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Editorial
Mapping challenges for adaptive water management in Himalayan towns

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1. Introduction

The Hindu Kush Himalaya (HKH) is characterized by complex topography, climate, hydrology, and hydrogeology. Each of these factors plays an important role in determining the availability of water for people living in the Himalayas (Scott *et al*., 2019). These physical features are also a constraint to rapid urbanization (Mukherji *et al*., 2018). Only 3% of the total HKH population live in larger cities and 8% in smaller towns (Basyal & Khanal, 2001). However, urbanization has increased in recent years with people from rural areas flocking to nearby urban centres in search of employment and other economic opportunities (Bajracharya *et al*., 2019). As a result, the share of urban population is increasing in the region, while that of the rural population is declining. Projections show that by 2050, more than 50% of the population in HKH countries will live in cities (UNDESA, 2014). The unique geophysical situation of mountain cities and towns requires a special approach when conceptualizing water management. Moreover, rapid urbanization has led to new challenges that require a different perspective, a mountain perspective if they are to be solved.

Unplanned urbanization is causing significant changes in land use and land cover and reducing the recharge areas of springs (Jeelani *et al*., 2017; Rani *et al*., 2018; Scott *et al*., 2019; Thakur *et al*., 2019). Climate-induced changes in the physical environment have resulted in increased rainfall variability and heat stress. Extreme rainfall events are leading to more landslides, while an increase in average temperatures has caused glacier melt and subsequent changes in hydrological regimes in the region (Xu *et al*., 2009). These critical stressors – climatic and non-climatic – are adversely affecting the socio-ecology of

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urban agglomerations in the HKH. The encroachment or degradation of natural water bodies and the disappearance of traditional water sources, such as springs, are evident (Sharma *et al.*, 2016). Most towns in the HKH meet their water needs from springs, streams, ponds, and lakes, which are largely interlinked systems, and their degradation and loss is leading to widespread water stress.

The demand for water has increased manifold with growing populations and increased consumption. At the same time, water availability in these towns has been adversely affected by the climatic and socio-economic change. Some towns are also major tourist destinations and host large floating populations during peak tourist season, challenging their carrying capacities (Shah & Kulkarni, 2015; Mondal & Roychowdhury, 2019; Ojha *et al.*, 2019). At such times, residents must cope with water scarcity as demand for water increases and water distribution through the public water supply systems becomes highly inequitable. Inefficient water utilities and governance challenges become much more critical as the sources of water are limited and the local geology hardly supports accessing groundwater unlike in the plains (Dame *et al.*, 2019). All these factors are resulting in increased water insecurity for the poor and marginalized in urban centres across the HKH.

This special issue looks at the challenges of water management in 12 towns from four corners of the Himalayan region. These include, from west to east, Murree and Havelian in Pakistan; Kathmandu, Bharatpur, Tansen, and Damauli in Nepal; Mussoorie, Devprayag, Singtam, Kalimpong, and Darjeeling in India; and Sylhet in Bangladesh (see Figure 1). All these cities face challenges of changing water budgets, increasing demand for water, and water scarcity, which is discussed in the papers. They also map future challenges that these towns will face in a 'business as usual' scenario. These cases draw from primary research and fill an important knowledge gap about the status of water resources and water supply in Himalayan towns. Authored by a multi-disciplinary team consisting of physical and social scientists, anthropologists, geographers, and planners, the papers highlight the concerns

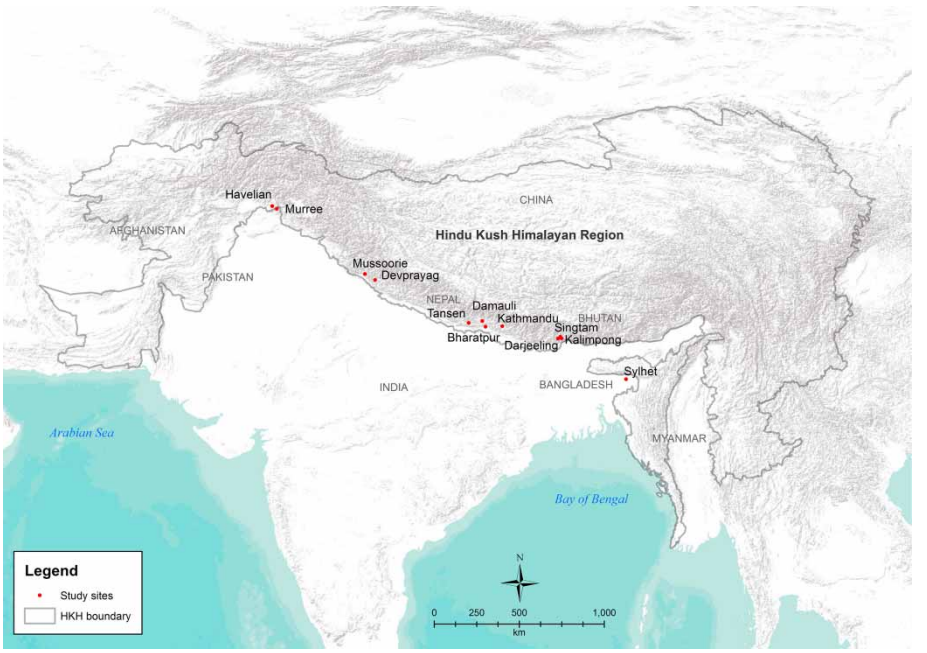

Fig. 1. Case study sites in the HKH region.

around unplanned and haphazard development in the region, which is leading to problems of inequity in water supply and unequal developmental outcomes. They also identify areas for future research and action on urban issues in the region.

2. Key messages from this volume

This special issue adds new findings and reaffirms some of the findings of recent studies on water trends in Himalayan towns. Below, we discuss some of the key concerns and messages emerging from these case studies.

2.1. Urban Himalayas running dry

This volume provides evidence that Himalayan towns are facing increased water insecurity. The review paper by Sreoshi Singh *et al*. (this volume) shows that the interlinkages of water resource availability, resources, water supply systems, rapid urbanization, and consequent increase in water demand (both every day and seasonal) is leading to increased water insecurity in towns in the HKH. The water insecurity is attributed to poor water governance, lack of urban planning, poor tourism management during peak season, and climate-related risks and challenges. Communities are coping via short-term strategies such as groundwater extraction, which is proving to be unsustainable. There is a lack of long-term strategies for water sustainability in urban centres, and this requires special attention by planners and local governments. In a study of two Himalayan towns in Pakistan's Indus River basin, such as Murree and Havelian, Virk *et al*. (this volume) show heavy dependence on groundwater as a primary source of water supply. Estimates of water availability, consumption, and water sufficiency ratio (WSR) reveal that available groundwater is insufficient to meet the requirements for consumption in Havelian. However, in the case of Murree, water availability is sufficient due to recent changes in the infrastructure. There is evidence that water is being mismanaged at the household level in both towns. Factors, such as rapid urbanization and population growth, are will increase the requirements of water in the future.

2.2. Failing governance of water towers

The papers in this volume show that water demand in urban locations is outstripping supply leading to a rise in the privatization of water supply, mostly through water tankers. These private tankers are fulfilling the demand by fetching water from the nearby rural locations, and this sector is largely unregulated. In their paper on understanding water resilience in Himalayan towns, Singh & Pandey (this volume) note that the world's urban population is expected to rise to 68% by 2050 with implications for Himalayan regions as well. Small towns will expand as this growth is expected to be greater in the developing countries. This review paper, based on the number of cases studies, shows that water governance in the HKH region remains a blind spot and challenges pertaining to urban water resilience are poorly understood. Himalayan towns depend on springs that are fed by numerous local aquifers and form the primary means of water supply. The springs also contribute significantly to base flows in Himalayan rivers. Even by gross, conservative estimates, there are more than a million perennial springs in the Indian Himalayan region alone (Shah & Kulkarni, 2015). These springs are under great threat from urban waste and sewage polluting the water bodies and catchments. This volume reaffirms the

findings of other studies that have indicated water quality issues in spring sources. Kumar *et al.* (1997) assessed physico-chemical characteristics of water from 12 springs located within the municipal limits of Almora, a central Indian Himalayan town. It indicated a direct influence of unplanned sewage disposal on spring water quality. Bharti *et al.* (this volume) further reemphasize these points in their study of two other towns in the Indian Himalayan region – Mussoorie and Devprayag. They find that in the current scenario of a changing climate, natural springs, their main water resource, are drying up. Mussoorie experiences an acute shortage of water in summer, precisely when the town hosts numerous tourists. In Devprayag, religious tourism and in-migration from rural areas have contributed to rising demand. The reduced discharge in nearby streams has further widened the demand–supply gap.

2.3. Caste inequalities and water rights

The papers in this volume show that understanding issues of gender and caste are important in cities where individual and household water rights are mediated through the politics of water distribution. Addressing water inequities and insecurities demand research as well as development and policy responses, which means going beyond physical aspects of water management and delving into the social science of how water is distributed. Molden *et al.* (this volume) provide new insights on water security from their case of Kathmandu, the capital of Nepal. Their study of 47 household water managers highlights three dimensions of water security: experiences of water security vary greatly between households over the year; social connections and landownership play an important role in mediating these experiences; and coping with poor water supply places a burden on certain household members. Raina *et al.* (this volume) provide evidence of both horizontal and vertical inequity in Kathmandu's informal water market. This study shows that 20% of Kathmandu's poor households do not have access to the formal water supply system, and they end up paying more for accessing water as compared with the richer households who have access. The study also found that the poor spend a greater proportion of their income on meeting their household water needs which means a much greater financial burden. Rich households spend 38.2% less on the water than poor households. Poorer households stand to gain if the water economy shifts from informal to formal.

2.4. Decentralization and powers to local bodies

An important aspect of urban water management is decentralized governance and the devolution of power to local bodies and institutions managing water. A study of Tansen and Damauli, two small towns in Nepal, by Singh *et al.* (this volume) shows that water institutions have played a very significant role in water supply management at the local level and that proper management can help avert critical water shortages. The paper compares two towns that have different outcomes for water supply and access. In Tansen, infrastructural constraints and large-scale corruption in the systems' upkeep and maintenance have implications on water governance, while in Damauli, the systems have been well managed due to the involvement of local communities. Shah & Badiger (this volume) present the case of Darjeeling in the Indian Himalaya where the water crisis is the result of a conundrum due to the interlinked problems of political unwillingness, insufficient investments, failure of cooperation between the state and regional institutions, and inadequacies in local governance, including institutional capacity. Ghatani (2015) finds similar challenges in Darjeeling. The study reveals that water management can be rational only if the

institutions responsible for such management are efficient. It shows how community participation in the enforcement of rules and regulations on illegal connections, and the misuse of water and optimization of the budget for public utility services has helped in maintaining the service levels although the challenges of access to water persist. Access is a larger issue of investment in water infrastructure and urban planning processes.

2.5. Looming climate risks

This volume reaffirms some of the studies that have indicated that climate risks, such as floods and landslides, are becoming more frequent, and therefore, they must be considered in the urban planning process. In the study of the Himalayan towns of Leh and Dharamshala in India, Sudhakar (2010) found clear linkages between climate change and water scarcity. Water supply in these towns comes from glacier melt. The author presents evidence of changes in the towns' local climate parameters, such as snowfall, rainfall, and temperature, and the hydrology of water bodies, which contribute to the water availability. These changes have caused an imbalance in the demand and supply of water, as the supply is further strained by changes in climatic conditions. The author notes that the response to this is largely supply-driven while adaptive measures are needed in the overall planning process to secure water for urban populations. Tiwari *et al*. (2018) note that expanding urban areas in the high mountains are now serving as centres of growth by creating opportunities for employment and access to services and infrastructure, thereby contributing to the development of their vast hinterlands through the trickle-down effect. However, rapid and unplanned urbanization have impacted the hydrological regimes of Himalayan watersheds – it has reduced groundwater recharge; decreased the availability of water for drinking, sanitation, and crop production; depleted forests and biodiversity; increased risks of natural hazards and disasters, both in urban as well as peri-urban areas; and increased the water, food, livelihood, and health insecurities of mountain communities. Moreover, climate change has stressed urban ecosystems by increasing the frequency, severity and intensity of extreme weather events. Briscoe *et al*. (2006) note that Pakistan's threatened wetlands were part of the drainage system and had averted floods in many cases. Especially in northern Pakistan, these wetlands were part of the flood control system, reducing the impacts of Indus floods while they accommodated water from Indus and torrential hill streams.

Pervin *et al*. (this volume) show how cities in South Asia are experiencing stormwater drainage problems due to a combination of urban sprawl, structural, hydrological, socio-economic, and climatic factors. The frequency of short duration, high-intensity rainfall is expected to increase in the future due to climate change. Given the limited capacity of drainage systems in South Asian cities, urban flooding and waterlogging are expected to intensify. The problems get worse when low-lying areas are filled up for infrastructure development and unplanned urban growth, reducing permeable areas and infiltration. In a study of Sylhet town in Bangladesh and Bharatpur in Nepal, they find that significant areas of both cities are at risk from flooding. With climatic changes, the threats to these areas will increase. The study suggests a number of measures to reduce long-term flooding risk in these cities.

3. Towards adaptive water management for Himalayan towns

From the case studies in this volume, we find that increasing urbanization and changing climate are two critical stressors that are adversely affecting the biophysical environment of urban areas in the HKH.

With development plans and policies focusing more on rural areas, the degradation of urban environments has not been a matter of concern. Across the region, the encroachment and degradation of natural water bodies (springs, ponds, lakes, canals, and rivers) and the disappearance of traditional water systems (such as stone spouts, wells, and local water tanks) are evident. The degradation and reclamation of water bodies affect wetland ecosystems and reduce retention capacities that prevent flooding. Consequently, urban drainage and flood management systems are impaired.

Rapid urbanization and climate change have short- and long-term implications for biophysical and socio-economic environments. Urban waste-water discharge and solid-waste disposal are polluting surface water bodies in urban and peri-urban areas. Waste-water re-use for agriculture, a common practice in peri-urban areas, often ignores potential health hazards and other adverse effects of polluted water. Groundwater is often contaminated with salts, chemicals, iron, and fluoride and characterized by hardness. The case studies point to declining groundwater reserves due to over-exploitation for domestic, industrial, commercial, and agricultural purposes. Groundwater recharge rates are reduced because of low rainfall and interventions in the recharge areas and processes such as sand mining.

The uniqueness in groundwater conditions in the HKH makes it a specific typology. Aquifers feed the springs which are the main water sources for urban and rural areas in the hills and mountains. Springs also contribute to base flows in the streams and rivers. However, there are challenges concerning contamination due to improper waste and sewage treatment and disposal and some aquifers that are recharged from greater distances are impacted by the sinking of wells. The recharge areas of these springs are not well protected because of the absence of such a component in the planning process. Increasing population pressure is also leading to competing claims over water from common aquifers.

The cases studies on water management in Himalayan towns highlight the need for course correction. Together, they indicate that the demand for water is outstripping supply in almost all the towns and the future looks bleak if the 'business as usual' scenario persists. Estimating and planning according to the seasonal carrying capacity of cities, waste management and springshed management are key to meeting future water demands. There is a range of water governance challenges and issues of equity that must be addressed to enhance water security for all.

We focus on five major points that can help in adapting to the issue of water scarcity and the looming crises induced by climate change in Himalayan towns and cities. *First*, we need to source water sustainably to bridge the gap between supply and demand. This could be done by reviving and protecting springs, increased water harvesting, and having multiple sources of water. More budgetary allocations could be made towards the above, so that water sources are protected and managed sustainably. We also found that in many towns, spring water is the only source and is insufficient to meet the needs across all seasons. Therefore, multiple sources of water could be part of the portfolio of the overall water supply for these towns. *Second*, we need to look at the governance and management of water beyond water utilities. Polycentric governance, meaning multiple governing bodies and institutions interacting with one another towards a coherent goal of providing access to water, could be a more suitable way to comprehend water governance in Himalayan towns and cities. *Third*, the equitable distribution of water needs more attention. We have found that the poor and marginalized are most affected when water supply dwindles. Many cities are faced with the challenge of providing access to safe water for the poor especially in the dry season when supply dwindles. *Fourth*, more appreciation is needed for women's multiple roles in water management and how they could be part of the planning and decision-making processes to provide solutions. *Fifth*, mountain cities need to be viewed in the broader context of mountain water, environment, and energy. Climate change impacts on these sectors are

presenting new and growing challenges that Himalayan towns and cities have to grapple with. This volume discusses various choices and options – from demand management to supply enhancement, understanding ecological footprints of towns to managing water at a bioregional scale. In doing so, it is vital to address issues of equity and empower local institutions in managing water. Lastly, the focus for the future must be on building urban resilience by strengthening the adaptive capacities of affected communities while also understanding the limits to adaptation.

References

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

Basyal, G. K. & Khanal, N. R. (2001). Process and characteristics of urbanization in Nepal. *Contribution to Nepalese Studies 28*(2), 187–225.

Briscoe, J., Qamar, U., Contijoch, M., Amir, P. & Blackmore, D. (2006). *Pakistan's Water Economy: Running Dry*. Oxford University Press, Karachi.

Dame, J., Schmidt, S., Müller, J. & Nüsser, M. (2019). Urbanisation and socio-ecological challenges in high mountain towns: insights from Leh (Ladakh), India. *Landscape and Urban Planning 189*, 189–199.

Ghatani, S. (2015). *Sustainable Urban Water Management in Darjeeling*. Doctoral Dissertation, Sikkim University. Available at: http://14.139.206.50:8080/jspui/bitstream/1/3112/1/Suvechha20Ghatani20(Geography).pdf (Accessed 23 November 2019).

Jeelani, G., Shah, R. A., Deshpande, R. D., Fryar, A. E., Perrin, J. & Mukherjee, A. (2017). Distinguishing and estimating recharge to karst springs in snow and glacier dominated mountainous basins of the western Himalaya, India. *Journal of Hydrology 550*, 239–252.

Kumar, K., Rawat, D. S. & Joshi, R. (1997). Chemistry of springwater in Almora, Central Himalaya, India. *Environmental Geology 31*(3–4), 150–156.

Mondal, T. K. & Roychowdhury, P. (2019). Water Scarcity in Himalayan Hill Town: A Study of Darjeeling Municipality, India. In: Ray B. & Shaw R. (eds) *Urban Drought. Disaster Risk Reduction (Methods, Approaches and Practices)*. Springer, Singapore, pp. 363–383.

Mukherji, A., Scott, C., Molden, D. & Maharjan, A. (2018). Megatrends in Hindu Kush Himalaya: Climate Change, Urbanisation and Migration and Their Implications for Water, Energy and Food. In: Biswas, A., Tortajada, C. & Rohner, P. (eds) *Assessing Global Water Megatrends. Water Resources Development and Management*. Springer, Singapore, pp. 125–146.

Ojha, H., Kovacs, E., Devkota, K., Neupane, K. R., Dahal, N. & Vira, B. (2019). Local experts as the champions of water security in the Nepalese town of Dhulikhel. *New Angle: Nepal Journal of Social Science and Public Policy 5*(1), 1–14.

Rani, M., Joshi, H., Kumar, K. & Tiwari, A. (2018). Recharge potential mapping in complex hydrological system of Kosi Basin. *Applications and Challenges of Geospatial Technology: Potential and Future Trends 9*.

Rani, M., Joshi, H., Kumar, K. & Tiwari, A. (2019). Recharge Potential Mapping in Complex Hydrological System of Kosi Basin in the Mid-Himalayan Region. In: *Applications and Challenges of Geospatial Technology*. Springer, Cham, pp. 9–23.

Scott, C. A., Zhang, F., Mukherji, A., Immerzeel, W., Mustafa, D. & Bharati, L. (2019). Water in the Hindu Kush Himalaya. In: Wester, P., Mishra, A., Mukherji, A. & Shrestha, A. (eds) *The Hindu Kush Himalaya Assessment*. Springer, Cham, pp. 257–299.

Shah, M. & Kulkarni, H. (2015). Urban water systems in India. *Economic and Political Weekly 50*(30), 57–69.

Sharma, B., Nepal, S., Gyawali, D., Pokharel, G. S., Wahid, S. M., Mukherji, A., Acharya, S. & Shrestha, A. B. (2016). *Springs, Storage Towers, and Water Conservation in the Midhills of Nepal*. Nepal Water Conservation Foundation and International Center for Mountain Development, ICIMOD Working Paper 2016/3, Kathmandu, Nepal.

Sudhakar, A. A. (2010). *Adaptation to Water Scarcity in Glacier-Dependent Towns of the Indian Himalayas: Impacts, Adaptive Responses, Barriers, and Solutions*. Doctoral Dissertation, Massachusetts Institute of Technology, USA.

Thakur, N., Rishi, M., Keesari, T., Sharma, D. A. & Sinha, U. K. (2019). Assessment of recharge source to springs in upper Beas basin of Kullu region, Himachal Pradesh, India using isotopic signatures. *Journal of Radioanalytical and Nuclear Chemistry* 1–9. https://doi.org/10.1007/s10967-019-06617-3.

Tiwari, P. C., Tiwari, A. & Joshi, B. (2018). Urban growth in Himalaya: understanding the process and options for sustainable development. *Journal of Urban and Regional Studies on Contemporary India 4*(2), 15–27.

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

Xu, J., Grumbine, R. E., Shrestha, A., Eriksson, M., Yang, X., Wang, Y. U. N. & Wilkes, A. (2009). The melting Himalayas: cascading effects of climate change on water, biodiversity, and livelihoods. *Conservation Biology 23*(3), 520–530.