible for proxy vote. In such case, there is a provision of transfer of tap ownership to women or an immediate family member to ensure the right to vote.

Membership based on landownership/house ownership is a gender-blind approach because nationally women from only 19.71% of households have ownership over land or property (CBS, 2012). Policy measures ensuring women's participation in water management formed in silos, that do not account the broader structural barriers of women's participation have little contribution to women's access to decision making. While the DDWSUC statute on one hand seems considerate towards women's representation as it has two seats reserved for women and also mentions that women can compete for more seats and positions (Dhulikhel Case Study, n.d.), on the other, creates barrier by demanding land/house ownership of women. The abovementioned percentage of property ownership among women is achieved after the provision of tax exemption on land registration from the government if registered under women's name. And our study cannot establish a direct correlation between this change in land registration policy and the increase in the number of women within DDWSUC, nevertheless, there has been an increase in the number of women committee members, as there are now six female members among a committee of 14. The increase in the number is a result of statute amendment of DDWSUC in 2012. The committee is in the process of another amendment which requires a male and a female representative from each ward. However, the draft amendment is yet to be approved by the general assembly.

As we have already stated that the increase in the number of women in a water management committee does not directly result into increased stake in decision making. Shrestha's quote at the beginning of this section underscores how women are 'brought into' the committee. Another female committee member, Shubha (pseudonym) has a similar route into the user's committee as she

was 'encouraged' by a male acquaintance with similar political ideology (party) to nominate her name for the position and used the political base in the community to "help [her] get the required votes to win the election" (FGD conducted in 2019). Having a male patron or supporter to be encouraged to take part in public position has been a common route for the women within the committee (also observed by Udas (2006)). Moreover, for women, the down side of having access to such political clout becomes a disadvantage because the position that she earns is considered as a result of the power rather than her individual capacity. Shubha, during the interview, repeatedly mentioned how her and in general, the capacity of women members, to deliver any task was constantly questioned, but not that of their male colleagues in the committee. Therefore, the mode of involvement leads to how women are perceived within the committee, which then defines the role/responsibility women are given in the water management committee.

In conclusion, despite the intentions and policies that ensures women's representation in water management committees, the structural arrangement and broader societal expectations and understanding of women's capacity and role has limited women's stake in decision making within DDWSUC.

## 2.2. Reproduction of reproductive role

Women like Shrestha in DDWSUC and elsewhere, perform multiple of tasks within their household and in community. These multiple domains where women perform their role are generalized in three categories[8] by Caroline Moser in 1989. Following Moser's categorization, the work that women do in the water management committees falls under the 'community management' work, a type of voluntary work that can be done during 'free' time for social good. It is believed that men use their community role for a political purpose whereas women's contribution is limited and perceived as

8 three categories, Productive- income generating work in public sphere, Reproductive- the unpaid household domestic work and child rearing and Community Management- social events or community resource management [can be read in detail at https://eige.europa.eu/thesaurus/terms/1442]

social good. The fact that the previous two mayors of Dhulikhel got the position based on their work on the same drinking water project underscores the inherent political nature of the committee and the power it withholds. Since both the mayors were men, reiterates the fact that men and women acquire different social capital from such engagement. Such differentiated gendered perceptions on the roles within the committee also dictate the functions women and men have within the committees.

When women as a result of the reservation policy, and through their personal power clout, reach to this powerful working committee, are relegated to the fringes, only involved in the activities deemed as stereotypically 'feminine' leaving 'technical' work to men. Such has been the division of roles in the DDWSUC as well. Shrestha with her more than two decades of work within the committee notes, "women members are often given the job of organizing cleanliness campaign in the community and seldom any responsibility about technical work as they [male members of the committee] think we do not have technical knowledge". Another women member of the committee who is in her second term in the committee shares similar experience. "In my first term, I could not do much because I did not get the opportunity, but this time [second term], I know that we have to work twice as much as male members to make ourselves visible as capable women".

Most of the women elected in the DDWSUC also have identities beyond this powerful committee. A majority of them own small to medium sized enterprises such as local grocery store, and stationeries; few are active members of political party while another work as teacher in government school. Despite their proven competencies in different fields, their capacities are questioned vis-à-vis to the male members of the committee for no apparent reason. The wider stereotypical perception of women's role as reproductive actors in a patriarchal society are reproduced within the microcosm of user committee.

## 2.3. Modeling behavior

During our interviews and in our informal conversations, a woman member always repeated a phrase "*hami ta chhuchi haru*", meaning "we are the mean ones", referring to herself and few other who went against the grain in the DDWSUC. She has accepted the label. She also adds "whoever speaks against the male majority, they are labeled as something or other". Other women, even when they are discontent with the committee decision, cannot openly voice their concern. "They tell us what we said was right or what we did was right but [they] do not do so in-front of everyone in the committee", she says. Within the committee, six women members are divided into two groups- based on the stake they claim in the decision made within the committee. With simple tactics such as labeling women within the committee are conditioned to assume the stereotypical behavior associated with women such as passive, reticent and subservient to men, as they think it is more preferred compared to those trying to change the status quo. More vocal women such as Shubha, while working in a mixed gendered group are faced with a conundrum, if they speak up and claim stake in decision making, they are labeled as '*chhuchi'* and if they assume a more passive roles, not only their capacity is questioned but also the usefulness of their representation in such committees.

Due to political nature of the committee and predominately governed by male majority, most of the women members of DDWSUC do not voice their dissent. On one hand, the wider socio-cultural expectations of the society discourage women to assert their demands, on the other, the fear of being labeled and "perceived benefits of being in good terms with the male majority" hinders women from having any say in decision making. During the focused group discussion, the women would talk among themselves of decisions made by the committee that they did not agree upon which included issues such as "changes in the water tariff", "the location for the new deep boring to increase water supply", "the committee's behavior towards the upstream community while negotiating new deals". The women committee members we interviewed thought that such decision in the past was made without adequate consultation and neglecting their voices of dissent. The interviewees also

mentioned that even though they foresaw the problem with those decisions they neither have a majority to challenge it nor the backstopping of all (women) members in the committee. The interviewees also mentioned that the committee had to retract someone the decisions on "water tariff[9] and deep boring location[10]" for its unfeasibility.

Women's position in decision making in water management had to be created to acknowledge their role in effective and efficient water management (Udas, 2006; GWA, 2006; Svahn, 2012) but it also has a higher goal that reaches beyond the confines of one committee. And that is the strategic goal of gender equality in the society at large. When/if women are subtly reprimanded for challenging the status quo within the committees through labeling, it can deter other women to raise their voice and more importantly discourage other women in the community to be part of the water management committee thereby affecting the efficiency of the committee itself.

## 3. CONCLUSION AND RECOMMENDATIONS

The need for women's participation in water management systems is not only for the broader goal of gender equality but there are evidences around the world that suggest effective management of water through women's participation. The scholars emphasize the importance of meaningful participation of women in public spaces such as the water management committees can help subvert gender subordination, promote women's empowerment, and ensure effective delivery of water (GWA, 2006; Svahn, 2012). This realization has been reflected in policies and plans both domestically and internationally. The importance of the participation of women is also reflected in the statute of the DDWSUC since its formation back in

9 In recent years, the water tariff has been amended twice. Once in 2014/15 and the second was more recent on 2020/21. Here, when our respondents said 'retraction of decision on water tariff, they do not mean the decision that is made formally and endorsed by the AGM. Before such final decisions are made, there are internal negotiations and contestations; one such incident is being reported by the respondents.

10 The are two deep borings dug by the DDWSUC to supplement its water source (one inside the forest and another within their office premises where the filtration plant is located. When another deep boring was started to be dug without the consultation of committee members, two of our interviewees halted the digging which was later supported by other committee members as well.

early 1990s. Albeit much effort, effective water management along with the goals of gender equality both within the microcosm of the management committee, and the broader society, will be difficult to achieve until there is a conducive environment for women's transformative participation within such groups.

One of the pitfalls of women's participation in policies and programs is their limitations in changing the socio-cultural environment where these policies/programs are implemented thereby limiting its effectiveness. The visibility of women in community water management institutions is an essential starting point but it does not ensure their active participation in water decisions or challenge the gendered roles in water management at household level (Ahmed, 2008). The same was witnessed in DDWSUC. The committee has policy provision for women's participation but the pre-existing patriarchal societal condition, stereotypical cultural expectations from women and preformed biases against their capacity have limited women's stake in decision making within DDWSUC.

Being in the committee but 'unheard' for a long period of time can cause women's self-alienation from such positions. However, in the case of DDWSUC, some female members are dealing the situation with much tenacity and hence will be able to bring some transformative changes within the committee and the society at large. Nevertheless, it is important to acknowledge that the broader societal relations dictate the roles and responsibilities of men and women within social groups resulting into differential access to decision making power (Agarwal, 1994). In those relations thus dictated, it is men who have more power in decision making and hence on the access and control over natural resources, when compared with women. That remains a present-day fact even in case of DDWSUC.

Going back to the same day, we had first met Shrestha outside the Dhulikhel Municipality office, waiting for hours before she slowly made her way to the municipality office, our rendezvous point, through the hilly winding roads of Dhulikhel. Having waited for hours, outside the municipality gate, seeing her at the end of the road had lifted our spirit for a brief second to be dismayed again by

the agonizingly slow steps she was taking. Now, having heard her story, her steps within the DDWSUC followed the same pace. After more than 25 years in the committee, only in the last election was she voted as the deputy-chairperson, an upgrade in her position but without any significance to her role within the committee. In this continuous slow walk, Shrestha has female colleagues within the committee and outside who want to increase their pace and walk faster. Below we have listed some ways that might be of help.

## Recommendations

- Mainstreaming gender is a process, rather than a goal (Sandler, 1997), therefore it is not an end in itself. Since its formation, DDWSUC has been inclusive of women's participation. With such a long history of water management, DDWSUC can take steps in increasing the number of women's participation not only as committee members but also as general members by changing the membership criteria that requires land ownership. With a greater number of women as general members, it can be assumed that more women will be elected within the executive committee and presumably also in position of leadership.

- While mainstreaming women in a water management system as members is a good start, their participation can be effective only if they represent as an empowered group with stake in decision making (Sandler,1997). This requires acknowledging and trusting their capacity. It also requires men in the executive committee to be more accepting of women's leadership roles with a willingness to listen to a different voice.

- Water management/governance system provides a unique opportunity to subvert the traditional perceptions on women and gender norms. Water management systems comprises of both social and technical aspect, and making women more visible in performing technical work can make them role models to younger women in the Dhulikhel community and beyond to pursue work/studies in technical sector such as water engineering, plumbing, environmental sciences which in long run can benefit the entire community.

- Within the scope of this study, an intersectional analysis of women's experiences could not be carried out. However, with the changes in the administrative boundary of Dhulikhel municipality, the wards covered through DDWSUC have also increased. Hence, representation of women from peripheral communities and marginalized groups can make the committee more inclusive, thereby increasing ability to address the problems of water users living in the peripheral areas.
- DDWSUC had started inclusive water governance practice even before the national policies were formulated. Despite its long history, there has been close to nothing written about this practice. There is a need to conduct research to document this history and the accrued benefits of having an inclusive water governance system. A more in-depth study on the experiences of women and people of marginalized group in the committee can be useful to understand the inner workings of this model water management committee.

## REFERENCES

Agarwal, B., 1994. Gender and command over property: A critical gap in economic analysis and policy in South Asia. *World Development*, 22(10), pp.1455-1478.

Agarwal, B., 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development*, 29(10), pp.1623-1648.

Ahmed, S., 2008. Gender and integrated water resources management in South Asia. *Water First*, p.185.

Bhattarai, B., Neupane, K.R., Devkota, K., Upadhyaya, R., and Ojha, H.R., 2020. *Reducing gender inequality in urban water management in Nepal.* Southasia Institute of Advanced Studies, SIAS Policy brief 1, July 2020.

CBS, 2012. National population and housing census 2011. *National Repo*rt.

Crow, B., 2001. *Water: gender and material inequalities in the global South* [Accessed from https://escholarship. org/uc/item/0rq308jc].

GoN, 2014. *National Water Supply and Sanitation Policy (2014).* Government of Nepal, Ministry of Urban Development. Kathmandu [Accessed from http://www. ess.gov.np/uploads /ck/a__1478598768_WSS%20Policy%20Dec14%20E.pdf].

GWA, U., 2006. Resource guide: Mainstreaming gender in water management.

Harding, S., 1995. Just add women and stir? In *Missing links: Gender equity in science and technology for development*. IDRC, Ottawa, ON, CA.

HMG, 1992. *Water Resource Act 2049 (1992*). His Majesty Government, Ministry of Physical Planning. Kathmandu [Accessed from http://www. lawcommission. gov.np/en/archives/17892].

HMG, 1998. *Drinking Water Rules 2055 (1998).* Government of Nepal. Kathmandu [Accessed from http://www. lawcommission.gov.np /en/wp-content/uploads /2018/09/drinking-water-rules-2055-1998.pdf].

HMG, 2004. *Rural Water Supply and Sanitation National Policy 2004*. Ministry of Physical Planning and Works. Kathmandu [Accessed from https://www.ircwash.org/sites/default/ files/202.3-04RUPO-19231.pdf].

ITN-BUET, n.d. Dhulikhel case study. n.d. Dhulikhel Drinking Water Supply Project. ITN-BUET, Dhaka [Accessed from: https://itn. buet.ac.bd/publications/sector-documents/cwp/ documents/casestudies/Case%20Study%20N-03.pdf.

Moser, C.O., 1989. Gender planning in the third world: Meeting practical and strategic gender needs. *World Development*, 17(11), pp.1799-1825.

Parajuli, R., 2018. Water in Kavre valley: Management attempts, opportunities and challenges. *Smarika*, Dhulikhel Municipality. Dhulikhel.

Sandler, J., 1997. Unifem's experiences in mainstreaming for gender equality. New York: UNIFEM.

Shrestha, G. and Clement, F., 2019. Unravelling gendered practices in the public water sector in Nepal. *Water Policy*, 21(5), pp.1017-1033.

Sitarz, D., 1993. Agenda 21: The earth summit strategy to save our planet.

Sultana, F., 2009. Fluid lives: subjectivities, gender and water in rural Bangladesh. *Gender, Place and Culture*, 16(4), pp.427-444.

Svahn, K., 2012. *Women's role and participation in water supply management: The case study of the Republic of Ghana.*

Udas, P.B., 2006. *Quota systems and women's participation: Lessons from water policy in Nepal.* INSTRAW.

# 7

# Future Climate Stress on Drinking Water of Kavre Valley: Case of Upper Roshi River

Anjit Gautam and Tikeshwari Joshi

## SUMMARY

*This chapter assesses the future climate change impact on the water discharge of the Upper Roshi River (86.2 km² catchment area), which is the primary water source for Kavre Valley Integrated Water Supply Project (KVIWSP). The 'abcd'[1] hydrological model was run under three Representative Concentration Pathway (RCP)[2] scenarios- 2.6, 4.5 & 8.5 against the climatic variables projected by the Statistical Downscaling Model (SDSM)[3] in the future for the entire period of 21st century. Assessment of the future stream flow shows that there could be a slight increase, to a maximum of 14%, in mean annual discharge by 2050 with reference to the baseline period (1971-2014). Seasonal discharge analysis shows a slight increase in the discharge in winter, monsoon and pre-monsoon, but a very slight decrease in the post-monsoon season throughout the different future time windows under all RCP scenarios. Though there are evidences of climate change, no significant impact of climate change is detected in the future causing a deficit or extreme flows of the water source areas of KVIWSP provided the water infrastructures work properly. However, this study has not considered the changes in land use/land cover, as well as, future water demands resulting from socioeconomic and demographic changes.*

1 abcd water balance model is a simple hydrological model for simulating streamflow in response to precipitation and potential evapotranspiration

2 RCP are newly developed greenhouse gas emission scenarios and adopted in the IPCC's fifth assessment report AR5

3 SDSM is a decision support tool for assessing local climate change impacts using robust statistical downscaling technique

## 1. INTRODUCTION

The impact of climate change on water resources is affecting the quality and quantity of water in many regions due to changing precipitation, and altering hydrological cycle (IPCC, 2014). Climate change is likely to worsen current stress on water resources, and one of the challenges is to respond to the uncertainties associated with future climatic conditions and the water need of rapidly growing urban populations (Broto and Bulkeley, 2013). It is estimated that by 2025, almost two-thirds of the world's population is likely to experience some kind of water stress, and for one billion of them, the shortage will be severe and socially disruptive (UNEP, 2004).

A higher rate of rising temperature than the global average (Shrestha and Aryal, 2011; Duncan et al., 2013), erratic rainfall with a greater spatial and temporal variability (SAGUN, 2010; Duncan et al., 2013) and a prolonged drought spell (Karki et al., 2017) have been reported recently in Nepal, which clearly indicate the growing impact of climate change. Consistent with these research findings, Nepal is already considered the 14$^{th}$ most vulnerable country in the world according to the climate change vulnerability index (Eckstein et al., 2017). The effect of water scarcity has already been realized in many villages due to the drying up of local spring sources (Dhakal et al., 2010).

The observed and predicted changes in the climate parameters are likely to alter Nepal's hydrological systems (MoE, 2010) where river discharges are more sensitive to precipitation change than temperature change (WECS, 2011). Climate change affects different aspects of the local hydrology of a river such as the timing of water availability, quantity and quality (Babel et al., 2014; Shrestha and Aryal, 2011; Gautam and Acharya, 2012). Fluctuations in the stream flow affect water availability, which has direct consequences on the livelihood of the people heavily dependent on stream flow for agriculture. It also has a potential impact on the economic development of the country, whose economy largely depend on agriculture and hydropower development. The combination of variability and uncertainty regarding future changes due to climate change is perceived to make water resources planning very challenging (Bharati et al., 2014).

Most of the hydrological studies have been conducted in the larger river basins of Nepal such as the Indrawati (Sijapati et al., 2014), Koshi (Sharma et al., 2000; Agarwal et al., 2014; Bharati et al., 2014; Devkota and Gyawali, 2015; Rajbhandari et al., 2016), Karnali (Pandey et al., 2019) and Bagmati (Sharma and Shakya, 2006). There is limited hydrological study conducted on small rivers like Roshi (Dahal et al., 2019), which limits thorough assessment of the link between changing climate and stream flow. Moreover, there is a notable lack of studies on the projection of future climate change scenarios for the Roshi River.

In this scenario, this chapter presents the findings of a study conducted in an upper Roshi River, with an objective of assessing the projected changes in bulk water resources due to climate change for the entire period of 21st century. The watershed has significant importance for future discharge to meet the objectives of the Kavre Valley Integrated Water Supply Project (KVIWSP). The project, with financial support from the Asian Development Bank (ADB), is under construction for the drinking water supply to the towns namely Banepa, Panauti and Dhulikhel of Kavre Valley. The expected primary source of water for this project is the headwaters of the Roshi River. The project is designed to divert 77.33 liter/sec of fresh water from tributaries of Roshi River: Muldol (35 liter/second), Sisha khani (25 liter/second), Baira Mahadev (7.5 liter/second), Gudgude (5 liter/ second) and Khar (5.23 liter/second). Hence, this river is socio-economically significant for the Kavre Valley. Therefore, it is very important to quantify the climate impacts in order to identify the adaptation options and, thereby, minimize the potential risk of climate change at the local level.

In the following section of this chapter, the authors present the brief overview of the study area and methodologies adopted. The findings section include the results obtained from trend analysis of observed data of precipitation and temperature, 'abcd' hydrological model under three RCP scenarios (2.6, 4.5 & 8.5) against the climatic variables projected by the Statistical Downscaling Model (SDSM) in the future for the entire period of this century. Finally, the chapter ends with conclusions and way forward.

## 2. STUDY AREA AND METHODOLOGY

The study area comprises of the upper Roshi River. The Roshi River as shown in Figure 1 and 2 starts from small tributaries in Kavre and Lalitpur districts and is entirely rain-fed. The required hydro meteorological data for the study was collected from the nearby hydrological and meteorological stations of the Department of Hydrology and Meteorology (DHM, 2017) as described in Table 1. The overall methodology consists of downscaling of the temperature and precipitation data with the help of Statistical Downscaling Model (SDSM), then SDSM again was applied for the projection of the future temperature and precipitation data under different RCP scenarios. The 'abcd' hydrological model was used for the hydrological analysis and calculation of the future discharge with the help of projected temperature and precipitation data. RClimDex[4] was used to assess the climate stress through the trend analysis of the observed temperature and precipitation data taken from the DHM.

The hydro meteorological data required for the study was collected from different stations of the Department of Hydrology and Meteorology (DHM, 2017) as described in Table 1.

**Table 1**
**Meteorological and hydrological data station of the study area**

| Station Name | Type | DHM Index No. | Altitude in meter | Latitude | Longitude | Data Availability |
|---|---|---|---|---|---|---|
| Roshikhola, Panauti | Hydrological (Daily) | 640 | 1480 | 27°34'50" N | 85°30'50" E | 1964-1987 |
| Godawori | (Temperature, precipitation) (Daily) | 1022 | 1400 | 27°21'N | 85°14'45" E | 1971-2014 |
| Khopasi | Precipitation (Daily) | 1049 | 1517 | 27°21' N | 85°18'36" E | 1971-2014 |

4 RClimDex is a software package designed to provide a user friendly interface to calculate indices of climate extremes for monitoring and detecting climate change

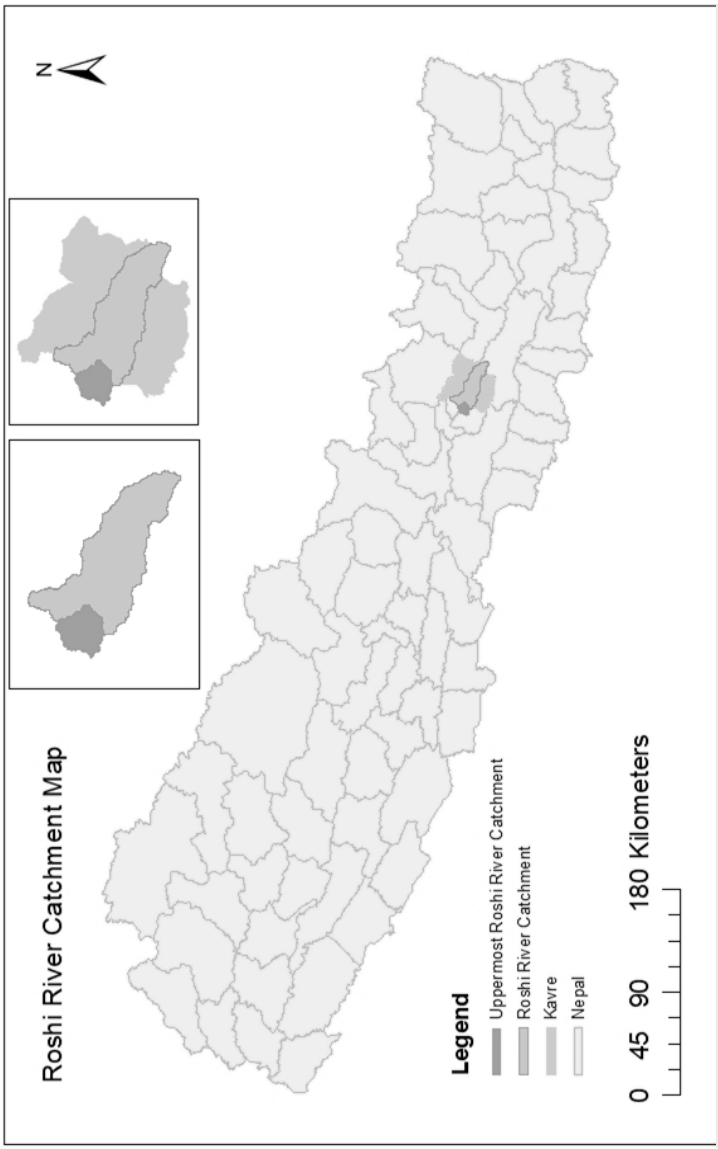


**Figure 1** Study Area, Upper Roshi River in Kavre District, Nepal.

Daily precipitation data for the period 1971 to 2014 were collected from the Godawori and Khopasi stations, which were later extrapolated using the Thiessen Polygon method. Daily temperature data for the same period of 1971-2014 from the Godawori station, and the daily discharge data for the period 1964-1987 were collected from the Roshi Khola, and Panauti hydrological stations. Figure 2 describes the upper Roshi River with meteorological and hydrological stations.

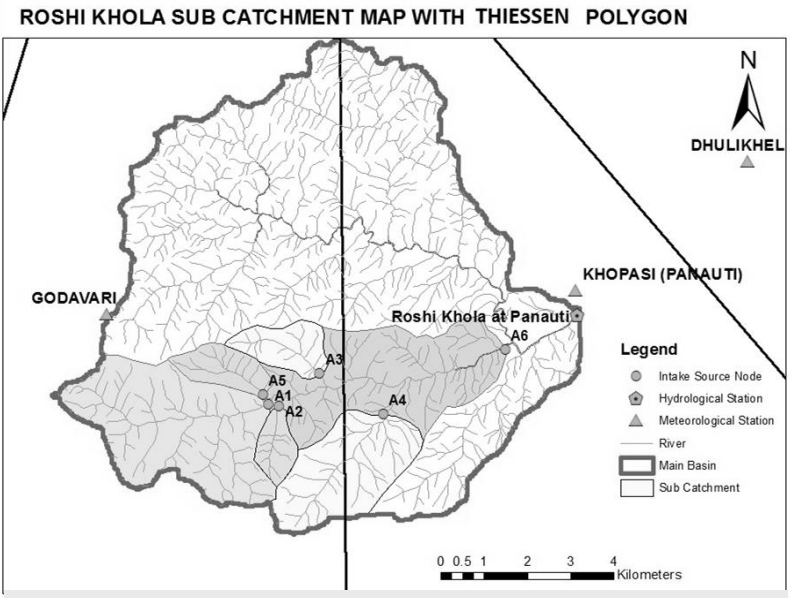


**Figure 2** Upper Roshi River (total catchment area = 86.2 km$^2$) with locations of the meteorological and hydrological stations.

The available observed historical data sets of precipitation and temperature (1971-2005) were divided into two groups. The data sets from 1971-1995 (25 years) were taken for the calibration and 1996-2005 (10 Years) were taken for the validation for both temperature and precipitation.

Using downscaled results, projected changes in maximum/ minimum temperature and precipitation for three periods; 2011-2040, 2041-2070 and 2071-2100 (addressed as 2020s', 2050s', and

2080s'), relative to the baseline period 1971-2014 were calculated for all the stations under three RCP scenarios. After calibration and validation of the 'abcd' hydrological model, it was run to calculate the future discharge of the river for three different RCP scenarios RCP 2.6, RCP 4.5, RCP 8.5 for the period 2006-2100. The period of 1964-1987 was taken as the baseline and the future discharge for three periods: 2011-2040, 2041-2070, and 2071-2100 (addressed as 2020s', 2050s', and 2080s'), were calculated for all the stations under three RCP scenarios.

## 2.1. Evaluation of the 'abcd' model performance

The accurate performance of the 'abcd' hydrological model was assured with the help of calibration and validation of the modeled discharge with respect to the observed data. The 17 years available data set of discharge from 1971 to 1987 was divided into two parts. The first 12 years data from 1971 to 1982 was taken for the calibration and the latter 5 years of data from 1983 to 1987 was taken for the validation of the model. The evaluation of the model with the statistical parameters: Root Mean Square Error (RMSE), Nash-Sutcliffe Efficiency (NSE), Pearsons' Correlation coefficient (r), Coefficient of Determination ($R^2$), and RMSE- observations Standard Deviation Ratio (RSR) was found to be in the acceptable range of performance for the model. The NSE of the model was noted to be 82% and 74% for the calibration and validation periods, respectively. Likewise, $R^2$ was found to be 0.83 and 0.79, respectively, showing the goodness of fit for the observed and simulated data. The results are tabulated as below in Table 2:

**Table 2**
**'abcd' model calibration and validation**

| | NSE | RMSE | r | $R^2$ | RSR |
|---|---|---|---|---|---|
| Calibration 1971-1982 | 0.82 | 0.89 | 0.91 | 0.83 | 0.42 |
| Validation 1983-1987 | 0.74 | 1.13 | 0.89 | 0.79 | 0.51 |

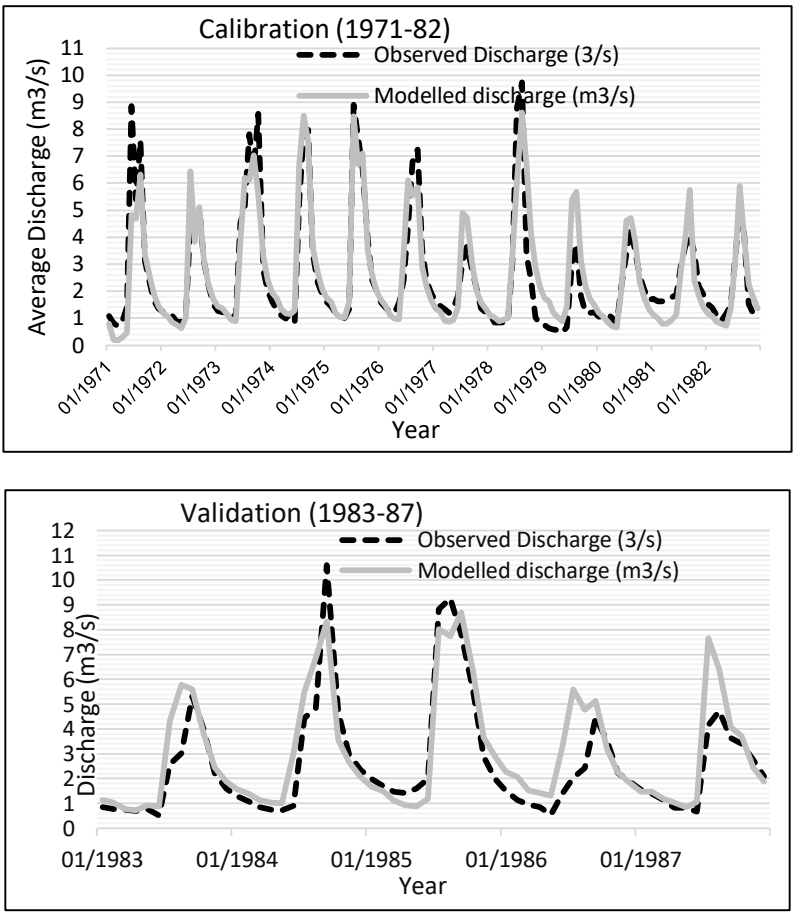


**Figure 3** Observed and modeled monthly hydrograph of upper Roshi River for the calibration and validation periods respectively

## 2.2. Evaluation of the performance of SDSM

The first set of data for 25 years (1971-1995) was considered for the calibration and remaining set of data for 10 years (1996-2005) was considered for the validation as the observed data sets were taken from climate stations monitored by DHM; the simulated data sets were generated by the model SDSM. The statistical results are shown in Table 3, namely, Root Mean Square Error (RMSE), Nash-Sutcliffe Efficiency (NSE), Pearsons' Correlation coefficient (r),

Coefficient of Determination ($R^2$), and RMSE- observations Standard Deviation Ratio (RSR). The efficiency was observed to be 94% and 88% for maximum temperature, 97% and 98% for minimum temperature, and 76% and 79% for precipitation for the calibration and validation periods, respectively. The goodness of fit was found 0.94 and 0.93 for maximum temperature, 0.97 and 0.98 for minimum temperature, and 0.77 and 0.79 for precipitation for the calibration and validation periods, respectively, indicating reasonable performance of the model.

**Table 3**
**Statistical evaluation of SDSM performance for calibration and validation periods with NCEP/NCAR**

| **Maximum Temperature (TMax)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| RMSE | | NSE | | r | | $R^2$ | | RSR | |
| 1971-1995 | 1996-2005 | 1971-1995 | 1996-2005 | 1971-1995 | 1996-2005 | 1971-1995 | 1996-2005 | 1971-1995 | 1996-2005 |
| 1.05 | 1.32 | 0.94 | 0.88 | 0.97 | 0.96 | 0.94 | 0.93 | 0.25 | 0.35 |
| **Minimum Temperature (TMin)** | | | | | | | | | |
| 0.99 | 0.79 | 0.97 | 0.98 | 0.98 | 0.99 | 0.97 | 0.98 | 0.18 | 0.14 |
| Precipitation (PPT) | | | | | | | | | |
| 78.93 | 79.15 | 0.76 | 0.79 | 0.88 | 0.89 | 0.77 | 0.79 | 0.49 | 0.46 |

## 3. DATA ANALYSIS AND RESULT

### 3.1. Precipitation

The trend analysis for the precipitation daily data of the Godawori (1022) and Khopasi (1049) weather stations for the period of 1971-2014 was done. For this data period, the analysis showed that RX1day (24-hour precipitation) was decreasing in both Godawari and Khopasi stations at rates of 0.18 to 0.69 mm per year respectively. The values were not statistically significant as both the stations have partial p-values not less than 0.05. Similarly, consecutive dry days (CDD) showed an increasing trend at the rates 0.62 and 0.63 days per year, for Godawori and Khopasi respectively,

mostly with mild trend, which was statistically significant for the station 1022 only. The analysis of the consecutive wet days (CWD) shows decreasing trends at both the stations at rates of 0.04 to 0.12 days per year, respectively, with statistically significant value for the station 1022. The index R95p (very wet days) shows decreasing trends for both the stations from 3.23 to 4.38 mm per year, respectively. The result was not found to be statistically significant at both the stations. Similarly, R99p (extremely wet days) values also has the gentle decreasing trend from 1.82 to 3.42 mm per year, respectively, for both the stations. The result was observed to be statistically significant only for the station 1022. Likewise, PRCPTOT showed a decreasing trend in both the stations at the rates of 6.45 mm and 10.12 mm per year, respectively with a statistically significant result for the station 1022.

Hence, the precipitation trend was observed to be similar at both the stations with most of the indices showing a decreasing trend with gentle slope, resulting in low statistical significances which represents the change in climate.

## 3.2. Temperature

The trend for the monthly maximum value of the daily maximum temperature (TXx) was observed to show a statistically significant increasing trend at the rate 0.05 ℃ per year. Similarly, the monthly minimum value of the maximum temperature (TNx) was also found to be increasing at a rate of 0.03 ℃ per year, which was also statistically significant. Likewise, monthly maximum value of the daily minimum temperature (TXn) was also seen to increase at the rate of 0.06 ℃ per year, which was statistically significant. Besides the above mentioned temperature indices, the monthly minimum value of daily minimum temperature (TNn) was found to be decreasing at a rate of 0.02 ℃ per year with no statistical significance. The monthly mean difference between maximum and minimum temperature (DTR) was, however, observed to show a statistically significant increasing trend at a rate of 0.07 ℃ per year.

Hence, most of temperature indices were noted to have an increasing trend with statistically significant results, with the exception of

monthly minimum value of the daily minimum temperature (TNn), which suggests that the rates of change actually represent a changing climate.

## 3.3. Future climatic variables projection

Downscaling of the future maximum temperature, minimum temperature and the precipitation under RCP 2.6, RCP 4.5 and RCP 8.5 scenario was done for the period of the 2006 to 2100 by SDSM. The future trend analysis of the climate variables was carried out in three time windows 2011-2040, 2041-2070 and 2071-2100 which are considered as the 2020's, 2050's and 2080's, respectively, from here onwards. The observed datasets of temperature and precipitation for the period 1971-2014 and of discharge for the period 1964-1987 are referred to the baseline.

### 3.3.1. Future Maximum Temperature (TMax)

The simulated future maximum temperature shows a slight increase in all the scenarios and time windows except a very slight decrease in the maximum temperature in 2020's for RCP 2.6 and RCP 4.5 by 0.05 and 0.07 ℃ respectively compared to the baseline. The highest increase in the TMax was found in RCP 8.5 in 2080's of 0.67 ℃. The overall trend of the maximum temperature was found to be increasing in the RCP 4.5 and RCP 8.5, but almost normal trend in the RCP 2.6 by 2100 as shown in Table 4 and Figure 4 below.

**Table 4**
**Future change in average annual maximum temperature (TMax) under RCP 2.6, 4.5 and 8.5 scenario with respect to baseline**

| Annual Average TMax (C ) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Baseline | RCP 2.6 | | | RCP 4.5 | | | RCP 8.5 | | |
| | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| 22.01 | 21.96 | 22.07 | 22.02 | 21.95 | 22.14 | 22.23 | 22.02 | 22.31 | 22.68 |
| Change( C) | -0.05 | 0.06 | 0.01 | -0.07 | 0.12 | 0.22 | 0.01 | 0.30 | 0.67 |

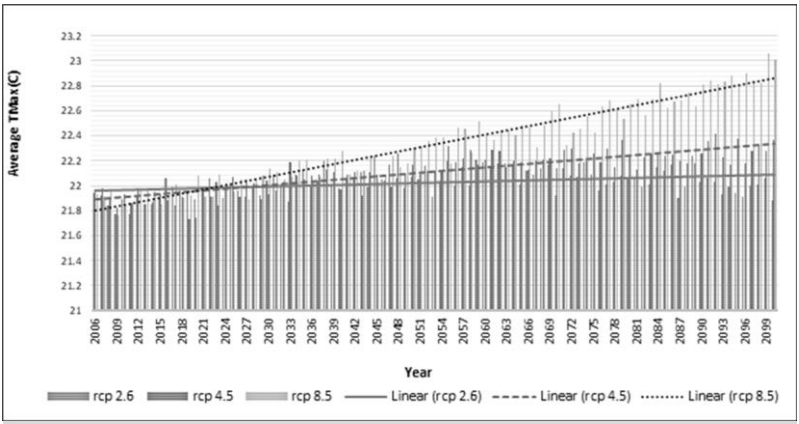


**Figure 4** Annual Average Maximum Temperature distribution over the period 2006-2100

### 3.3.2. Future Minimum Temperature (TMin)

The simulated future minimum temperature (TMin) follows the increasing trend in all the time windows under all RCP scenarios with reference to the baseline. The increment in the mean annual temperature ranges from 0.64 ℃ (RCP 4.5, 2020's) to 1.91 ℃ (RCP 8.5, 2080's). Though there was no distinct increasing trend for RCP 2.6, there was a higher slope for an increase in the future temperature for scenarios RCP 4.5 and RCP 8.5 by the end of this century.

**Table 5**
**Future change in average annual minimum temperature (TMin) under RCP 2.6, 4.5 and 8.5 Scenario with respect to baseline (1971 to 2100)**

| Annual Average TMin (C ) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Baseline | RCP 2.6 (C ) | | | RCP 4.5 (C ) | | | RCP 8.5 (C ) | | |
| | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| 11.44001 | 12.12 | 12.33 | 12.29 | 12.08 | 12.34 | 12.50 | 12.17 | 12.71 | 13.35 |
| Change | 0.68 | 0.89 | 0.85 | 0.64 | 0.90 | 1.06 | 0.73 | 1.27 | 1.91 |

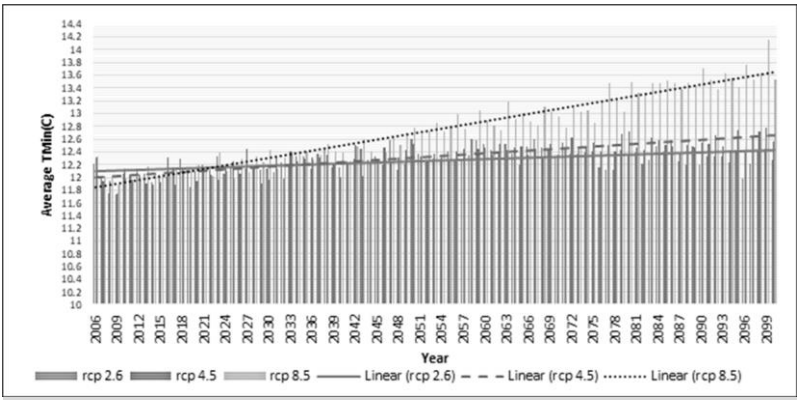


**Figure 5** Future Average Annual Minimum Temperature (TMin) projection over the period 2006-2100

### 3.3.3. Future Precipitation (PPT)

The projection of the future precipitation does not show any specific trend explicitly under all RCP scenarios by the end of this century. Though, the trend line shows very slightly decreasing trend for the mean annual precipitation in most of the time windows under the RCP scenarios, there is increase in the mean annual precipitation with reference to the baseline. While moving from 2020's to 2080's, a slight decrease was found in the annual mean precipitation in most of the time windows and RCP scenarios, with the exception of a slight increasing trend from 2020's to 2050's under RCP 2.6. The highest precipitation was found in July and the lowest precipitation value occurred in November.

**Table 6**
**Future change in average annual precipitation (PPT) under RCP 2.6, 4.5 and 8.5 Scenario with respect to baseline (1971 to 2100).**

| Sum of PPT, annual average(mm) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Baseline | RCP 2.6 (mm) | | | RCP 4.5 (mm) | | | RCP 8.5 (mm) | | |
| | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| 1597 | 1737.04 | 1764.39 | 1720.63 | 1743.27 | 1730.10 | 1718.98 | 1721.22 | 1661.54 | 1662.02 |
| Change | 140.04 | 167.39 | 123.63 | 146.27 | 133.10 | 121.98 | 124.22 | 64.54 | 65.02 |

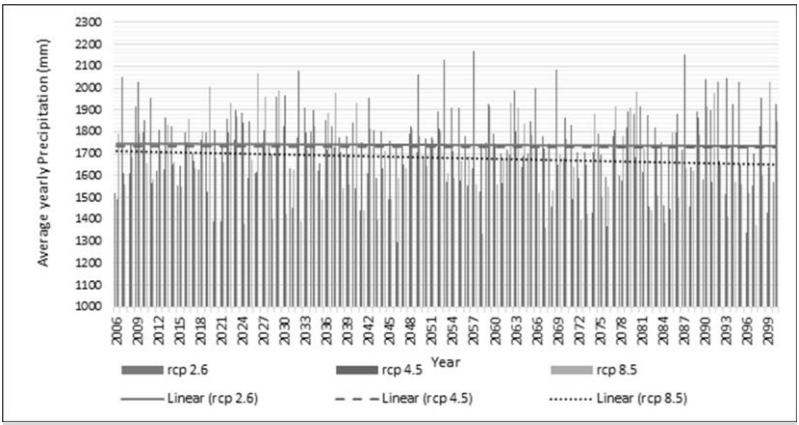


**Figure 6** Future Average Precipitation (PPT) projection over the period 2006-2100

## 3.4. Impact of future climatic change on stream flow

The main objective of this study was to project the future stream flow of the upper Roshi River based on the future downscaled precipitation and temperature data under the different RCP scenarios for chosen time windows. No significant increasing or decreasing trends in stream flow were observed, but a slight increase in the mean annual discharge in the future with reference to the baseline was predicted as shown in the table and figures below. Though, there is no distinct projected change in the discharge of the future stream flow under different RCP scenarios with reference to the baseline, a slight increase in the mean annual discharge was noted, with highest discharge (2.81 $m^3/s$) projected in 2050's RCP 2.6 and the lowest discharge (2.54 $m^3/s$) is projected in 2050's, RCP 8.5 (Table 7 and Figure 7).

**Table 7**
**Percentage change in mean annual discharge with respect to baseline period**

| % Change in average annual discharge with respect to baseline | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discharge | Baseline | RCP 2.6 ($m^3/s$) | | | RCP 4.5 ($m^3/s$) | | | RCP 8.5 ($m^3/s$) | | |
| | | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| Mean ($m^3/s$) | 2.458 | 2.689 | 2.810 | 2.675 | 2.733 | 2.683 | 2.687 | 2.649 | 2.547 | 2.553 |
| Change | - | 0.231 | 0.352 | 0.217 | 0.275 | 0.225 | 0.229 | 0.191 | 0.089 | 0.095 |
| % Change | - | 9.39% | 14.32% | 8.81% | 11.18% | 9.13% | 9.33% | 7.78% | 3.63% | 3.85% |

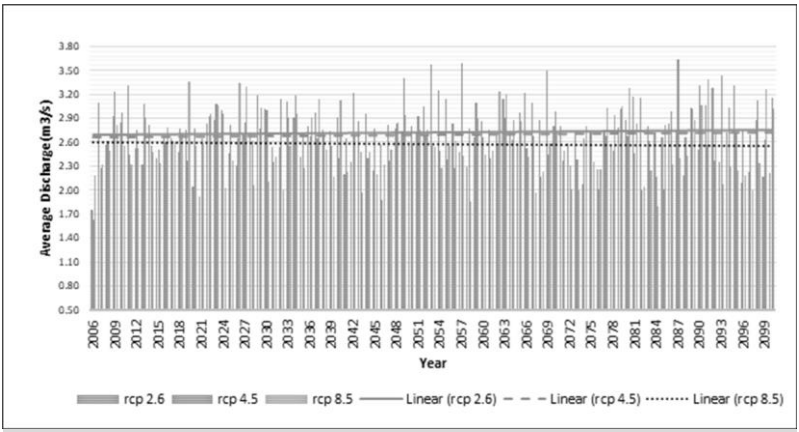


**Figure 7** Future Average Discharge projection over the period 2006-2100.

## 3.5. Impact of future climatic change on seasonal stream flow

As climatic variations are more likely supposed to affect the seasonal flow, the analysis of the future stream flow was done for four seasons. The result showed an increase in the stream flow during the pre-monsoon (March–May), monsoon (June–September) and winter (December–February) seasons, and a decrease in the post-monsoon (October–November) season throughout the various future time windows under all RCP scenarios (Tables 8 & 9). The highest increase (21.28%) in the discharge is seen in winter in 2050's, RCP 2.6, and the highest decrease (3.74%) is seen in the post-monsoon for the time window 2050's, RCP 8.5 with reference to the baseline (which is 1971-2014). The pre-monsoon season has a lower rate of increase in the discharge in comparison to the monsoon and winter season has the higher rate of increase in the future discharge under all RCP scenarios.

**Table 8**
**Mean seasonal flows of Roshi River.**

| Average Seasonal Discharge (m3/s) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Seasons | Baseline | RCP 2.6 | | | RCP 4.5 | | | RCP 8.5 | | |
| | | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| Pre-monsoon | 0.966 | 1.017 | 1.012 | 1.024 | 1.002 | 1.015 | 0.979 | 1.002 | 0.947 | 0.978 |
| Monsoon | 4.313 | 4.865 | 5.037 | 4.763 | 4.965 | 4.804 | 4.828 | 4.750 | 4.536 | 4.427 |
| Post-monsoon | 2.671 | 2.613 | 2.855 | 2.667 | 2.653 | 2.669 | 2.681 | 2.627 | 2.571 | 2.719 |
| Winter | 1.327 | 1.509 | 1.609 | 1.546 | 1.540 | 1.531 | 1.545 | 1.510 | 1.480 | 1.517 |

**Table 9**
**Percentage change in mean seasonal discharge with respect to baseline.**

| Percentage change in average seasonal discharge with respect to baseline | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Seasons | RCP 2.6 | | | RCP 4.5 | | | RCP 8.5 | | |
| | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' | 2020s' | 2050s' | 2080s' |
| Pre-monsoon | 5.29% | 4.74% | 5.98% | 3.72% | 5.04% | 1.37% | 3.74% | -1.93% | 1.29% |
| Monsoon | 12.80% | 16.78% | 10.43% | 15.13% | 11.38% | 11.94% | 10.13% | 5.17% | 2.64% |
| Post-monsoon | -2.16% | 6.89% | -0.14% | -0.68% | -0.08% | 0.37% | -1.63% | -3.74% | 1.79% |
| Winter | 13.68% | 21.28% | 16.50% | 16.06% | 15.38% | 16.45% | 13.78% | 11.54% | 14.33% |

## 3.6. Future discharge analysis of the Kavre Valley Integrated Water Supply Project (KVIWSP)

The designed water discharge for KVIWSP is 77.73 lps from five different nodes at Roshi River, while the dry season measured discharge (2014 March) was 160 lps (KVIWSP, 2014). The analysis of the future discharge in the 5 different source nodes of the project was conducted comparing the result of available discharge measured with the designed discharge as explained in the table below.

**Table 10**
**Node-wise water discharge of KVIWSP.**

| S.N | Stream/River | Sub-basin | Designed water discharge for KVIWSP (lps) | Measured discharge in March 2014 (lps) |
|---|---|---|---|---|
| 1 | Muldole/Roshi | A1 | 35 | 76 |
| 2 | Baira Mahadev | A2 | 7.5 | 20 |
| 3 | Gudgude | A3 | 5 | 13 |
| 4 | Kharkhola | A4 | 5.23 | 24 |
| 5 | Sishakhani | A5 | 25 | 27 |
| Total | | | 77.73 | 160 |

*Source:* KVIWSP, EMP 2014

As the projected discharge of the watershed in the future under different RCP scenarios is projected to have a trend of slight increase in the discharge during the winter, pre-monsoon and monsoon seasons, there is no significant climate change impact causing a deficit or extreme flows of water at the source nodes. However, there could be some stress in water availability at the source nodes during the post-monsoon season. Hence, the Sishakhani source node is more likely to be sensitive in post-monsoon as this source node has only a 2 lps surplus discharge compared to the designed discharge.

## 4. CONCLUSION AND WAY FORWARD

Future discharge of the upper Roshi River was assessed with respect to the future climatic variables (temperature, precipitation) using 'abcd' hydrological model and SDSM climate models. Assessment of the future stream flow of the Roshi River shows that there will be slight increase up to maximum of 14% in mean annual discharge in 2050's. Seasonal discharge analysis shows slight increase in the discharge in winter, monsoon and pre-monsoon but a very slight decrease during the post-monsoon season would occur. This indicates that if water supply infrastructure is in place to store and transfer water, then the problem of water deficit due to any changes in seasonal flow over time could be managed (Bharati et al., 2014). Moreover, such change in stream flow will increase the intensity of floods and droughts with substantial impacts on the water resources

at local and regional levels (Barnett et al., 2005). A recent study conducted by Joshi et al. (2019) indicates that the community of the Roshi River had already experienced heavy flooding during the monsoon which destroyed the lives and livelihoods of the local people. The risks associated with such extreme events will also affect the development of water supply infrastructure. Therefore, changes in flow volumes or water balance components from climate change might not affect development plans, if managed properly. Hence, increases in variability, including extreme events such as flood risk needs to be taken into consideration while planning water related initiatives.

Since the Kavre Valley Integrated Water Supply Project (KVIWSP) has a designed discharge of 77.3 lps of total water from all the 5 source nodes, the measured discharge for those source nodes during the dry season (i.e., March of 2014) was 160 lps leaving about 80 lps of water surplus at the source. Based on this analysis, no significant future climate stress is likely to occur on most of the source nodes, but the source node of Sishakhani could be affected during the post-monsoon in future as this source node has only marginal surplus discharge as per the design discharge by KVIWSP. However, this analysis does not resonate with Dahal et al. (2019), where the authors, through trend analysis conclude that the decline of streamflow of Roshi would cause a shortage of water for domestic, agricultural, and industrial uses in the downstream.

However, this study has not considered the changes in land use/land cover, as well as changes in water demand of the communities due to population growth and socioeconomic development in the future. Therefore, a comprehensive research considering the uncertainties in future climate affecting the water availability as well as predicting the future land use/land cover and demand for water by various economic sectors including ecological demand is recommended. Furthermore, while planning any water project in climate vulnerable countries like Nepal, there is a need to assess the impacts of projected climate changes as this helps to build resilience against its possible impacts through enhanced institutional flexibility and the consideration of climate-related risks in the planning process.

## REFERENCES

Agarwal, A., Babel, M.S. and Maskey, S., 2014. Analysis of future precipitation in the Koshi river basin, Nepal. *Journal of Hydrology*, 513, pp.422–434.

Babel, M.S., Bhusal, S.P., Wahid, S M. and Agarwal, A., 2014. Climate change and water resources in the Bagmati River Basin, Nepal. *Theoretical and Applied Climatology*, 115(3-4), pp.639-654.

Barnett, T.P., Adam, J.C. and Lettenmaier, D.P., 2005. Potential impacts of a warming climate on water availability in snow-dominated regions. *Nature*, 438, pp.303-309.

Bharati, L., Gurung, P., Jayakody, P., Smakhtin, V. and Bhattarai, U., 2014. The projected impact of climate change on water availability and development in the Koshi Basin Nepal. *Mountain Research and Development*.

Broto, V.C. and Bulkeley, H., 2013. A survey of urban climate change experiments in 100 cities. *Global Environmental Change*, 23(1), pp.92-102.

Dahal, N., Shrestha, U.B., Tuitui, A. and Ojha, H.R., 2019. Temporal changes in precipitation and temperature and their implications on the streamflow of Rosi River, Central Nepal. *Climate*, 7(1), p.3.

Devkota, L.P. and Gyawali, D.R., 2015. Impacts of climate change on hydrological regime and water resources management of the Koshi River Basin, Nepal. *J. Hydrol. Reg. Stud*, 4, pp.502–515.

Dhakal, K., Silwal, *S. and Khanal, G., 2010. Assessment of climate change impacts on water resources and vulnerability in Hills of Nepal. A case study of Dhare Khola watershed of Dhading district*, Government of Nepal.

Department of Hydrology and Meteorology (DHM), 2017. *Observed climate trend analysis in the districts and physiographic regions of Nepal (1971-2014).* Department of Hydrology and Meteorology, Kathmandu.

Duncan, J.M., Biggs, E.M., Dash, J. and Atkinson, P.M., 2013. Spatio-temporal trends in precipitation and their implications for water resources management in climate-sensitive Nepal. *Appl. Geogr.*, 43, pp.138–146.

Eckstein, D, Kunzel, V. and Schafer, L., 2017. *Global Climate Risk Index 2018*. Who suffers most from extreme weather events? Weather-related loss events in 2016 and 1997 to 2016 Available at: https://germanwatch.org/sites/germanwatch.org/files/publication/20432.pdf

Gautam, M.R. and Acharya, K., 2012. Streamflow trends in Nepal. *Hydrol. Sci. J.*, 57, pp.344–357.

IPCC, 2014. IPCC, Climate Change 2014: Impacts, Adaptation, and vulnerability.

Joshi, T., Kovacs, E.K. and Neupane, K.R., 2019. Incentives for securing water in a Himalayan town: A case From Dhulikhel, Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 6(1), pp.1–20.

KVIWSP, 2014. *Updated Environmental Management Plan of Kavre Valley Integrated Water Supply Project 2014*.

Karki, R., Schickhoff, U., Scholten, T. and Böhner, J., 2017. Rising precipitation extremes across Nepal. *Climate*, 5, p.4.

MoE, 2010. *National Adaptation Programme of Action to Climate Change*, Ministry of Environment, Kathmandu, Nepal.

Pandey, V.P., Sharma, A., Dhaubanjar, S., Bharati, L., Joshi, I.R., 2019. Climate shocks and responses in Karnali-Mahakali Basins, Western Nepal. *Climate*, *7*(7), 92. Available at: https://doi.org/10.3390/cli7070092.

Rajbhandari, R., Shrestha, A.B., Nepal, S. and Wahid, S., 2016. Projection of future climate over the Koshi River basin based on CMIP5 GCMs. *Atmospheric and Climate Sciences*, 6(02), p.190.

Strengthened Actions for Governance in Utilization of Natural Resources (SAGUN) Program, 2010. *Climate change impacts on livelihoods of poor and vulnerable communities and biodiversity conservation: A case study in Banke, Bardia, Dhading and Rasuwa Districts of Nepal*. Kathmandu: SAGAN and CARE Nepal.

Sharma KP., Vorosmarty C.J .and Moore, B., 2000. Sensitivity of the Himalayan hydrology to landuse and climatic changes. *Climate Change,* 47(1), pp.117-139. DOI:10.1023/A:1005668724203.

Sharma, R.H. and Shakya, N.M. 2006. Hydrological changes and its impact on water resources of Bagmati watershed, Nepal. *Journal of Hydrology*, 327(3-4), pp.315-322.

Shrestha, A.B. and Aryal, R. 2011. Climate change in Nepal and its impact on Himalayan glaciers. *Reg. Environ. Chang.,* 11, pp.65–77.

Sijapati, S., Bhatti, M.T. and Pradhan, N.S., 2014. Climate change impact on water availability, and farmers' adaptation strategies: case studies from Pakistan and Nepal. In: R.A. Vaidya and E. Sharma, eds. 2014. *Research insights on climate and water in the Hindu Kush Himalayas*. Kathmandu: ICIMOD, pp.109–128. Available at: http://lib.icimod.org/record/29963/files/SAWI.pdf.

UNEP, 2004. *Women and environment*. United Nations Environment Program.

WECS, 2011. *Water resource of Nepal in context of climate change,* Government of Nepal water and Energy Commissions Nepal.

# 8

# *Pani Chautari* as a Tool for Evidence - Informed Policy and Practice: Experiences from Dhulikhel

**Kamal Devkota, Gyanu Maskey and Dil Khatri**

## SUMMARY

*There is limited practice of using evidences and dialogue among the related stakeholders while formulating policy in Nepal. This chapter examines the dynamic interface of science, policy and practice for inclusive and sustainable water management by bringing insights from Pani Chautari in Dhulikhel. Pani Chautari is a complete cycle of a policy process that brings water related stakeholders into a single platform, engage with them to generate knowledge and deliberate for informed decision making. This chapter is based on the insights of the authors and researchers from SIAS engaged in facilitating Pani Chautari. In the chapter, we document the emergence, process and outcomes of Pani Chautari series in Dhulikhel. Our analysis revealed that Pani Chautari has contributed in expanding the deliberative space and has positively impacted the policy learning culture of water stakeholders. Specifically, it has promoted innovation and practices of evidence based policy making for water management. It has further fostered collaboration among key stakeholders and contributed to further institutionalize up and downstream relations in Dhulikhel. Pani Chautari is not an alternative model of governing water but the engagement of researchers, community and government representatives have created an innovative model of involving users and stakeholders in planning and policymaking. This integration of research into policy process can be exemplary to other local government bodies.*

## 1. INTRODUCTION

The federalization in Nepal has strengthened the local governance with greater level of authorities and responsibilities including the mandate to craft policies at the local level. The newly formed Palikas (municipalities) are grappling with the challenges to formulate needed polices and legislations in order to perform the development and administrative functions. As the newly constituted Palikas have limited experience and expertise on policy making, they often rely on hired experts or follow the departmental guidelines. Due to such limitations, the concept of 'evidence informed policy making' can sound farfetched to most of the palikas. Nevertheless, during our work, we came across some Palikas with visionary leadership, taking nascent steps towards evidence based policy and practices by collaborating with researchers. This chapter is the documentation of one such collaboration- where we worked with Dhulikhel municipality on science-policy-pracitce interface. In this chapter, we document the experiences of Dhulikhel municipality on science-policy-practice interface. The municipality collaborated with Southasia Institute of Advanced Studies (SIAS) for organizing *Pani Chautari* as a platform for dialogue among researchers, policy makers and practitioners which helped in some policy and practical solutions to tackle the issue of urban water management.

Scholars highlight the importance of the interface among scientists, policymakers and citizens as a key for evidence-based public policy making (Ojha et al., 2019; Shrestha and Mahjabeen, 2011). While scientists provide a comprehensive analysis and generate evidence to inform policy processes, citizens can bring practical experiences and local knowledge to inform policy decisions. Since a policy is a contract for collective action among citizens (Ojha et al., 2012), citizens' insights and reflections are highly important for its effectiveness (Figueiredo Nascimento et al., 2016). The evidence based policy making provides greater emphasis on policy process rather than merely on the outcomes (Dente, 2011) and it helps crafting policies that address the everyday problems of citizen (Bartel and Bricknell, 2016). The importance of evidence based policy making in informing policy process (Sutcliffe and Court, 2005; Davies, 1999) is demonstrated through its features that integrates

experience, judgement and expertise with best available external evidence from systematic research.

Deliberation among multiple stakeholders characterized by conflicting interest and rationalities is key to evidence based policy making. The collaborative evidence based policy making brings in the participatory domain, taking into consideration the diverse range of voices and views leading to a greater acceptance. Collaborative, participatory and inclusive policy making thus ensures greater equity (Bartel and Bricknell, 2016) and for water-related decision-making, raises awareness about risks and related costs, and reduces the potential for conflicts over water (Akhmouch and Clavreul, 2016). In the situation of uncertainty and crisis, disjoint efforts in policy governance cannot resolve and address the complex sustainable water usage, quality and water supplies diversification (Head, 2010).

However, public policymaking in developing countries like Nepal rarely benefits from evidence and dialogue among policymakers, experts and citizens (Dhimal et al., 2016). Resultantly, the public policies often are not effective in addressing the problems that citizens face. Ojha et al. (2012) maintain, the resource management sector such as forestry suffers from this problem where public policymaking is dominated by techno-bureaucratic forces i.e. technical knowledge and bureaucratic authority. Drawing lessons from these centralized policymaking practices, this chapter documents an innovative attempt of evidence-informed policymaking at the municipal level. Taking the case of *Pani Chautari* – a cycle of evidence informed policy process, this paper shares the experiences and insights from Dhulikhel municipality which can be beneficial for municipalities across the country and the policy process across scales.

This chapter is largely based on the experiences and insights of the authors along with other researchers from SIAS who have been actively engaged in facilitating *Pani Chautari* in Dhulikhel and other towns such as Dharan, Bidur and Diktel. Though we primarily focus on the six *Pani Chautari* series conducted between November 2016 to February 2020 in Dhulikhel, we also bring insights from our

engagement in other municipalities. We brought the insights from the rich discussions and reflections among researchers and municipal actors through out the process of evolution of *Pani Chautari*. The current form of *Pani Chautari* evolved through the process of iteration among researchers and municipal authorities. We also conducted interviews with eight key actors involved in the *Pani Chautari* and municipal government representatives focusing on their perception on *Pani Chautari* and its contribution in linking science to policy for sustainable water management in the towns.

In the following section, we elaborate the idea of *Pani Chautari* and the process through which it evolved to its present form. Following this, we discuss the key outcomes of the series of *Pani Chautari* towards contribution in developing and implementing sustainable solutions for urban water security through evidence-based planning at the municipality. We conclude the chapter by drawing key insights for policy making to other Palikas. We argue that the dialogue among major stakeholders informed by research based evidence helps towards achieving policy effeciencies to address the day-to day problems of people.

## 2. *PANI CHAUTARI*

### 2.1. What is it ?

*Pani Chautari* is a complete cycle of a policy process towards fostering evidence informed dialogue and critical policy engagement, aimed at addressing city level water-related issues. It helps to identify water-related issues, generate credible knowledge, facilitate to formulate specific policy and then translate that policy into practices to resolve the issue. *Pani Chautari* not only aims to provide a platform to diverse actors for informed dialogue but it also helps strengthening the capacity of city-level water stakeholders and enhance partnership towards ensuring water security. Its specific objectives include:

- To identify the water related issues/problems that people are facing in their daily life

- To generate or consolidate evidence through research or focused diagnostic studies that help to inform the poliy process
- To provide an opportunity for city stakeholders to interact with the research team and learn from the work of the researchers
- To provide space for reflection and capacity building among city level stakeholders who can champion the water management at local level
- To develop policy responses or technical innovation that help cities to address water problems in the face of rapid urbanization and climate change using research

Beyond its specific objectives, *Pani Chautari* broadly promotes the culture of co-learning and co-creating knowledge among the diverse stakeholders through research and engagement.

## 2.2. How has it evolved ?

The idea of *Pani Chautari* initially emerged as a discussion platform among the key actors during a stakeholder consultation program organized to identify water related issues in Dhulikhel. Prior to that, there were very limited multi-stakeholder discussions on water related issues. Realizing from these multi-stakeholder discussions, water managers and the users from Dhulikhel initially proposed an idea of promoting a stakeholder forum on a regular basis. Their initial expectations were to conduct a series of discussions on ongoing issues of water management such as equitable distribution, institutional transformation, inclusive decision making and tariff fixation. SIAS, being engaged in action research on urban water management in Dhulikhel nurtured this idea to promote evidence based discussions and contribute to the policy process. A series of bilateral and collective discussions among the water managers, municipal authorities and SIAS researchers were conducted over last five years.

In the beginning, two discussion events were held in Dhulikhel where SIAS researchers shared findings based on their three years of research on water security in Dhulikhel. These discussions

focused on generic water management issues but highlighted the need for sustainable and long-term solutions for water management in the town. The evidence generated from the research by SIAS provided the stakeholders with an understanding of the impact of changing climate and rapid urbanization on water management in the town. They further benefitted from the presentation of some eco-friendly and cost effective solutions for water management in these discussions which has further established the importance of such dialogues. These initial discussions helped to refine the methodological processes and coin the name for the series as '*Pani Chautari*'. Method and process of *Pani Chautari* has been further refined and made comprehensive which we will elaborate in the following sections.

Participants representing municipality, community-based water user committees and private sector highly appreciated the idea of this dialogue as they perceived the series of this event could promote learning culture on diverse aspects of water management and create synergy among the researchers, policymakers, and practitioners. They further perceived that the regular dialogue can bring water stakeholders together into a common platform to discuss the issues related to the water security. From the initial discussions, a broader modality of *Pani Chautari* was agreed, however, adequate flexibility in terms of issues to discuss, number and types of participants, process and frequency were kept open so that it could be customized as per the requirement.

The following series of *Pani Chautari* in Dhulikhel were more rigorous in terms of methodology, outputs of the event and its linkages to the municipal policy. By that time, the presence of elected representatives further helped to identify issue, facilitate discussion events and take them forward towards the policies and programs. Key issues identified for dialogue included groundwater recharge and revive drying springs, the role of the private sector on water management, issues of women in water management and up-stream and down-stream linkages for water management. These issues were identified based on the requirement of municipality and consultation among facilitating team of SIAS and the municipal government representatives. Following table shows the detail accounts of last four series of *Pani Chautari* held in Dhulikhel.

**Table 1**
***Pani Chautari* Details**

| Identified issues | Evidence generated | Participants in the dialogue | Outcomes of Pani Chautari |
|---|---|---|---|
| Decreasing volume of water in the local spring | Formative study on the potentials of ground water recharge in Dhulikhel | Newly elected municipal representatives and members of Dhulikhel Drinking Water and Sanitation Users Committee (DDWSUC) | Decision to pilot recharge ponds, increased budget to revive the existing ponds, promotion of new ponds |
| Limited private sector enagement on urban water management | Review of best practices and documentation of experiences from enterprenuers on water management | Kavre Hotel Association, Dhulikhel Chamber of Commerce and Industries, DDWSUC, larger water users, hotels, homestay managers, small and medium enterprises (SMEs), party palace, schools and university | Subsidy to rainwater harvesting, promotion of recycle and reuse of water in industries, contribution of industries to water source conservation |
| Women's issues and voices are ignored in water related decision making | Review of national and Dhulikhel specific water management policies, brief consultation with women members and analysis of data from prior studies by SIAS | Elected municipal women members, women members of DDWSUC, Division Drinking Water Office, District Forest Office (DFO), Kathmandu University and Nepal Forum for Environmental Journalists (NEFEJ) | Priority to women issues in water management |
| Up and downstream relation for water management further detriorated | Consolidation of research and insights from two previous water related research projects by SIAS in Dhulikhel | Government organizations, water user committees, local government, representatives from upstream | After long time people came together into a single platform to discuss on contested issues, proposal of |

## 3. *PANI CHAUTARI* PROCESS

Steps in *Pani Chautari* process are determined based on the experience of organizing these events in Dhulikhel and Dharan. SIAS's earlier experiences of hosting stakeholder dialogues also helped to refine the process.

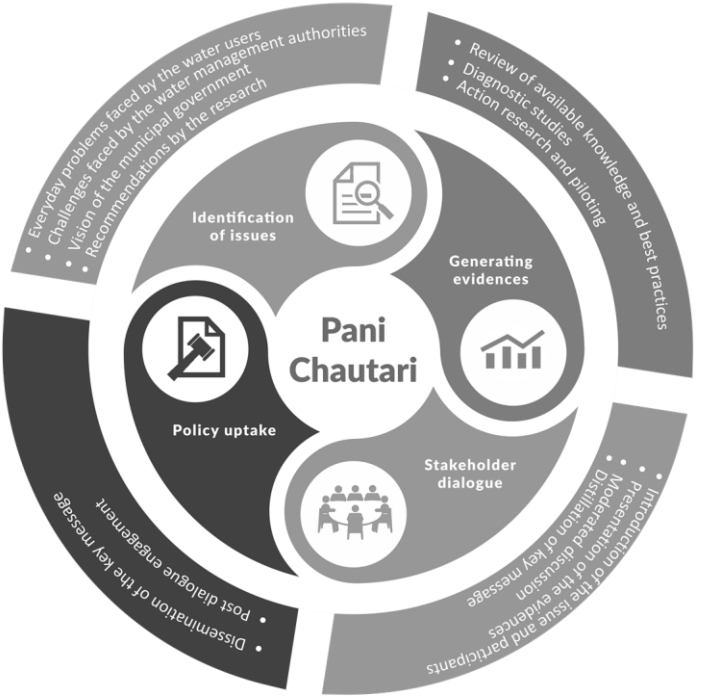


**Figure 1**. Process of *Pani Chautari*

As shown in Figure 1, the identification of the issues, generating evidence, stakeholder dialogues, and post-dialogue engagements and communication for policy uptake are four key steps of *Pani Chautari*. Multiple stakeholders including representatives from the municipality, government organizations, water user committees, private sectors, excluded community, commercial users are directly engaged throughout the process.

## 3.1. Identification of issues

The *Pani Chautari* process starts with the identification of day to day water related problems that need to be resolved. City specific issues also come from the long term vision of the municipality and elected municipal governments. As per the experiences from Dhulikhel, while most of the issues were proposed by stakeholders, some of them were suggested by the researchers as well. For instance, the issues of 'private sector engagement on urban water management' emerged during a study of SIAS and later taken to the wider discussion through *Pani Chautari* series. Similarly, the issues for third series in Dhulikhel 'decreasing volume of water in the local spring' was initially raised by the Dhulikhel DDWSUC and later on discussed in the *Pani Chautari*.

## 3.2. Generating evidences

This step of *Pani Chautari* require collecting or generating evidences to inform the dialogue and policy process. Researchers either review the literatures and best practices on the identified issues or conduct quick and focused studies, or both where in possible. Evidences can also be generated from ongoing and past researches and through the lessons and observations from the experimentation and field testing of some of the tools and technologies. In case of Dhulikhel, the evidences were generated mostly from the ongoing studies. In a particular case, a collective field visit to another village by expert and stakeholders was organized. The visit helped to collect hands on experiences on ground water recharge to replicate in Dhulikhel and revive the drying springs. The insight from this field visit was complemented by the scientific research reviewed by the researchers which was presented among the stakeholders during *Pani Chautari* event. Similarly, for the latest series on 'up and down stream relations', we presented data and insights from our earlier research. In this stage, researchers are more active than the stakeholders as they undertake research for evidence and prepare the presentation in more vernacularized language.

## 3.3. Stakeholder dialogue

This is the most important step of *Pani Chautari* where a comprehensive presentation of evidences guide the dialogue among multiple stakeholders. They rigorously discuss on the multiple aspects of the pre-identified issue taking presentation as the reference and the discussion is carefully moderated and synthesized in an action oriented key conclusion. This event is well prepared in terms of identifying participants, making the presentation in local language, setting the key questions for discussion and facilitation. In general, the modality of all the stakeholder dialogue events in Dhulikhel were similar. However, we used visual materials in some of the events to make the discussion more engaging. In some cases external presenters were invited to share their experiences in the related issues. The carefully moderated discussion provided space to raise their voices. Despite many considerations for inclusivity, there could be instances of 'participatory exclusion' because of the power differentials within different stakeholder (Bhattarai et al., 2020). Often people from marginalized groups (women) were found less vocal therefore, a gender specific dialogue was organized to provide women and other marginalities conducive space to raise their concern. The event is recorded with the consent of the participants and documented in the form of a report.

## 3.4. Policy uptake

The outcomes of the *Pani Chautari* events are well documented and disseminated through different medias. In most of the cases in Dhulikhel, the journalists participating in the discussion published news in the local and national media. In other cases, press releases were jointly issued by the municipality and SIAS. The researchers also wrote blogs and opinion articles capturing the key messages of the discussion. After this dialogue, researchers engage with the respective stakeholders and the municipal authorities to further facilitate the policy uptake of the discussion. As per our experiences, this engagement includes – post event meeting with Mayor and the senior staffs, informal meeting and communication with the related stakeholders, individual discussions with selected beneficiaries of the policy etc. The post event informal discussion is vital to prioritize the issue at hand and discuss multiple policy options with the municipal policy makers.

## 4. CHALLENGES OF *PANI CHAUTARI* PROCESS

The idea of *Pani Chautari* evolved organically from the collaboration between SIAS researchers and the stakeholders from Dhulikhel, and took its present shape with iterative discussions. Initially, the challenge was to form a common understanding on what *Pani Chautari* meant among stakeholders and researchers as both the groups come from vastly different epistemic background. While the researchers were more interested on testing innovative method to generate distinct insights and contribute to the wider literature through by documenting and analysing the process, municipal authorities had expectation on generating direct impact to their policy and practices. It took quite a bit of efforts and deliberation among researchers and stakeholders to provide the shape to the *Pani Chautari* process. Similarly, the municipal priorities fall on physical development rather than the institutional solutions. Hence, initially, it took some effort for convincing the stakeholders including municipality to be a part of *Pani Chautari* process as they were not convinced that simply discussion would lead to positive changes in water governance.

The cycle of *Pani Chautari* faced additional challenges while dealing with contested issues, such as upstream -downstream relations. Identifying issue specific participants, bringing them into this process and requesting for their voluntary contributions have been quite challenging. Also strictly maintaining neutrality by researchers and moderator during the discussion on contested issues is not an easy task. Another challenge we faced in this process specifically during stakeholder dialogue phase, was retaining the busy stakeholders for the full duration of the event. Mainly after the local government election, elected municipal representatives were extremely busy on establishing new federal system hence they had limited time to allocate to the specific deliberations. This has sometimes affected on drawing conclusion of dialogue and ways forward. Further, translating evidence generated by research into vernacular language is also challenging. Additionally, the highly technical and sophisticated solutions against the issues are beyond the capacity of municipality. Hence, making solutions simple, easier and cost effective requires greater efforts.

## 5. *PANI CHAUTARI* OUTCOMES

The series of *Pani Chautari* conducted in Dhulikhel has contributed to different aspects of water management in the town. Each cycle has contributed either to the municipal planning and policy process or to initiate new approaches and activities for efficient water management. Several technical and institutional solutions for the water related problems have emerged. Some of these solutions are being implemented by the municipal leadership. In this section, we provide a brief overview of the contribution of *Pani Chautari* in water security of Dhulikhel.

### 5.1. Internalization of evidence based policy making among municipal authorities

The municipality has started appreciating the practices of using data, evidence and cases in the municipal policy processes. The practices of evidence informed dialogue followed by policy making through *Pani Chautari* series have led to the realization in municipality regarding the value of evidence in policy making. For instance, our experimentation of recharge ponds to revive small springs in Dhulikhel has generated good evidence which has been useful for its upscaling policy. With this, the municipality has increasingly expanded its interest on research and critical insights in water management even on other aspects of municipal development. For example, the Mayor and his team are requesting researchers for conducting assessment of ground water condition in the town. The municipality is also promoting research often with its own resources to generate knowledge for policy making. This clearly reveals that Dhulikhel has appreciated the value of evidence in policy making process through research and engagement.

### 5.2. Promoting innovation in water management

The Municipality and water users have started using efficient and cost effective technologies for water management. Larger water users in the town have been benefited from the *Pani Chaiutari* series which made them aware of rainwater harvesting and its technical and financial aspects, gray water recycling and reuse. With this, the

municipality has provisioned subsidies to the users who install rainwater harvesting system and the hotels and industries to recycle and reuse water. Similarly, the larger water users (eg. Banquet and catering services) are now exploring efficient water management technologies in their businesses (Shrestha et al., 2019).

Similarly, Dhulikhel municipality started piloting recharge ponds and contour trenches to revive drying springs. The municipality, water user committees and experts from SIAS collaborated to pilot this activity in the nearby forest in the catchment where ten springs are tapped to supply water to the town. The monthly data of spring measurement from April 2017 till May 2020 showed that the series of recharge ponds and contour trenches have gradually contributed towards the increase in volume of water in the local springs.[1] Details of these ponds and their contribution to recharge the ground water are explained in chapter 9 of this book by Shrestha et al., 2021 and also available at Devkota et al. (2019). These results have encouraged the municipality to upscale and outscale these activities to the wider area of the town.

## 5.3. Fostering collaboration with key stakeholders

*Pani Chautari* series brought multiple stakeholders together to discuss the water related issues. In addition, the collaboration among stakeholders from forestry, irrigation, soil conservation and private sectors have been strengthened. One of the forest officer shared, "this sort of collaboration has contributed to avoid duplication in activities and create synergies between environment conservation works of municipality and District Forest Office." Similarly, the private sectors like hotels, industries and Small and Micro Enterprises (SMEs) in Dhulikhel have started collaborating with municipality for efficient water management and watershed conservation. Their joint declaration to contribute to the water management of the town from fourth *Pani Chautari* series clearly reveals that *Pani Chautari* has contributed to bring private sector and the local government into a single platform. In this declaration, while the municipality expressed its commitment on up-taking

1. The forest is the source areas where more than 10 small springs are being tapped into the water supply system of the town

research into policy and providing subsidies to the industries, Hotel Association and Chamber of Commerce were committed to invest on water-efficient technologies to run their businesses and contribute to the sustainability of water sources.

## 5.4. Facilitating up and downstream relations for sustainable water management

*Pani Chautari* is contributing to take the prolonged contestation between Dhulikhel and Bhumedanda (the upstream community) from where Dhulikhel brings water to the logical end. *Pani Chautari* brought together the key stakeholders of both communities together to discuss and resolve the ongoing contestation. A collaborative environment was created in the forum wherein the upstream community and decision-making authorities expressed their commitment on conserving the water sources while the downstream authorities promised to continue support to upstream users in the best possible ways. One of the institutional mechanisms proposed in the forum was forming a 'Water Council'. The idea of the Water Council was proposed as a formally authorized as well as institutionally and technically capable and socially inclusive institution. Water Council is conceived to help facilitate amicable relations between people from source and supply region and sustainably manage the water sources.

## 5.5. Providing an opportunity of co-learning and capacity building

*Pani Chautari* series has contributed to co-learning and co-creation of knowledge with regular engagement among researchers, policymakers and municipal stakeholders. It has also enhanced the researchers' learnings from stakeholders experiences of water management by gaining in-depth information and knowledge on emerging water-related issues. The research team reflected on the approaches of *Pani Chautari* mainly on the methodological effectiveness, engagement strategy with participants, visual data presentation, gathering selected stakeholders into specific series, identifying action points based on discussion and raising awareness through sharing the best practices from other cities. Overall, our

reflection revealed that the participation of concerned stakeholders and municipal authority in the common platform has facilitated co-learning.

More importantly, the series of engagement with water managers, stakeholders and users have contributed on enhancing their capacities on water management. The series of visual presentations with illustrations and infographs from local data sets and sharing of best practices from global experiences during the discussion event have encouraged local water champions to engage in the issues.

## 6. CONCLUSION

In this chapter, we documented the emergence, process and outcomes of *Pani Chautari* series as a tool to foster evidence based policy. Drawing the insights from *Pani Chautari* series, the chapter stressed that the research and stakeholder dialogue can help enhance effectiveness of policy and practice. The importance of evidence on local level policymaking has been sufficiently realized and taken into the practices in Dhulikhel municipality. Dhulikhel municipality has appreciated the importance of research into policy process. This can be an important lesson to other local government bodies.

The locally elected representatives have remarked on the importance and the benefit of *Pani Chautari* series including the deliberation among stakeholders. Besides, the assurance of continuation of *Pani Chautari* through the Municipality's policy and programs clearly shows that the series has now been institutionalized into the municipal system. However, it is yet to see how the series advances independently with the municipality as the driver. While looking after the initial outcomes, it has been somehow successful to create positive impact in five specific aspects mentioned in the earlier section.

*Pani Chautari* is neither an alternative model of governing water nor a panacea to resolve all problems but the engagement of researchers, community and government representatives have created an innovative model of involving users and stakeholders in

planning and policymaking. The reflective dialogues among them support to develop locally appropriate strategies on managing water stresses. This has contributed towards strengthening capacity of city level water champions, enhance collaborations and foster innovations. Though this initiative was piloted in the urban water sector in some towns, the procedural approach, overall insights, and lessons are highly useful to wider sectors and across different levels. The series of *Pani Chautari* held in Dhulikhel revealed that it has become a complete cycle of policy process that provides opportunities for several water stakeholders to get new insights, put views regarding their agendas, openly discuss and contest with the arguments and explore the solutions collectively. Overall, *Pani Chautari* has contributed on expanding the deliberative space at the municipal level and has positively contributed towards the policy learning culture among water stakeholders.

## REFERENCES

Akhmouch, A. and Clavreul, D., 2016. Stakeholder engagement for inclusive water governance: "Practicing what we preach" with the OECD water governance initiative. *Water*, 8(5), p.204.

Bartel, R. and Bricknell, S., 2016. Researchers and practitioners: Building collaboration for evidence-based policy-making. In Environmental crime and collaborative state intervention (pp. 213-235). Palgrave Macmillan, London.

Bhattarai, B., Neupane, K., Devkota, K., Upadhyaya, R. and Ojha, H., 2020. *Reducing gender inequality in urban water management in Nepal.* Policy Brief. Southasia Institute of Advanced Studies, Kathmandu.

Davies, P.T., 1999. What is evidence-based education? *British Journal of Educational Studies*, 47(2), pp.108– 121.

Dente, B., 2011. *Le decisioni di policy*. Bologna: Il Mulino. (In Italian).

Devkota, K., Khatri, D. and Neupane, K.R., 2019. Water conflicts in urbanising regions in the Himalaya: Case studies from Dhulikhel and Bidur in Nepal. *New Angle: Nepal Journal of Social Science and Public Policy*, 5(1), pp.49-73.

Dhimal, M., Pandey, A.R., Aryal, K.K., Subedi, M. and Karki, K.B., 2016. *Translation of health research evidence into policy and planning in Nepal: An appraisal 2016*. Nepal Health Research Council.

Head, B.W., 2010. Water policy—evidence, learning and the governance of uncertainty. *Policy and Society,* 29(2), pp.171-180.

Figueiredo Nascimento, S., Cuccillato, E., Schade, S. and Guimarães Pereira, A., 2016. *Citizen engagement in science and policy-making*. Luxembourg: Publications Office of the European Union.

Ojha, H., Regmi, U., Shrestha, K.K., Paudel, N.S., Amatya, S.M., Zwi, A.B., Nuberg, I., Cedamon, E. and Banjade, M.R., 2019. Improving science-policy interface: Lessons from the policy lab methodology in Nepal's community forest governance. *Forest Policy and Economics*, p.101997.

Ojha, H.R., Paudel, N.S., Khatri, D.B. and Bishwokarma, D., 2012. Can policy learning be catalyzed? Ban Chautari experiment in Nepal's forestry sector. *Journal of Forest and Livelihood*, *10*(1), pp.1-27.

Shrestha, K.K. and Mahjabeen, Z., 2011. Civic science, community participation and planning for knowledge-based development: Analysis of Sydney Metropolitan Strategy. *International Journal of Knowledge-Based Development*, *2*(4), pp.412-432.

Shrestha, S., Pandey, CL., Ojha, H.R., Neupane, K.R., Devkota, K., Bajracharya, R.M. and Dahal, N., 2019. *Understanding engagement of private sector in urban water management*. Policy Brief. Southasia Institute of Advanced Studies, Kathmandu.

Sutcliffe, S. & Court, J., 2005. Evidence-based policy making: What is it? How does it work? What relevance for developing country? London: Overseas Development Institute.

# 9

# Application of Recharge Ponds for Water Management: Explaining from Nature Based Solution Perspective

**Suchita Shrestha, Kamal Devkota, Ngamindra Dahal and Kaustuv Raj Neupane**

## SUMMARY

*Growing urbanization along with the impact of climate change are the prominent reasons contributing to the increasing water scarcity situation in Himalayan towns. There are several emerging alternative solutions to traditional grey infrastructure to address the challenges of water scarcity. However, city government who are more familiar with hard engineering infrastructures does not seem to adopt them widely. In this chapter, we present the case of Dhulikhel municipality that promoted water recharge ponds and contour trenches to improve the ground water recharge and revive drying springs. We present the insights based on the experiential learning during participatory action research conducted from 2016 to 2019. Data were gathered from water forums, stakeholder meetings and field observation. We explained that the approach and technology that was implemented in the study site is principally aligned to the emerging concept of nature-based solution (NbS). The analysis showed that the implementation of the solution follows a cyclical and consultative process where both the local stakeholders and experts continuously learn and co-produce knowledge and co-design the context-specific nature-based solutions. The implementation framework that organically emerged from the process has practical implications to operationalize the 'concept' of NbS into successful 'action' towards sustainable water resource management in Himalayan towns.*

## 1. INTRODUCTION

As cities grow the range of interconnected pressures, such as land-use change, loss or degradation of natural areas, competing demand of water, soil sealing due to the densification of built-up areas disrupts the functionality of the ecosystem – all contributing to the water stress (Kabisch et al., 2017). Water related challenges are more pronounced in the urban centers of the Himalayan region. These centers are vulnerable to water stress because of unplanned and unsustainable urbanization trend coupled with inherent geographical fragility, less adaptive capacity and weak water governance system (Chu et al., 2016; Devkota, 2018; Singh et al., 2020). Evidently, local government are struggling to cater the service of rapidly growing demand of clean drinking water of its citizens. Small and medium sized towns with limited provision of access to safe drinking water and waste water treatment will have to withstand the worst of future urbanization growth (UNHabitat, 2006). In addition, the impact of climate change can further aggravate water related challenges due to increasing temperature, disproportionate distribution of rainfall and the probability of more extreme events such as drought and flooding (Vinke et al., 2017).

Emerging towns across the hilly regions of Nepal traditionally rely on springs, streams and rivers in the catchments surrounding them for drinking water (Devkota and Neupane, 2018). These towns are reeling under the water crisis as local springs and streams are either vanished or are in the brink of extinction (Poudel and Duex, 2017). Changing rainfall patterns, increasing dry spell, unsustainable extraction of aquifer water coupled with unplanned road construction are said to be some of the driving factors for drying of these sources (DoLIDAR, 2013; Shrestha et. al., 2017; Gurung et al., 2019).

One of the examples of growing cities in Nepal is Dhulikhel Municipality. Because of its unique geographic and cultural features, over the decade, the landscape of Dhulikhel has changed significantly and is continuing to change. Eventually, concrete buildings and other infrastructure is slowly taking space of field or forest, open spaces are being narrowed to pocket parks and the hills in the proximity are turning into holiday spots cladded with luxury hotels. Such rapid transitioning from rural to urbanscape, has

indisputably brought tremendous economic opportunities and transformed the quality of lives but the problem of resource depletion, environmental degradation, and disruption in ecological functions are also being felt simultaneously. Though the magnitude of the urbanization in Dhulikhel is not as higher as other bigger cities in Nepal, one of the various manifestations of impacts of urbanization is already evident broadly in the form of – water scarcity and specifically as – drying of springs around the hills. Once regarded as municipality with one of the best community managed water supply systems of the country, Dhulikhel is struggling to fulfill water demand of city dwellers.

As a response to the increasing water scarcity, the municipality has been traditionally opting for grey or hard engineering infrastructure solutions. These conventional engineering solutions may solve the problem of water scarcity for short-term, but are energy-intensive with larger investment requirements and a greater impact on ecosystem functions (Sonneveld et al., 2018). Moreover, it has also been argued that this built infrastructure alone cannot keep up with future water security and resilience against predicted climate change impacts (Ozment et al., 2015). Thus, considering complex environmental and social issues, the focus is being gradually shifted from technocratic to alternative methods such as Nature based Solutions (NbS) that may not require major new engineering construction or work in parallel with grey infrastructure (UNWater, 2018). NbS is an emerging concept that is gaining attention as an alternative and/or complementary solutions for addressing water management problems more cost-effectively and sustainably (UN Environment-DHI, UN Environment and IUCN, 2018). However, city governments do not seem to adopt these alternative solutions as widely and willingly as infrastructure projects as these solutions might take relatively more time to have immediate impacts and also political, institutional and knowledge-related barriers exist (Sarabi et al., 2020).

In this chapter, we present our insights of action research in Dhulikhel municipality, focusing on exploration and application of climate adaptive, socially inclusive, resource-efficient and ecologically sustainable solutions to address water scarcity. We draw the major lessons while identifying and implementing this

alternative water management practices and hence offer a framework to operationalize and mainstream those practices in the similar contexts. We also explained that our intervention underlies within the concept of NbS. The information and data were gathered from several multistakeholder consultations through *Pani Chautari* (see Chapter 8 of this book by Devkota et al., 2021), meetings with the municipal government and water users committee and field observation.

The chapter is organized as follows. In section 2, we will present the detailed case of Dhulikhel municipality including the emergence of water issues, design and implementation of solution that is more climate adaptive and socially inclusive based on the reflection of the action research. Then, in section 3, we discuss that the technology we adopted and the approach of our implementation resonate the emerging idea of nature-based solution and offer the implementation framework. We, thereby, conclude in section 4 by drawing key lessons.

## 2. EXPLORING AN ALTERNATIVE APPROACH FOR WATER MANAGEMENT

To deal with the increasing problem of water scarcity, Dhulikhel municipality has already been adopting various engineering solutions such as drilling sub-surface to extract water from deep aquifers, lifting surface water from the river and diverting water from other watershed several kilometers away from the town. These infrastructure projects fulfill the immediate needs of water supply but are often costly, unsustainable and are impacted by climate variability such as damage of the pipeline of the system by flood/landslide.

In the action research project, we targeted to identify innovative Climate Adaptive and Socially Inclusive Plans and Strategies to address the burgeoning issues of water scarcity. Based on the reflection of the pilot study, here, we will elaborate the processes we adopted in the simplified steps.

## 2.1 Assess and Design

We adopted multistakeholder forums to assess the major local issues within the drinking water management and design the innovative climate adaptive and socially inclusive solution. During a city scale inception workshop, the stakeholder suggested to create a common platform where they could come together to discuss on the water management problem and find the strategies to solve them and hence the concept of *Pani Chautari* forum emerged. Later this forum was organized in series to identify and prioritise problems and design solution. A rapid assessment to determine the feasibility of the said solution was done before piloting.

### Identify problem

An institutional setting of *Pani Chautari* provided the platform for collective learning among researchers and stakeholders supporting in planning and managing complex problems of water scarcity. Representatives from government, civil society, private sector and local community representatives from users' committees and women's group participated ensuring inputs of knowledge from diverse stakeholders. Researchers facilitated the forum with diagnostic questions making the dialogue more systematic and interactive. To instigate the discussion, researchers also shared the current available knowledge on impact of climate change on water resources, gender perspective of urban water management, water and urbanization, and overview on currently constructed water supply project.

Intensive participatory discussion and exercise done with the stakeholders was vital to understand the complexities, challenges and opportunities of water management practices in Dhulikhel. The sectoral group division of the participants within the workshop helped to make an individual 'divergent' thinking into a 'convergent' thinking' (Pagano et al., 2019) and later on the release of the 'declaration paper' as a common agenda of the workshop also helped to build consensus among various understanding and interests. Participants prioritised – declining water volume from local springs – as one of the most crucial water related problems of the town. Therefore, a mutual dialogue among the stakeholders instead of

conventional one-directional transfer of expert knowledge was found vital for information production as well as exchange in response to complex environmental challenges (Pahl-Wostl, 2002).

## Design solution

On the basis of series of discussion and knowledge exchange among stakeholders and researchers, we collectively identified and prioritised, "constructing recharge ponds" as the most appropriate intervention to revive drying springs. During the process, knowledge from diverse stakeholder about the recharge ponds was assessed and diagnosed. First, the stakeholders highlighted the traditional knowledge of how people used to construct ponds for religious, irrigation or other domestic purposes. Those ponds played key role to recharge local aquifers but over the years, those ponds have started to vanish drastically as people started relying less on those ponds because of declinement of livestock and the availability of a piped water supply system. Second, the assessment conducted by Dhulikhel municipality on the ground water potentials also recommended the installation of water recharge ponds as mitigation measures of proposed deep boring projects. Third, a collective field observation to Dapcha, a neighboring village where the traditional ponds were revitalised to revive local springs also reinforced the idea of "recharge pond" as the promising solution for spring revitalisation.

## Feasibility study

As the consensus were being built upon the "recharge pond" construction, a team of experts including soil scientist, watershed expert, along with water resource engineer working in Dhulikhel conducted a rapid hydrogeological study in the Thuloban of Dhulikhel. The team visited watershed area to examine the basic geological structure, drainage configuration, catchment area and identify locations for recharge pond construction. The design and location of ponds within the watershed were determined considering three important factors: runoff collection, drainage channels and safe disposal of excess water. A micro catchment map (Figure 1) of the identified drying springs with catchment boundaries and discharge channels were developed to check the drainage flow of rain

water and to locate the potential recharge areas. Figure 2 shows the location of springs and the potential recharge area within the forest cover. As the purpose of recharge ponds was envisioned to augment the groundwater so the location of pond was determined to be inside the forest at higher elevations away from the settlement area.

The national guideline provided by Department of Local Infrastructure Development and Agriculture Roads (DoLIDAR) for recharge pond construction was followed for the recharge ponds construction. Three types of recharge ponds, namely, excavated ponds, embankment ponds and contour trenches were found suitable for the topographical feature. An excavated pond is generally built on ridge of the hill where flat area is available whereas embankment pond is built without excavation by building a stone masonry or earthen dam to impound flowing water in a stream or on gently sloping gully. Contour trenches are ditches dug along a hillside to check the runoff on the slope (DoLIDAR, 2013).

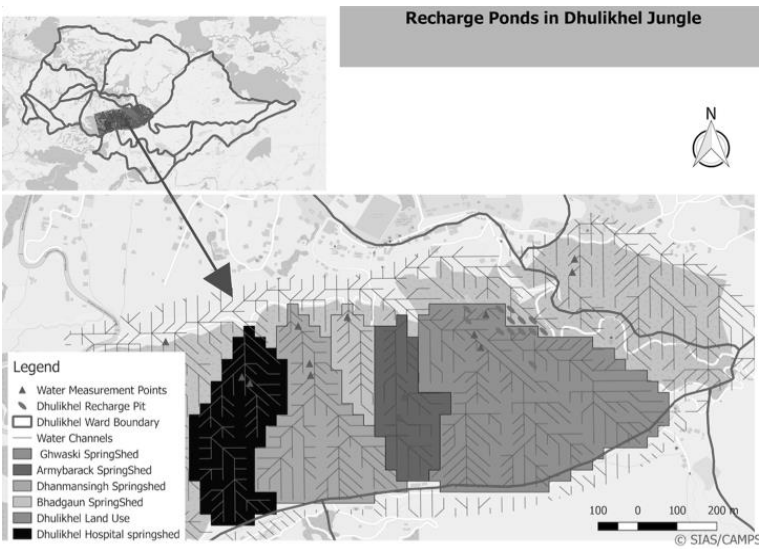


**Figure 1** Map of micro catchment and recharge ponds located in Thuloban, Dhulikhel

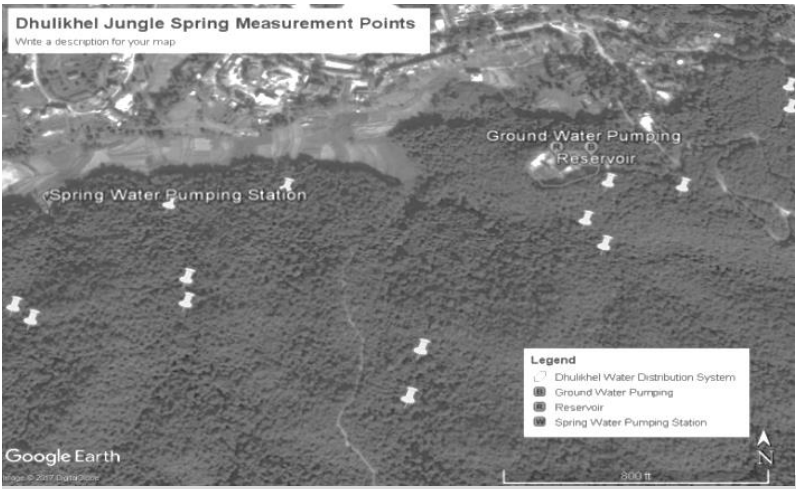


**Figure 2** Locations of spring monitoring points in Thuloban, Dhulikhel

## 2.2. Piloting

After the identification and feasibility study of the potential of recharge ponds on augmenting spring discharge, the recharge ponds were built at piloting scale. The piloting allowed assessing what works and what not in the local context and allowed innovation. During pilot, the concept was demonstrated on the ground which provided an opportunity to assess the immediate effect of the solution, collaborate with institutions and estimate the cost and explore financing possibilities.

### Demonstration

A combination of "recharge ponds" and " contour trenches" was deployed according to the geographical condition of the site. Altogether 64 small-scale ponds ranging from 3.45 $m^3$ to 35.69 $m^3$ were constructed in two phases at terraces of hills to cover a wider area as a recharge zone. The shapes of ponds were varied according to the location – from rectangle, circular and oval. Though the length and the breadth of the ponds were determined according to the location, the height of the ponds were constantly maintained less than 2m for the safety purpose. In some cases, network of ponds

was formed by joining three or four ponds located at similar contour lines by the means of trenches that allowed to flow runoff from one pond to another within the cluster. Besides immediate runoff from the catchment, the overflow from the ponds network from the upper terrace is collected by the network of ponds situated at lower terrace. In addition, few recharge ponds were single without connection to suite the geographical location. Bottom of ponds were left unlined to allow infiltration. All ponds were tagged with number for identification to monitor the pond. The piloting phase contributed in enhancing the confidence level of stakeholders by generating evidence on effects, the idea of the cost incurred and the possibility of any negative impact on the society and environment.

## Assessment of effects

A continuous monitoring mechanism was set to measure the discharge of the springs using a simple bucket method[1] to test the correlation between recharge ponds and spring flow. The spring discharge of ten selected local springs and streams below the recharge pond constructed area were monitored once a month (twice a month during monsoon) from May 2017 till Jan 2020. For this, a local person was trained to measure the springs, keep records and send us the data. Figure 3 shows a time series data of average monthly discharge with a linear trend line for the given period indicating a low but gradual increment of water flow from these sources. As this spring hydrograph has discharge peaks immediately after rainfall events, these 10 springs have rapid flow systems which means that these aquifers are generally unable to store water for long periods.

1 Bucket method: The bucket method is a simple way of measuring flow in very small streams. The entire flow is diverted into a bucket and the time for the container to fill is recorded. The flow rate is obtained simply by dividing the volume of the container by the filling time.

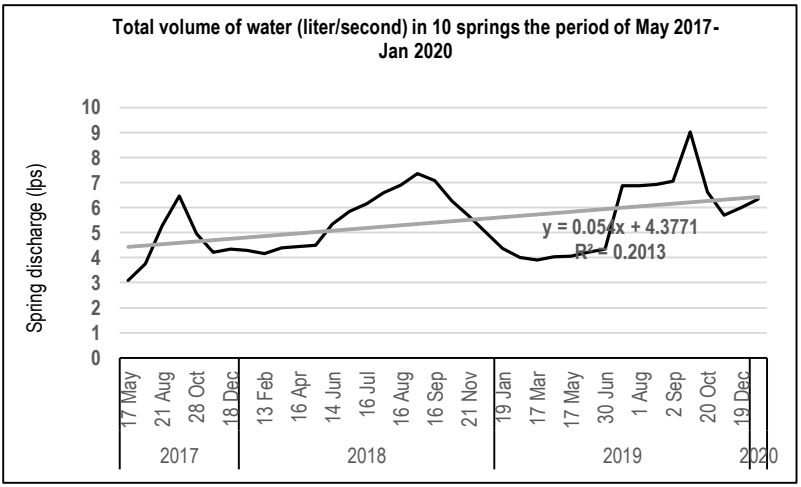


**Figure 3** Trend of water discharge in the springs

The evidences generated by the monitoring revealed that there has been a gradual increment of water volume in the springs over the time. The graph in figure 3 clearly shows that there are seasonal fluctuations of the discharge, however, if we compare the yearly peak discharge then there is a gradual increase from 6.4 litre per second (lps), 7.3 lps to 9.0 lps on 2017, 2018 and 2019 respectively. In addition, the nature of peak discharge has also changed from 'abrupt' in the year 2017 to 'steady' in the year 2018 and 2019 depicted by the area under each hydrograph. The area implies the volume of discharged water for the recording period which is comparatively larger in following years of 2018 and 2019 than on the pilot year of 2017. While it may not be possible to attribute the increased volume of discharge entirely to the recharge pond-contour trench network, it is likely that the increment in the flow of spring discharge in the following years of intervention has been contributed by recharge ponds construction. This evidence created a strong base for stakeholders to realise the importance of recharge ponds and to upscale the idea to landscape level.

## Partnership for implementation

The *Pani Chautari* created a conducive environment for the possible partnerships and collaboration with relevant stakeholders for

implementing the solutions. In our site, Dhulikhel Municipality and Dhulikhel Drinking Water Supply and Sanitation Users Committee (DDWSUC), institutions actively engaged on the process of *Pani Chautari* from early on, also got ready for the financial contribution and provided institutional support for sustainable management of the interventions from the beginning. Hence, in Dhulikhel case, the existing institutional set up played a vital role in owning the process as well as pilot action and thus operation and maintenance of recharge ponds in future was secured.

> Dhulikhel will exploit its potential springs for augmenting water supply in future and therefore its proper utilization and conservation is of high priority for us. Hence the recharge pond concept is appropriate for conserving these springs. More recharge ponds need to be constructed in the surrounding hills of Dhulikhel (Deputy Mayor, Dhulikhel Water Forum V, 30th April 2019).

Because the major objective of the current intervention was to augment spring flow without other direct co-benefits such as recreation or livelihood enhancement, therefore the scope of collaboration with other institutions were found less in this particular case. Nevertheless, consultation was done with the representative of Division Forest Office, District Soil Conservation Office, Gokhureshwor Community Forest Users Committee to construct recharge ponds in the forest premises. Hence, the important role of community forest users community as a provider of the land was found to be crucial for the implementation of the intervention.

We found that the scope of the collaboration depends upon the major objective of the intervention, its type, location, feeling of stewardship of the stakeholders among others. To facilitate the collaboration, multistakeholder engagement process through water forum helped to explore probable institutional collaborators among stakeholders. Other local institutions such as university for knowledge generation, private sector for example hotels and resorts for finance and Nepal army for physical labor contribution were found potential for collaboration but not materialsed during this particular project.

### Cost and financing

Dhulikhel municipality showed their strong willingness to financially contribute to construct the recharge ponds. While municipality agreed to allocate budget into it, DDWSUC made technical and in-kind contributions to construct the recharge ponds. The initial fund from the research project to pilot the action worked as a triggering factor to collect other financial support. On an average, it cost approximately Nepalese rupees 8500 to construct a pond of 7 cubic meters including materials like stone, gabion wire and labor cost (Rai et al., 2019). The first phase of construction was co-financed by Southasia Institute of Advanced Studies (SIAS) and Dhulikhel municipality whereas municipality alone allocated funds for the second phase of ponds construction.

## 2.3. Mainstreaming in municipal policy for scaling up

To up-scale the ponds construction and make it sustainable, Dhulikhel municipality, after the successful piloting of recharge ponds, adopted a policy of promoting recharge ponds. In the municipal policy and programs of the fiscal year 2017/18, the municipality has recognized the benefits of recharge pond. Specifically, it has adopted the policy of revitalizing existing and building new ponds in each municipal ward. For example, "one ward one pond program" considering climate change impact on ground water and small springs has been launched in the fiscal year 2017/2018 with the allocation of NPR 5 million. Additionally, NPR 2 million was allocated. NRs. 1.16 million[2] budget was allocated for the water resources (springs wells, ponds and stone spouts) conservation and management activities for the fiscal year 2017/18. Further, municipality is planning to adopt a public private partnership approach to build recharge ponds integrating component of tourism and livelihood.

> Municipality is happy to adopt the appropriate policy provision recommended by Dhulikhel Water Forum on sustainable water management of the city. Municipality will definitely take

2 https://dhulikhelmun.gov.np/sites/dhulikhelmun.gov.np/files/स्वीकृत%20बजेट%20तथा%20कार्यक्रमहरु%20...pdf

> ownership of such policy based on empirical research. Moreover, municipality is willing to make water security policy for which such initiative plays an important role. (Executive Officer, Dhulikhel Water Forum II, 10th February, 2017)

> Similar to how we recharge our mobile phone, if we recharge the ground water, it will contribute to revitalize local springs. With the technical support from SIAS, municipality has already built 70-72 recharge ponds in the Thuloban forest which will be further upscaled in other appropriate locations. Municipality has plans to promote existing traditional wells and ponds that contribute to recharge ground water for which we have allocated budget (Mayor, Dhulikhel Water Forum VI, 11th March, 2020).

On the planning and budget document of the fiscal year 2020/2021, it has been mentioned that Dhulikhel municipality will continue multistakeholder engagement through water forums, build recharge ponds and implement other conservation measures to ensure sustainable use of water resources (Dhulikhel Municipality, 2020)

## 2.4 Monitoring and feedback

Monitoring mechanism at two different levels – one of overall process and another of the ground action – were deemed necessary for checking the effectiveness over time and for the adaptive management of the intervention. For the ground action monitoring, the regular monthly monitoring of the discharge of the spring (figure 3) was continued. In our case, the yearly maintenance of the constructed recharge pond was found to be essential, as over the months, soil is accumulated in the ponds decreasing its original capacity to hold the rainwater. Therefore, a low cost maintenance was done to keep intact the performance of the recharge pond. For the long term monitoring and maintenance, local institutions ownership and collaboration is the must. Otherwise, it might be affected by the limited availability of funds, less prioritised by the stakeholders and sometimes also the lack of clarity on how long monitoring should be undertaken.

Besides, to reflect on the overall process and drawing the lessons learnt from the practice and policies implemented on ground was found to be the key for making improvements and adjustments to upscale these solutions on the landscape level. For this, *Pani Chautari* itself worked as a forum for internal reflection and feedback loops from wider stakeholders. The municipality and SIAS co-hosted *Pani Chautari* for review and self-reflection of these initiatives. Our reflection revealed that, we have been able to consolidate the scattered activities of water management through the *Pani Chautari* and document the lessons for future references. These sort of initiatives have fostered the collaboration among multiple stakeholders and create innovation for city specific water management strategies.

## 3. EXPLAINING THE INTERVENTION AS NATURE-BASED SOLUTION

Based on the process of learning and engagement with multiple stakeholders in Dhulikhel described in the above sections, we tried to summarize those steps into a simplified cyclical framework (Figure 4) with the four major steps – (i) **Assess** problem and **Design** solution (ii) **Pilot** testing (iii) **Mainstream** in policy for scaling up, and (iv) **Monitoring** for feedback and readjustments. The figure demonstrates that the overall process of identifying the major (water) issue, selecting locally attuned solutions, implementing and getting the space in the policy provisions was not simply linear rather it was an iterative process that needed continuous engagement among local stakeholders and researchers. First, we assessed the problems by engaging all the relevant actors, identified solutions through more inclusive, participatory and partnership approaches and studied feasibility. Secondly, we experimented the proposed solutions through pilot testing. During pilot, we collaborated with local government and other local institutions for co-financing and other institutional support. As an outcome of the regular engagement, prioritizing the local issue and demonstrating the solution supported us in mainstreaming the initiatives in municipal policy. With the consideration of complex and changing nature of landscape, the regular monitoring of the performance of the adopted

solution and the regular consultation with the governing institutions was done for a feedback loop to redesign the practice, or to work on new policies if needed.

We found that our experience of implementation of climate adaptive solution that promotes sustainability of nature as well as addresses societal challenge is conceptually the closest ally with the emerging global idea of NbS. The cyclical implementation framework (Fig 4) emerged from the case study has been proposed as the NbS implementation framework that puts multistakeholder engagement and ecological based solutions at its heart.

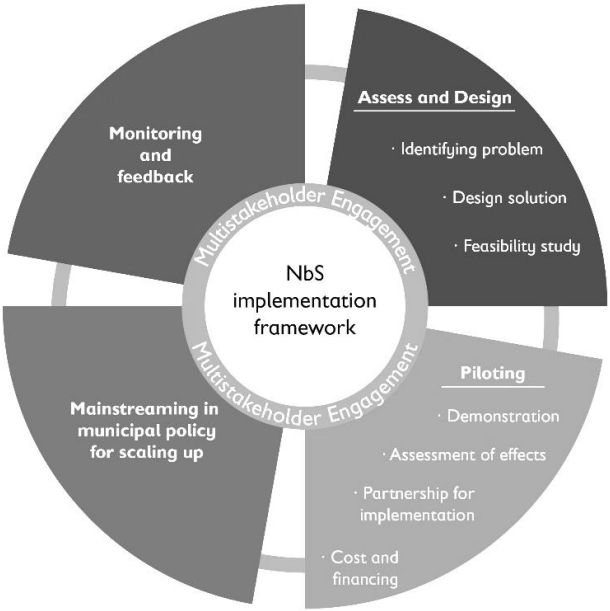


**Figure 4** Proposed NbS implementation framework

As mentioned earlier, NbS is a concept that covers a range of ecosystem-based approaches and offers multitude of other benefits such as improvement on human well-being and biodiversity conservation and even improve stakeholder and community engagement. NbS are "actions which are inspired by, supported by or copied from nature to address societal challenges while providing

multiple benefits and co-benefits" (European Comission, 2015). Conceptually, NbS considers local context (Cohen-Shacham et al., 2019) and the existence of a plurality of human perspectives on the understanding of environmental problems and solutions (Vasseur et al., 2017). Hence, the multistakeholder approach is preferred to integrate diverse types and systems of knowledge and values (Raymond et al., 2017) fostering the social innovation (Biggs et al., 2010) during the identification of the problem, solution, its implementation and beyond. In our case, as the project targeted to innovate "climate adaptive water management practices and policies" to address increasing water insecurity, the multistakeholder platform majorly *Pani Chautari* was used as a common platform for discussing and prioritizing issues, similar with the approach of NbS. The forum allowed a conducive environment of collecting substantial input from different stakeholders perspective and knowledge including traditional and local, institutional as well as emerging scientific knowledge that were crucial for determining and prioritizing the site-specific problem and locally suitable solution. In doing so, the (multistakeholder) approach during the implementation of the climate adaptive solution, as in NbS, helped to make the whole process socially accepted, increased inclusiveness and legitimise (Nesshover et al., 2017).

In terms of practice, NbS use nature for tackling challenges such as climate change and water resources management. Specifically, in the urban areas, NbS are being used for addressing water management issues by harnessing three functions of ecosystem – water supply regulation, water quality regulation and moderate extreme climate events (UN Environment-DHI, UN Environment and IUCN, 2018). In relation to mitigate the drying springs, the technology of the recharge system constructed in our study site has used the nature-based solution to enhance the natural process of infiltration. Similar to NbS, our intervention promotes the use of ecosystems (Canals and Lázaro, 2019) to address the challenge of the declining state of water supply of the town. Several ponds and trenches made, as piloting, at the surface of the recharge zone worked as extra pockets to store surface runoff. This helped in providing water for longer period and thus enhanced percolation

rate depicted in the Figure 3 boosting the replenishment of the underlying aquifers and hence increasing the spring yield. The piloting was found to be an important step in order to demonstrate among city stakeholders the localized evidence of the efficiency of natural systems and the economic viability as described by Cohen-Shachamet al. (2019) for NbS pilot. The pilot part of the overall (action) research increased the level of trust (Frantzeskaki, 2019) and ownership (Raymond et al., 2017) of the stakeholders involved.

In contrast with hard engineering solutions, NbS is affordable and offers multitude of co-benefits (Kabisch et al., 2016). Similarly, we adopted the low cost method among the available options to recharge groundwater with other multiple usages such as maintaining soil moisture for vegetation, store storm water during extreme events reducing downstream flooding and potentially mitigate forest fire. For sustainable management of the solution, we collaborated with municipality and DDWSUC from the beginning and we also tried to make partnerships with other institution in the process. Institutional collaboration amongst different policy areas, sectors and stakeholders enables for adoption and sustainability of NbS (van Ham and Climmeck, 2017). Long-term collaboration with both non-profits and policy makers is required to fully operationalizing NbS (The Nature Conservancy, nd). In Dhulikhel case, the partnership with local government created synergies to operationalize climate adaptive solutions in the ground by contributing financially and institutionalizing the practice into policy.

## 4. LESSONS LEARNT AND KEY MESSAGES

In this chapter, we documented the experiences of implementing climate adaptive solution in Dhulikhel Municipality and concluded that the solution, both in practice and in principle, build upon largely on the emerging concept of NbS. In the context of environmental change and the high dominance of modern engineering solutions, NbS as illustrated in the case of Dhulilkhel, is alternative to addressing the issue of declining water yield in the springs. The experiential learning from the implementation of this solution in the real life showed that it follows a cyclical and

consultative process where both the local stakeholders and experts continuously co-produced knowledge and co-designed the context-specific solutions.

Dhulikhel has become an exemplary to lead the piloting of climate adaptive and socially inclusive solution for water management and mainstream it into its planning and policy. Municipalities across the Himalayas, can adopt this sort of implementation framework. Further, the process and initial outcomes of piloting this solution in Dhulikhel has helped in drawing important lessons summarized into three major points (a) engagement, (b) evidence and (c) ownership for the success of any NbS at ground level.

First, the engagement of relevant stakeholders at all stages – from prioritizing the issue of water management to the selection of suitable solution and its implementation is critical. Continuous engagement with technical experts, municipal authorities and local stakeholders helped to bring multiple ideas, address concerns and interest, generate new knowledge, share outcomes from the pilot study and more importantly facilitate the social acceptance.

Second important factor is the solution must be backed up by as much evidences as possible. Ideation, planning, designing, implementing, monitoring and upscaling phases need integration of evidences from both biophysical and social aspects as well as local experiential and traditional knowledge. Regular consultation with local community and sectoral experts, assessment of local context to identify best suitable solutions, feasibility study, local best practices, gathering necessary data of biophysical, economic and social aspects and the assessment of effectiveness are very important. In addition, gradual revisions in the design of the solution and thereby in the municipality level policies and plans with the reflection of monitoring data, experts updated knowledge, institutional learning and feedback of local stakeholders are required.

Third, the ownership of municipal leaders and community is important to build consensus on actions and processes for addressing water management issues. This often require substantive efforts, time, and resources. With ownership, there

comes openness towards acknowledging scientific knowledge and technological innovations and political willingness to translate evidence into policy. Dhulikhel municipality stepped forward to integrate the recharge ponds to municipal planning that ensured the sustainability of the intervention. Not only municipality but also other institutions such as forest department or soil conservation department or private company who can benefit from this approach have owned the process. In that case, inter-departmental ownership, responsibility sharing and resource leverage are essential.

The emerging concept of NbS in Nepal is still on its initial stage though it holds considerable promise to address various societal challenges including water management. There are already some examples but they are implemented on a fragmented and ad hoc basis without systemic interventions. The case of Dhulikhel, presented on this chapter, can be taken as a successful case of NbS in the form of climate adaptive and socially inclusive solution and the lesson learned can be taken into consideration by other municipalities of Nepal in Himalayas to operationalize the 'concept' into successful 'action' to sustain the water security of the area.

## REFERENCES

Biggs, R., Westley, F.R. and Carpenter, S.R., 2010. Navigating the back loop: fostering social innovation and transformation in ecosystem management. *Ecology and Society*, *15*(2).

Canals Ventín, P. and Lázaro Marín, L. 2019. *Towards nature-based solutions in the Mediterranean*. IUCN Centre for Mediterranean Cooperation, Spain.

Chu, E., Anguelovski, I. and Carmin, J., 2016. Inclusive approaches to urban climate adaptation planning and implementation in the Global South. *Climate Policy*, *16*(3), pp.372-392.

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C.R., Renaud, F.G. and Welling, R., 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. *Environmental Science & Policy*, 98, pp.20-29.

Devkota, K., 2018. Challenges of inclusive urbanization in the face of political transition in Nepal. In: *Handbook of research on urban governance and management in the developing world*, pp. 159-171, IGI Global.

Devkota, K. and Neupane, K.R., 2018. Water governance in rapidly urbanising small town: A case of Dhulikhel in Nepal. *Journal of Water Security*, *4*.

Dhulikhel municipality, 2020. *Policy, program and budget of the municipality for the FY 2020/21*. Dhulikhel Municipality

GoN, 2013. *Recharge ponds handbook for WASH programme*, DOLIDAR.

European Commission, 2015. *Towards an EU research and innovation policy agenda for nature based solutions & re-naturing cities*. Final report of the Horizon 2020 Expert Group on nature based solutions and re-naturing cities.

Frantzeskaki, N., 2019. Seven lessons for planning nature-based solutions in cities. *Environmental Science & Policy*, *93*, pp.101-111.

Gurung, A., Adhikari, S., Chauhan, R., Thakuri, S., Nakarmi, S., Ghale, S., Dongol, B.S. and Rijal, D., 2019. Water crises in a water-rich country: case studies from rural watersheds of Nepal's mid-hills. *Water Policy*, 21(4), pp.826-847.

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., Haase, D., Knapp, S., Korn, H., Stadler, J. and Zaunberger, K., 2017. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society*, 21(2).

Nesshöver, C., Assmuth, T., Irvine, K.N., Rusch, G.M., Waylen, K.A., Delbaere, B., Haase, D., Jones-Walters, L., Keune, H., Kovacs, E. and Krauze, K., 2017. The science, policy and practice of nature-based solutions: An interdisciplinary perspective. *Science of the Total Environment*, 579, pp.1215-1227.

Ozment, S., DiFrancesco, K. and Gartner, T., 2015. *The role of natural infrastructure in the water, energy and food nexus.* Nexus Dialogue Synthesis Papers. Gland, Switzerland: IUCN.

Pagano, A., Pluchinotta, I., Pengal, P., Cokan, B. and Giordano, R., 2019. Engaging stakeholders in the assessment of NBS effectiveness in flood risk reduction: A participatory System Dynamics Model for benefits and co-benefits evaluation. *Science of The Total Environment*, 690, pp.543-555.

Pahl-Wostl, C., 2002. Towards sustainability in the water sector–The importance of human actors and processes of social learning. *Aquatic Sciences*, 64(4), pp.394-411.

Poudel, D.D. and Duex, T.W., 2017. Vanishing springs in nepalese mountains: Assessment of water sources, farmers' perceptions, and climate change adaptation. *Mountain Research and Development*, 37(1), pp.35-46.

Rai, R.K., Neupane, K.R., Bajracharya, R.M., Dahal, N., Shrestha, S. and Devkota, K., 2019. Economics of climate adaptive water management practices in Nepal. *Heliyon,* 5(5), p.e01668.

Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M.R., Geneletti, D. and Calfapietra, C., 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, *77*, pp.15-24.

Sarabi, S., Han, Q., Romme, A.G.L., de Vries, B., Valkenburg, R. and den Ouden, E., 2020. Uptake and implementation of nature-based solutions: An analysis of barriers using interpretive structural modeling. *Journal of Environmental Management*, 270, p.110749.

Shrestha, R., Desai, J., Mukherji, A., Dhakal, M., Kulkarni, H. and Acharya., S. 2017. *Application of eight-step methodology for reviving springs and improving springshed management in the mid-hills of Nepal.* ICIMOD.

Sonneveld, B.G., Merbis, M.D., Alfarra, A., Ünver, O. and Arnal, M.F., 2018. Nature-based solutions for agricultural water management and food security. *FAO Land and Water Discussion Paper*, 12.

Singh, S., Tanvir Hassan, S.M., Hassan, M. and Bharti, N., 2020. Urbanisation and water insecurity in the Hindu Kush Himalaya: Insights from Bangladesh, India, Nepal and Pakistan. *Water Policy*, 22(S1), pp.9-32.

The Nature Conservancy, nd. *Strategies for operationalizing nature-based solutions in the private sector.* The Nature Conservancy Business Council, Natural Infrastructure Working Group.

UN Environment-DHI, UN Environment and IUCN, 2018. Nature-based solutions for water management: A Primer U.S. Environmental Protection Agency, 2003. Protecting water quality from urban runoff. EPA 841-F-03-003. U.S. Environmental Protection Agency, Washington, DC, USA.

United Nations Human Settlements Programme, 2006. Meeting Development Goals in Small Urban Centres: Water and Sanitation in the World's Cities, 2006. UN-HABITAT.

UN Water, 2018. UN World Water Development Report, Nature-based Solutions for Water.

van Ham, C. and Klimmek, H., 2017. Partnerships for nature-based solutions in urban areas–showcasing successful examples. In *Nature-Based Solutions to Climate Change Adaptation in Urban Areas*, pp. 275-289. Springer, Cham.

Vasseur, L., Horning, D., Thornbush, M., Cohen-Shacham, E., Andrade, A., Barrow, E., Edwards, S.R., Wit, P. and Jones, M., 2017. Complex problems and unchallenged solutions: Bringing ecosystem governance to the forefront of the UN sustainable development goals. *Ambio*, *46*(7), pp.731-742.

Vinke, K., Schellnhuber, H.J., Coumou, D., Geiger, T., Glanemann, N., Huber, V., Kropp, J.P., Kriewald, S., Lehmann, J., Levermann, A. and Lobanova, A., 2017. *A region at risk: The human dimensions of climate change in Asia and the Pacific.*