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Urbanisation and water insecurity in the Hindu Kush Himalaya: Insights from Bangladesh, India, Nepal and Pakistan

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Abstract

This paper reviews the interlinkages of critical state of water resources, supply systems, rapid urbanisation and demand regime, aggravated by tourism leading to increasing water insecurity in the Hindu Kush Himalaya (HKH). Urban centres in the HKH have been defined based on different criteria, but mountain-specific criteria are lacking. In the mountains, small settlements such as district headquarters perform a large number of functions, typical of an urban centre. However, they are not formally classified as urban centres because they do not meet the census-defined nationally set criteria of the respective country. Nonetheless, water insecurity is a reality, attributed to: (i) water governance issues; (ii) inappropriate urban planning, failing, and to some extent, unable to account for the floating population, such as tourists; and (iii) the scourge of climate change which could worsen the situation further. Short-term coping strategies to meeting water demands often involve unsustainable solutions, such as groundwater extraction, with long-term repercussions. However, long-term strategies for water sustainability by the governments have been beneficial while others are yet to show success. Initiatives by civil society and governments along similar lines in other countries could lead to a water-secure future for the fragile urban centres of the HKH region.

Keywords: Adaptation; Coping strategy; Hindu Kush Himalaya; Urbanisation; Water insecurity

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Introduction

More than half the world's population already lives in urban centres and this proportion is likely to increase to 66% by 2050. Therefore, urban areas need to be ready to serve another 2.5 billion people by mid-century, 90% of whom will be concentrated in Asia and Africa (UNDESA, 2014). Like the rest of the world, the Hindu Kush Himalayan (HKH) region is witnessing rapid urbanisation attributed to multiple bio-physical and socio-economic drivers leading to large-scale migration; therefore, water crises in the urban centres which are already recognised as one of the global high risk factors by WEF (2017) might be a potential issue of geopolitics. HKH region is regarded as remote and largely inaccessible, but has become the seat for several urban centres, propelled by infrastructural, economic and cultural changes, mostly tourism and religious pilgrimage. Others have been colonially strategic locations expanding into large settlements drawing tourists from across the borders. Further, urban growth has been fuelled by large-scale migration of the labour force for new opportunities, students from surrounding rural areas for better education and an immensely growing tourism services sector, leading to urbanisation becoming a reality in the Himalayan region despite its unique physiographic conditions. The absolute population in the mountains is lower than the plains, due to terrain constraints. However, the factors leading to the rapid urban growth in the HKH may be examined, although city-level case studies indicate that urbanisation trends are rather limited, while substantial literature focuses on environmental degradation mainly due to climate change.

The HKH system extends for about 3,500 km from Afghanistan in the west to Myanmar and China in the east, and runs through Pakistan, Nepal, India, Bangladesh and Bhutan. Since the protection of this ecosystem was stressed during the 'Sustainable Conference' in Johannesburg in 2002, it is important to identify the impact of urbanisation in this area. The paper highlights the trends and patterns of urbanisation in mountain states and provinces of Bangladesh, India, Nepal and Pakistan and factors that have led to the urban development. Table 1 shows the regions that are part of HKH in these four countries and

Table 1. Urban population in HKH regions of Bangladesh, India, Nepal and Pakistan.

Country	Names of states/provinces which are a part of HKH	Total population (in millions)	% of population in HKH to total population in the country	Data source
Bangladesh	Chittagong Hill Tracts (Khagrachari, Rangamati and Bandarban districts)	1.5	1.2	BBS (2014a, 2014b)
India	West – Jammu and Kashmir, Himachal Pradesh	19.4	1.6	Census of India (2011a, 2011c, 2011d)
	Central – Uttarakhand	10.1	0.8	
	East – West Bengal (only Darjeeling district), Sikkim, Nagaland, Manipur, Mizoram, Meghalaya, Tripura, Arunachal Pradesh and Assam (only Karbi Anglong and Cachar districts)	18.9	1.6	
Nepal	Mountain and hill districts	13.1	49.3	CBS (2014)
	Terai (plains)	13.3	50.7	
Pakistan	Khyber Pakhtunkhwa (KPK), Federally Administered Tribal Areas (FATA), Gilgit-Baltistan, and 12 districts of Baluchistan Province	24.5	18.6	PBS (1998)

their respective urban population. In most of these countries however, state reorganisation, boundary changes and changes in definition of what constitutes urban centres make it difficult to compare long-term trends of urbanisation in the region.

Mountain urban centres grow and prosper as a result of different physical and socio-economic drivers, e.g., large cities having grown by encroaching upon nearby hills, like Nainital in Uttarakhand State of India, which began expansion towards its hill sides in the 1970s (Tiwari & Joshi, 2014). Other instances have shown smaller towns growing through 'amenity migration' as urban centres offer new livelihood options to rural migrants, which has augmented the growth of a large resident population where additional demands for housing and other facilities have been created. The HKH region has varied geo-environmental conditions and resources available for development, and hence declared as ecologically sensitive by the Indian government (Kapoor *et al*., 2009 in Kumar & Pushplata, 2013).

The HKH region produces one of the largest freshwater supplies on Earth with mainly Asia's largest six rivers, namely, Indus, Ganges, Brahmaputra, Mekong, Yangtze and Yellow rivers. The South Asian HKH region covers the major river basins of the Indus, Ganges and Brahmaputra in Pakistan, India, Nepal and Bangladesh. The HKH region is characterised by a variety of climatic conditions from tropical to alpine. The high mountains are a major barrier of the monsoon cloud flow from southwest to north-west (5,000 m), hence most of the precipitation occurs due to this barrier and this precipitation pattern dominates in the east rather than in the west. Mean annual precipitation ranges from 300 mm in Ladakh area in the west to 1,400 mm in Kathmandu and 4,000 mm in Pasighat in the Brahmaputra basin (ICIMOD, 2002). The duration of the rainy season increases from the west (two months) to the east (eight months) of Himalayas, therefore, the duration of high flow season increases from west to the east. Precipitation is also highly influenced by local orography, i.e., it increases from valleys to high mountains where the windward slope receives more precipitation than the leeward slope. Table 2 summarises the water resources of major river systems in South Asian HKH region with annual discharge, number of glaciers and lakes. The Indus river basin is the largest (1,165,000 km^2) while Brahmaputra is the longest river (3,848 km) with the highest mean annual discharge of 19,800 m^3/s (Wikipedia, 2017; Groot *et al*., 2018). The numbers of glaciers and lakes are larger in Indus and Brahmaputra basins than in the Ganges.

Unfortunately, the unprecedented population growth has led to an overexploitation of water sources in the region pushing the inhabitants to a state of despair. Urban centres in the mountains largely depend on springs and rivers (supplied through piped networks). As these sources are snow- and glacier-fed, the impact of climate change may affect the quantity of water available from these sources leaving groundwater sources as more critical for these cities in different seasons. Several mountain urban centres

Table 2. Water resources of major river systems in South Asian HKH region.

Parameter	Indus	Ganges	Brahmaputra
Catchment area (km^2)	1,165,000	907,000	712,000
Total length (km)	3,200	2,500	3,848
Average annual discharge (m^3/s)	6,600	16,648	19,800
No. of glaciers	16,049	6,237	10,106
No. of lakes	411	87	474

Source: Adapted from Sharma *et al*. (2013a) and Wikipedia (2017).

are now augmenting their water supplies through water transfers from distant sources, as existing water sources are insufficient to meet rising water demands. However, due to the inherent fragility of mountain environments (Perlik, 2014; IHCAP, 2017) such water transfers may not always be feasible due to the high infrastructure and energy costs involved (Buytaert & De Bièvre, 2012).

Rising urban population leads to increasing demand for municipal water. Infrastructure development attempts to bring more people under the formal water supply systems, rather than increasing dependency on other sources (McDonald *et al.*, 2014). However, the burden of population increase leads to unplanned urban growth through increased pressure on water resources that are limited and unable to cope with increasing demands; and hence the need to access water from alternative sources, close or distant. When alternative water sources are tapped from long distances, it may help urban centres to escape water stress, but often are expensive projects. Alternative sources could be available within close proximity, but the terrain may be a constraint compared to that of the plains. Being located in developing countries, temporal solutions would be required for these urban centres through arranging either an interim water supply from sources close to them or adopting other strategies that are cost-effective.

Compared to most other ecosystems in the world, mountains are still relatively less explored and researched, therefore, it would be unwise to ignore this ecosystem from which half the global population benefits (Yi *et al.*, 2016). **Where do urban Himalayas stand in such a setting and what are their capacities to meet their water challenges?** This great research question is still not well documented in the literature, but an answer is necessary for the existence of urban Himalayas in the future. This review paper attempts to answer it through a substantial review of existing literature – journal articles, working papers, reports, online resources and the grey literature. It also attempts to highlight the key urbanisation trends in the four countries of the HKH region, using the latest available census data. Further, it enquires into the existing state of water sources that currently meet the water demands of growing populations; it evaluates individual and community coping and adaptation strategies regarding water scarcity. It also explains the history, geography and economics of urbanisation in the region, in order to identify the impact of this process on water demand in the future. Finally, it highlights the issue of data inconsistency in the region, and draws attention to further research questions for future research.

Urbanisation in Bangladesh, India, Nepal and Pakistan

Definitional conundrum: what is urban and should it be defined differently for the mountains?

In all these four countries, urban centres are broadly defined in terms of a population threshold and the nature of economic activities carried out by a majority of the population. Many of these countries have revised their definition of what constitutes urban centres over the last few decades, making it difficult to compare long-term trends of urbanisation in the mountains. In this section, a critical look is taken at what constitutes urban, and if urban so defined meets the special needs of the mountains as a region.

In Bangladesh, according to the censuses of 1981 and 2001, an urban area included city corporations, municipalities, upazila (sub-district) headquarters, growth centres, a cantonment, and urban agglomerations adjacent to large cities, i.e., city corporations termed as statistical metropolitan areas (SMA).

Table 3. Size class classification of urban centres in India.

Size class of urban areas	Population criteria
Class I	> 100,000
Class II	50,000–99,999
Class III	20,000–49,999
Class IV	10,000–19,999
Class V	5,000–9,999
Class VI	< 5,000

Source: Adapted from Census of India (2011a).

In 2011, the concept of SMA, growth centre, and some other urban areas was abandoned, thereby, urban areas are limited to only city corporations, paurashavas (municipality areas), upazila headquarters and cantonment areas (BBS, 2014b) with amenities such as metalled roads, improved communication, electricity, gas, water supply, sewerage, sanitation, and a high population density and people mostly engaged in non-agricultural occupations (Islam & Khan, 2013). One direct consequence of changing the definition was that the percentage of urban population of the country declined to 23.3% in 2011, which otherwise would have been around 28% according to the previous definition.

In India, a place is considered an urban centre, if it has a minimum population of 5,000 and at least 75% of the main workers[1] are engaged in non-agricultural pursuits and the density of population is at least 400 per km^2. Urban centres that meet the above criteria are designated as 'census towns' (see Table 3). Other places, such as municipality, corporation, cantonment board, notified town area committee, etc., are 'statutory towns' and mostly belong to size class VI (Census of India, 2011a). However, this definition poses difficulty for urban geography studies, since some settlements, especially in the Himalayan region, which truly are urban centres from a physical and economic standpoint, fail to meet the criteria laid down by the Census of India.

In Nepal, the term 'urban centre' has been defined differently across the census years from 1952, 1962, and 1992 (CBS, 2003). A final consensus only emerged as late as 1999. From merely counting people living in prominent settlements (with over 5,000 population), Nepal provided a specific definition of a *sahar* or urban centre for the first time in 1961. The 1962 Nagar Panchayat Act provided municipal status to urban centres with a minimum population of 10,000, which was again reduced to 9,000 in 1976, since several urban centres were excluded when the Village Development Committee (VDC) became the main unit of enumeration in the 1971 census. After the Local Self-Governance Act of 1999 came into force, these municipalities were categorised into three types, i.e., metropolitan city, sub-metropolitan, and municipality with different criteria for municipalities of the hills and the Terai (Table 4). These definitions are likely to be modified again, for under the new federal structure declared by the Constitution of 2015 of Nepal, existing districts and VDCs will be dissolved to form *Nagarpalikas* (urban areas) and *Gaopalikas* (rural areas). So far, Nepal is the

[1] As per the Census of India, workers are broadly classified into main workers and marginal workers. Those workers who had worked for the major part of the reference period (i.e., six months or more) are termed main workers. Main workers are again classified into nine categories. Conversely, workers who had worked for the minor part of the reference period (i.e., less than six months) are termed marginal workers. Both males and females are included in this classification.

Table 4. Post-1999 definition of urban centres in Nepal.

Category	Criteria
Metropolitan city (*Mahanagarpalika*)	Minimum population size of 300,000, annual revenue of at least NRs.400 million (US$3.6 million), facilities of electricity, drinking water, communication, paved main and subsidiary roads, provision of specialised health services, essential infrastructure for international sports events, adequate opportunities for higher education in different fields, at least one established university, adequate urban facilities, and an area that has already received the status of a sub-metropolitan city
Sub-metropolitan city (*Upamahanagarpalika*)	Minimum population size of 100,000, annual revenue of at least NRs.100 million (US$0.9 million), facilities of electricity, drinking water, communication, paved main roads, education and health services of a high standard, general infrastructure for national and international sports events, provision of public parks and a city hall and similar urban facilities, and an area that has already received the status of a municipality
Municipality (Terai/plains) (*Nagarpalika*)	Minimum population size of 20,000 and revenue of NRs.5 million (US$45 K). Facilities such as electricity, road, drinking water, communication, and other similar urban facilities should be present
Municipality (Hills) (*Nagarpalika*)	Minimum population size of 10,000 and revenue of NRs. 500,000 (US$4.5 K). Facilities such as electricity, road, drinking water, communication, and other similar urban facilities should be present

Source: Adapted from CBS (2003).

only country in the HKH which has a mountain-specific definition of an urban centre. It recognises that places with a lower population or economic activity threshold should qualify as an urban centre in the hills and mountain regions, given the limitations imposed by the physical geographies of the mountains.

In Pakistan, the census definition of an urban area was almost similar in the 1951, 1961 and 1972 censuses, where a place qualified as an urban centre if it had a minimum of 5,000 inhabitants. In 1981, the definition was changed by replacing the size-specific definition with an administrative criterion, whereby an urban area included a metropolitan corporation, municipal corporation, municipal committee or cantonment (Arif & Ibrahim, 1998). According to this criterion, 361 places identified as rural areas in the previous census but now showing more urban characteristics were added as urban centres in 1998 (Arif, 2003; Ali, 2013).

Definition of an urban area has been changing as the criterion for identifying a place as urban has been changing in different countries. These changes make it difficult to assess the actual population that should be considered for planning any developmental activity. If the changing definition of an urban area poses challenges for planning in any country, lack of separate definitions of an urban area for the mountains and plains may lead to neglecting several areas which need attention, especially that due to physical location. For instance, the inner and outer Terai region of Nepal has more urban centres vis-à-vis the higher mountains as they are points of contact for the hills and plains, sources of agricultural products and seats for industrial growth. However, in recent years, Nepal has seen the growth of several urban centres, in the hilly region, which have been given the status of municipality. The urbanisation process in the Himalayas in general has most often been boosted by tourism and development of road infrastructure, further leading to the emergence of smaller urban centres. The urban centres of touristic importance in the Himalayas receive seasonal population as tourists, as well as

population migrating from surrounding rural areas. Nonetheless, Satterthwaite (2006) mentioned that there is a myth: 'smaller urban centres are growing faster than large cities, which are characterised by limited economic activities'. Satterthwaite (2006) further argues that the processes and nature of population growth varies between the small and large urban centres and within the small urban centres as well. It is, in fact, the unique character of locational advantage which predominantly plays a role in rapid growth of urban centres, both small and large. Some of these processes and dynamics have been examined in the next section.

As mentioned earlier, among the four countries of the HKH region, only Nepal has a mountain-specific definition of what constitutes an urban area by taking cognisance of the fact that relatively smaller conglomerations of population in a space restricted terrain, like the mountains, can function like an urban centre in terms of provision of amenities and services to a spatially dispersed rural hinterland. For other countries, a rather fixed definition of an urban area, irrespective of their physical location, could lead to excluding several large settlements of the mountain regions as being urban. Places like a small sub-district headquarter providing all urban services miss out on being called an urban centre, and hence are deprived of additional revenues and investments. Here, definitional changes by using a lower population threshold for the mountains can help ensure that unique characteristics of urbanisation in the mountains is recognised. This can also help in creation of suitable urban governance mechanisms for mountain cities, followed by the development of basic infrastructure for the large population.

Trends and drivers of urbanisation in the HKH

Urbanisation trends in the HKH display a unique character, with all four countries in the region showing that the urban population is increasing, while that of the rural population is declining. The literature also highlights that by 2050 more than 66% of the global population will live in urban centres which could add another 2.5 billion people to urban populations by 2050, with close to 90% of the increase being concentrated in Asia and Africa (UNDESA, 2014). Although rapidly urbanising, more than 61 million out of 200 million inhabitants living in the HKH region are below the poverty line (Hunzai *et al*., 2011) and still suffer from low incomes, lack of employment opportunities, lack of infrastructure and lack of access to basic amenities. Migration to large cities for better economic opportunities is an obvious consequence and more random in nature as opposed to the past. Moreover, increased access to information, better connectivity and lower travel costs have enabled more people to move. As a result, most of the large cities and medium-sized towns in the HKH are witnessing their maximum growth; however, of course, continuing to be lower in size and population than the urban centres in the foothills and plains. One exception to this is the Chittagong Hill Tracts (CHT) in Bangladesh, where the urban population is 30% as opposed to 23% in the country as a whole (Table 5). This

Table 5. Percentage of urban population in Bangladesh, India, Nepal and Pakistan and in HKH parts of these countries.

Country	Urban population in the country (%)	Urban population in states and provinces of HKH region (in %)	Year	Sources
Bangladesh	23	30	2011	BBS (2014a, 2014b, 2012a, 2012b, 2012c)
India	31	26	2011	Census of India (2011a, 2011c, 2011d)
Nepal	17	5	2011	Central Bureau of Statistics (2014)
Pakistan	33	19	1998	PBS (1998)

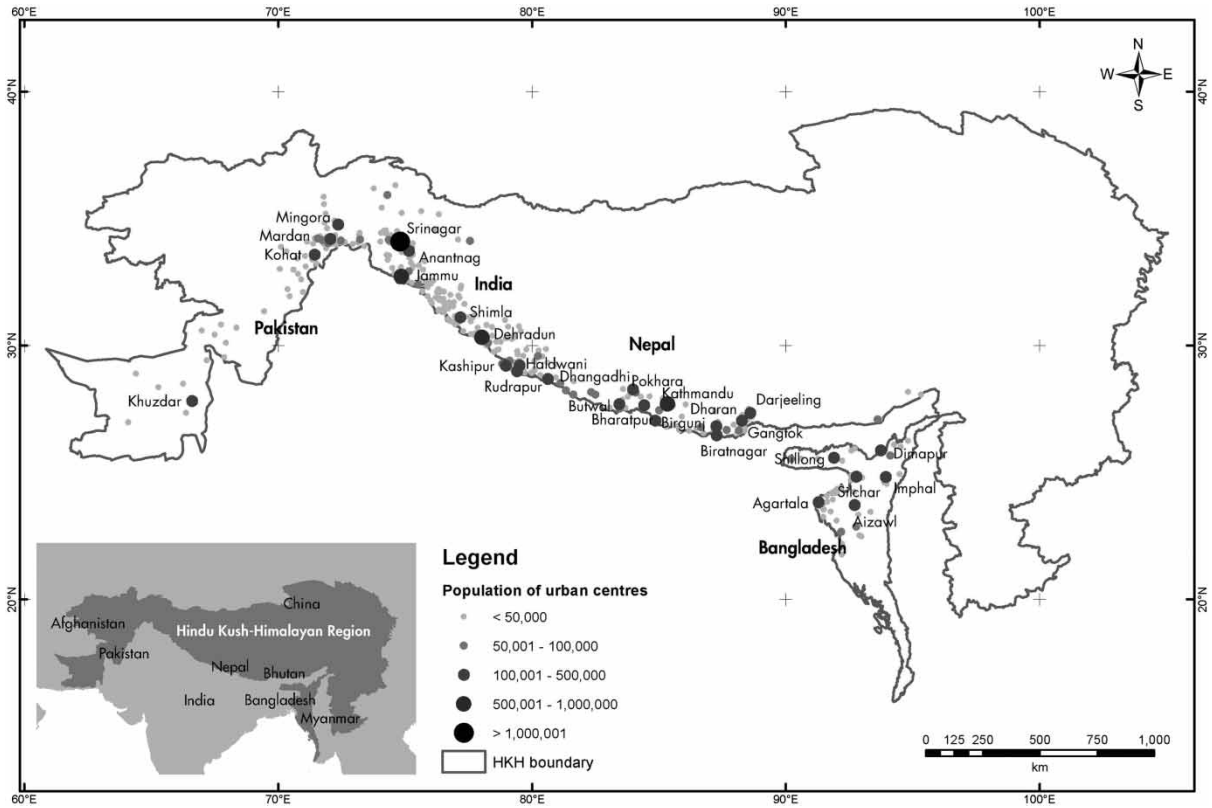

Fig. 1. Distribution of urban centres in HKH regions of Bangladesh, India, Nepal and Pakistan.

could be a consequence of the in-migration of the large Bengali population after mass out-migration of the local indigenous population from the region. Figure 1 shows the distribution of urban centres in the HKH regions of Bangladesh, India, Nepal and Pakistan.

Of the 200 million migrants worldwide, 15% (30 million) are from the HKH countries of Bangladesh, China, India and Pakistan, of which a significant proportion (although the exact figure is not known) are from the mountainous regions due mainly to: (i) rain-dependent agriculture leading to food insecurity (Sharma, 2011); (ii) lack of alternative sources of income due to strong feudal systems and internal conflicts (Hasan & Raza, 2009); and (iii) poor infrastructure, that has further accelerated the process of migration (Mamgain & Reddy, 2015). Entire family out-migration from the remote mountain regions in Uttarakhand in India to regions in the newly emerging urban areas within the state (between 2001 and 2011), like Dehradun, Kotdwara, Haldwani, Roorkee and Hardwar-Rishikesh have been witnessed (Census of India, 2011a). About 64% of all migrants in Pakistan have migrated to urban areas, while 25% of all migrants migrated to large cities like Karachi, Lahore and Rawalpindi where more job opportunities are available than in small towns (Hasan & Raza, 2009).

A recent study by Maharjan *et al.* (2018) on migration documented that 39% of rural communities have at least one migrant, of whom 80% are internal and the remaining 20% are international, while

a quarter (10%) were reported as environmental displacement. Internal migration is mainly due to education purposes in mountainous areas and for employment opportunities in the plains. International migration is limited mainly to a south–south movement. Internal migration is mostly male-dominated (83%), mainly for the purposes of education and seeking employment. Female migration (17%) is mainly for higher education in urban destinations. Migration in mountainous areas is higher than in the plains. The major driver of the migration decision is economic, but environmental displacement was also prevalent in the study sites. However, Maharjan *et al*. (2018) evaluated the migration pattern of only households where some members are left behind in the rural areas. People who migrated with all household members were not considered. Moreover, how many people migrate from rural to urban areas was not directly documented.

Anbalagan (1993) pointed out that urbanisation has been very rapid in the Himalayas, but unplanned and unregulated. Ghosh (2007) states that greater accessibility of remote areas owing to improved road connectivity, publicity and marketing of new tourist locations and consequent growth of domestic and international tourism; development of horticulture; economic globalisation and gradual shift from primary to secondary and tertiary sectors; and the absence of urban land use policy have been responsible for the growth of urban centres, their growing numbers and complexity. However, the regional factors for migration do vary. For example, in the state of Jammu and Kashmir in the western section of the Indian Himalayas, tourism has contributed to in-migration into Srinagar while construction workers have migrated into Jammu city. The literature stresses the importance of religious power factors and long-distance trade for city formation in Ladakh region (Mathieu, 2003) where, in the last two decades, the population in the town of Leh has almost tripled. A study has shown that Leh has a substantially higher level of urbanisation (23%) than Kargil (9%). Some nomadic tribes have also migrated to Leh due to loss of grazing lands following the Sino–Indian war. The Changpa communities, for example, have also had to accommodate a large number of Tibetan refugees and their herds. However, introduction of subsidised food rations and improved road accessibility have reduced their need for arduous long-distance trade journeys. The town of Leh now has an entire colony where these nomadic tribes have settled, mostly in the working age group or within the age group of 10 to 19, the latter being unable to start schooling at such a late age and having to get into the workforce (Goodall, 2004). A study by Tiwari *et al*. (2018) revealed that 500 villages across the ten mountainous districts of Uttarakhand showed a decline in farm production and therefore reduced livelihood opportunities in the agricultural sector. This is mainly due to reduced rainfall, decreasing rainy days and resultant decline in irrigation potential, therefore increased frequent incidences of crop failure. These have resulted in increasing trends of rural out-migration contributing largely to urban growth in all parts of the Himalayas (Tiwari *et al*., 2018).

Khawas (2005) points to the fact that nearly 28% of the urban population of the north-eastern Indian Himalayas is concentrated in about 4% of the cities. More than 73% of the small towns in the region collectively accommodate only just over 35% of the total urban population, as of 2001. Because of the hilly terrain, lateral expansion has not been possible in the north-east. However, several factors have played a role in the development of the urban centres and include reorganisation of boundaries after independence, attractive development projects from the state and central governments, contribution of Christian missionaries in terms of upgrading the quality of lives of tribal people, and heavy investment in the education and infrastructure sectors.

In Nepal, as many as 23 of 75 districts have seen negative population growth in 2001–2011 and they are all mountain districts, while the city of Kathmandu has seen a double-digit growth rate during the same period (Bakrania, 2015; Thapa, 2017). In Uttarakhand Himalayas (India), the plain districts of Dehradun, Udham Singh Nagar and Haldwani have seen a population growth of more than 30% between 2001 and 2011, while the mountain districts of Almora and Pauri have seen a negative population growth. The state has 1,053 uninhabited villages and another 405 villages with less than ten inhabitants – all in the five mountain districts of the state affecting the social composition of the population (Pathak *et al.*, 2017).

The variation in urban population concentration is also visible across the HKH, with Pakistan showing the highest growth rate of 5% per annum. This could be attributed mainly due to natural increase and internal migration, although reclassification of towns based on the changing definition of 'urban' may also have some role to play in this regard (Arif & Ibrahim, 1998). Within India, the urban population concentration is higher (41%) in the eastern Himalayan region than in the western (34%) and central Himalayas (25%) (Census of India, 2001, 2011a, 2011b, 2011c, 2011d), possibly because of lower average elevations in the eastern Himalayas. The growth rate is also higher in the eastern Himalayas compared to the western and central Himalayas (Table 6).

Much of the urban growth in some countries is restricted to the existing cities and towns (Table 7). For example, in Pakistan, not many new urban centres have emerged in the provinces of Khyber Pakhtunkhwa (KPK) and Baluchistan. In the Indian Himalayas, conversely, a number of rural areas have received the status of 'urban' from one census to another due to the change of definition of urban centres (for more information, please refer to the section 'Definitional conundrum: What is urban and should it be defined differently for the mountains?), a possible reason for drastic increase in the number of urban centres. For example, 173 new urban centres were added during 2001–2010, and most of these were in the size classes IV, V and VI (Census of India, 2011a, 2011b, 2001). In contrast, Nepal had no new urban centres in 2011, although this is likely to change with the newly created federal structure (Bakrania, 2015).

Table 6. Urban population concentration and growth rate across census years in HKH states and provinces of Bangladesh, India, Nepal and Pakistan.

Country	Province/State/District	Urban population (2001)	Urban population (2011)	Compound annual growth rate (CAGR) in %
Bangladesh	Chittagong Hill Tracts	433,989	728,904	5
India	Western Himalayan states	3,112,219	4,121,794	3
	Central Himalayan states	2,179,074	3,049,338	3
	Eastern Himalayan states	3,319,170	4,908,159	4
Nepal	Mountain and hill districts[a]			5.1 (AAGR)
	Terai (plains)[a]			3.2 (AAGR)
Pakistan[a]	HKH provinces	2,177,440	4,775,337	5

Sources: BBS (2014a); CBS (2012); Census of India (2011a, 2011c, 2011d); GOGB (2013); PBS (1998).
[a]*Note*: The data for Pakistan are based on the 1981 and 1998 censuses; urban population data (1981) exclude Gilgit-Baltistan, FATA and two districts of Baluchistan (data not available). Urban population across ecological divisions of Nepal not available. Growth rates have been shown from Bakrania (2015).

Table 7. Urban centres in HKH region of Bangladesh, India, Nepal and Pakistan (2001–2011).

Country/State/Province	Number of towns in 2001[a] (except Pakistan where data pertain to 1981)	Number of towns in 2011[a] (except Pakistan where data pertain to 1998)
CHT, Bangladesh	5	6
Western Himalayas, India	132	181
Central Himalayas, India	86	115
Eastern Himalayas, India	143	238
Hills, Nepal	27	27
Mountains, Nepal	2	2
Terai, Nepal	29	29
KPK, Pakistan	52	55
FATA, Pakistan	2	5
Balochistan, Pakistan	40	46
Gilgit-Baltistan, Pakistan	Data not available	5

Sources: BBS (2014a); Govt. of Gilgit-Baltistan (2013); Census of India (2001, 2011a, 2011b, 2011c, 2011d); CBS (2014); PBS (1998).

[a]*Note*: The data for Pakistan are based on the 1981 and 1998 censuses. Urban population data (1981) exclude Gilgit-Baltistan, FATA and two districts of Baluchistan (data not available).

Explaining urbanisation in the HKH: history, geography and economics

Local history, geography and economics of mountains impacted development activities and propelled urban growth. Historically, major trade routes ran parallel to the HKH, apart from the Ganga–Indus connection to the south and the Silk Road to the north that connected China to South and West Asia. Following this, some semi-urban and urban settlements emerged later in connection with Buddhism in the form of Lamaistic monasteries, which spread initially around Ladakh from the 12th century onwards (western Himalayas), then towards Sikkim (eastern Himalayas) by the 17th century (Mathieu, 2003). Consequently, many of these towns expanded and became gateways for pilgrims from Hindu and Buddhist communities. The towns of Joshimath in Uttarakhand and Dharamshala in Himachal Pradesh, for example, are gateways to the Badrinath Dham and the Dalai Lama monastery in McLeodgunj.

Urbanisation in the HKH also gained momentum during the British colonial period in the South Asian sub-continent. For instance, Shimla, Shillong and Darjeeling in India, and Muree in Pakistan, all served as summer capitals of British India, while the city of Dehradun grew during the early colonial period with the establishment of railroads, followed by the settling of ex-army personnel in the town during the early 20th century. Later, several national institutions were established in the city and, together with a growth in tourism, provided an optimum condition for several small industries to flourish, further attracting migrants from the rural hinterland (Sharma, 2001).

In the post-colonial era, events like border disputes and internal conflicts led to the initiation of development programmes by regional governments followed by growth of urban centres. For example, urbanisation in the Garhwal Himalayas in India was a consequence of the Indo–Sino war along the border, which led to the initiation of road construction and the emergence of urban corridors along highways (Maharjan, 2017). Rapid urbanisation in the north-eastern Indian Himalayas resulted from a government policy to facilitate rapid infrastructural development in the region (Pokhriyal, 2001). In Bangladesh, tribal insurgency in the CHT in the 1970s prompted the government to undertake

multi-sectoral development activities in the region from the 1980s. Market development was one aspect, which coincided with the construction of roads under military supervision. Later, other forms of infrastructure development were undertaken through intervention of the Chittagong Hill Tract Development Board and several other agencies (Huq, 2001).

The unique geography of the HKH, its rich cultural diversity, favourable climate and picturesque landscape make several Himalayan towns like Rangamati, Bandarban and Khagrachhari (Bangladesh); Leh, Srinagar, Shimla, Haridwar, Rishikesh, Darjeeling, Gangtok, Shillong (India); Kathmandu, Pokhara, (Nepal); and Muree (Pakistan) be attractive tourist destinations. Table 8 estimates tourist arrivals in some of the major urban centres in the HKH based on various sources, including newspaper reports.

Tourism (specifically, religious tourism) has played an important role in creating new urban centres and expanding existing ones thanks to improved accessibility, drawing thousands of pilgrims each year (Sharma, 2001). Moreover, tourism for leisure is also gaining popularity with better road connectivity, thereby increasing economic opportunities in these urban locations.

Much of the urban growth in the mountains has also been due to economic development after the initial creation of market towns in the region, followed by further expansion when road networks were set up, boosting trade in the region. Additionally, Portnov *et al*. (2007) identified that indicators like road length, telephone lines, spatial association of urban centres, international boundaries, large rivers and large urban centres are major determinants for urban growth in Nepal. With a productive hinterland in the Terai, Nepal has promoted several industries like carpet weaving and food processing in the Kathmandu valley. Hence, the cities of Kathmandu, Lalitpur and Bhaktapur have almost become a conurbation (Muzzini & Aparicio, 2013) and the most urbanised region in Nepal (Thapa, 2017), attracting people from all over the country and abroad. In Pakistan, the HKH region, comprising the North-West Frontier Province (NWFP), is extremely remote with very low economic development that has led to migration to large cities like Karachi, where the migrants are preferred as labourers over those who live within the Sindh province. Of the total migrants across Pakistan, 12% of these migrants are from KPK, due to extreme vulnerability to crisis and conflicts (Hasan & Raza, 2009; Shahbaz *et al*., 2012). In India, the city of Srinagar has become the largest city in the Kashmir Division

Table 8. Estimates of tourist influx in various urban centres in the HKH.

Urban centres/state/district	Total visitors	Source
Bandarban district (CHT), Bangladesh	0.65 to 0.70 million (yearly)	Hasan *et al*. (2013)
Jammu and Kashmir (J&K), India	About 1.3 million (yearly)	Correspondent (2017a)
Leh town, J&K, India	About 0.18 million (yearly)	LAHDC (2011)
Shimla, Himachal Pradesh, India	Over 2 million (peak season of April, May and June)	Das (2014)
Haridwar and Rishikesh towns, Uttarakhand, India	About 0.27 million (religious pilgrims only)	Correspondent (2013)
Darjeeling, West Bengal, India	0.55 million (April to June; September to mid-November)	Sarkar (2013)
Sikkim (entire state), India	0.61 million (yearly)	Govt. of Sikkim (2015)
All north-eastern states of India	Over 7 million (yearly)	Lyngdoh (2016)
Nepal	0.6 million (yearly)	Govt. of Nepal (2015)
HKH region of Pakistan	80 million (yearly)	Correspondent, (2017b)

(Bhat, 2008; Kuchay & Bhat, 2014a), attributed to migration, and accounting for over 73% of the urban population in the state (Census of India, 2011a).

From the above discussions, it may be summarised that the push and pull factors of migration across the HKH region vary from one country to another. In Pakistan (weak economic development and conflicts) and Nepal (remote), push factors play a more dominant role in migration as compared to the pull factors. Migrants from northern areas of Pakistan are mostly travelling to cities, like Karachi in the Sindh province, and not as many to urban centres within NWFP. In Nepal too, migrants are travelling mostly to Kathmandu valley or outside the country. In contrast, in the Indian Himalayas, pull factors seem to be stronger and migration mostly takes place to nearby towns within the state. This is due to the well-established tourism sector from Kashmir to the eastern states of Sikkim and West Bengal, which provides a large employment base for people migrating from rural areas, who have mostly settled here due to the access to social structures. This trend, of course, indicates very clearly the tremendous pressure that these urban centres are experiencing. Unfortunately, with population growing beyond capacity, the infrastructure and urban services may no longer remain adequate. Housing demands are increasing and this necessitates acquisition of agricultural lands and forests, which leads to environmental damage and affects other natural resources, particularly water. The next section will explore the change in the availability of water in the Himalayas due to urban expansion.

There are similarities in the processes of urbanisation between the plains and the mountains (migration-led growth) and also similarities in impacts of urbanisation (stress on water and resultant water insecurity). However, what sets apart mountain urban centres from their counterparts in the plains is that problems like water insecurity are much harder to solve, given the inherent natural fragility of these urban centres. The rivers of the Himalayan region get their water supply from snowmelt of the glaciers and the dwellers in urban centres get water pumped from the rivers for use. The flat terrain of the plains makes distribution of water easy compared to mountainous regions where slopes are dominant. The next section looks at issues of urban water stress in the HKH.

Status of water security in urban Himalayas

Urban growth in the HKH region has increased the demand for water in these urban centres. The spatial and temporal variability of precipitation is very high in the HKH region, with more than 80% of the annual rainfall occurring during the monsoon. While this often causes rivers to overflow their banks, bringing devastation to the people living in the floodplains, for the remaining months, acute water shortages due to seasonality in river flows are experienced (Molden *et al.*, 2014). Rural and urban areas bear the brunt of the changing physical conditions in the mountains, but the latter suffers more as water demands are very high. Over the years, when the urban centres of the mountains expanded, forests and agricultural lands have been replaced by concrete structures affecting infiltration, therefore, groundwater recharge decreases. Most of the urban centres are being provided water through a piped network; however, it is not sufficient considering the demand. The change in the availability of water in the urban areas of the HKH region is manifested in reduced discharge in the rivers, spring sources and overexploitation of groundwater resources to meet water demands. While catchment degradation was identified as the main cause for drying up of the springs in the last century, climate change is now emerging as the new threat in the 21st century (Tambe *et al.*, 2012).

Increasing demand and limited resources have culminated in the entry of private parties into the business of water. The new economic policy in 1991 gave a special boost to privatisation. In the water sector, privatisation takes place by treatment of water as a commodity (Bhattacharya *et al*., 2013; Mukhopadhyay & Bhattacharya, 2013). Hence, big companies are in the business of water, sanitation, solid waste management, sewerage, bottled water, beverages and more in different forms of public–private partnership (Bhattacharya & Banerjee, 2015). The acute water crisis which Darjeeling faced in the late 1980s and early 1990s prompted the local government to supply water through tankers. Later in 1995, the Darjeeling Municipality requested the Darjeeling Gorkha Hill Council to form a committee to prepare a proposal for source augmentation options and to improve the supply infrastructure. The result was a proposal to lift water from the Balasun river into the two Senchal reservoirs (Boer *et al*., 2011) at a cost of Indian rupees (INR) 400 million (approximately USD 6 million, as on 14 May 2018). While the World Bank had come forward to provide assistance, the project could not be accepted due to the irreconcilable differences on the project design, implementation and operation between the three parties involved. Later in 2004, this project was again considered as a necessary step towards improving water security and started, but the cost had increased to INR 560 million (USD 8.4 million) (Shah & Badiger, 2018). Community narratives collected during a study in the Darjeeling Himalayas by Rai *et al*. (2016a) indicate governance and convergence issues as primarily responsible for the inability to manage groundwater in the region. Additionally, despite clear mandates across departments being provided, the forest department has not been able to extend its mandate to include artificial recharge outside protected areas, which is another reason why rejuvenation of springs has not been possible across the region.

Spring sources which are the traditional water sources for the region have been largely affected during road construction and urban expansion (Sharma *et al*., 2013b). While it still remains a source for some residents, the water quality is unreliable (Government of India, 2005), as experienced in Himachal Pradesh and Uttarakhand in the Indian Himalayas. However, in the eastern Indian Himalayas, monitoring of springs has shown that the quality of water from springs is excellent and suitable for drinking, but due to shrinking of the monsoon period as well as less snowfall in some areas, these springs are drying up (Sharma *et al*., 2013b). Water quality deteriorates during the monsoon season as soil and mud is often washed out.

Water supplied by the municipal authorities also faces threat from degraded catchments and reduced recharge to existing storages. Further, encroachment of surface water bodies during urban expansion in several parts of the HKH (Ashraf, 2013; Kuchay & Bhat, 2014b) has been another factor leading to reduced 'sponge action' of land (Sharma *et al*., 2013b). The network of pipelines and storage systems are old (IUCN, 2015), therefore, contamination from industrial pollution and domestic effluents (Annandale & Bailly, 2014) becomes inevitable. Several parts of these urban centres are also unserved due to lack of sufficient water in the sources. The crisis worsens during the dry seasons, particularly in large cities of touristic importance, as consumption levels soar, while recharge is limited. As local water sources have shrunk over the years, urban authorities have been compelled to augment supplies by developing planned water supply systems from other distant sources, like rivers, surface water bodies, etc. For instance, the city of Kathmandu is on the verge of importing 170 million litres per day (MLD) of water from the Melamchi river through a 26-km long tunnel. The Kathmandu valley on the whole faces a shortage of 210 MLD (Subedi, 2010). Most of the large cities of the HKH are facing shortages, as shown in Table 9 where the literature documented deficit of average daily gap of demand and supply is summarised. However, seasonal gap fluctuates, e.g., during summer demand increases as well as supply also increases due to an abundance of water during the monsoon.

Table 9. Gap between municipal demand and supply of water (in million litres per day (MLD)) in selected towns and cities in HKH regions in Bangladesh, India, Nepal and Pakistan.

Name of the urban centres and sources	Country	Population	Water demand (MLD)	Actual supply (MLD)	Deficit (MLD)
Rangamati (Chakma, 2008)	Bangladesh	84,000	9.1	6.4	2.7
Baramula (Baba, 2016)	India	71,434	22.7	7.9	14.8
Shimla (Correspondent, 2016a)		169,578	42	20.6	21.4
Mussoorie (Misra, 2016)		30,118	14.5	7.7	6.8
Darjeeling (Darjeeling Municipality, 2018)		118,805	7.0	1.9	5.1
Kohima (Yhokha & Resu, 2015)		99,039	10	1.2	8.8
Tansen (Khatri, 2016)	Nepal	29,095	2.5	0.5	2
KUKL service areas in Kathmandu valley (Udmale *et al*., 2016)		1,346,518	362	184	178
Pokhara (Correspondent, 2016b)		255,465	65	45	20
Quetta (Balochistan) (Shahid, 2016)	Pakistan	489,046	170	106	64
Rawalpindi (KPK) (Ahmed, 2015)		1,410,000	79	20	59
Mansehra (KPK) (Ahmed & Kiran, 2011)		49,534	8.1	4.4	3.7
Karak (KPK) (Correspondent, 2016c)		27,893	1.3	0.6	0.7

Water shortage is an inevitable consequence of rapid urbanisation in the HKH, as indicated in the previous discussions. The advantage in the plains is that water can be sourced from long distances, while in the mountains this process may not always be feasible or can be very expensive. Investment in such projects is, therefore, usually limited, while old infrastructure disrupts the supply system and often causes water deficits. In this context, households struggle daily to meet their water needs, trying to find ways to respond to immediate shortages by coping methods, while a few long-term adaptation strategies can also be documented. The following sections identify these strategies by households in urban Himalayas.

Literature from across the HKH region indicates that most households in the urban Himalayas are shifting to distant spring sources when those within the close vicinity dry up; this increases their engagement time in fetching water. This has been experienced in the cities of Gilgit and Quetta (in Pakistan); Champawat, Gangolihat, Almora, Dwarahat, and Pithoragarh in Uttarakhand; Kurseong, Darjeeling and Kalimpong in West Bengal (PSI, 2003; Lepcha, 2013), Kohima (Correspondent, 2016d), and Mokukchung in north-eastern Himalayas. There are also instances of informal arrangements whereby temporary pipelines are organised for bringing water from distant springs. Another means through which households cope with water shortages in the urban centres of HKH, mostly in India, Nepal and Pakistan, is to buy water from tankers (ATREE, DGC, DLR Prerna & DNGON, undated; PSI, 2003; Shrestha & Shukla, 2014). This water is mostly sourced from distant springs or groundwater bore wells. While charges for water purchased from tankers may vary according to distance, it does have financial implications for poorer households, who often restrict the purchase of water, and therefore, the quantity used (Raina, 2016). Since the Bangladesh section of the HKH is characterised by low hills, additional water demands are met through community hand pumps (Khan, 2015). It may be understood that coping with water shortages is a household's individual decision.

The long-term strategies, better known as adaptation strategies, are undertaken by households as well as at the level of urban local governments towards managing chronic water shortages in HKH towns. Therefore, it would perhaps be a matter of greater relevance to say that households initially cope,

and later as the problem escalates, they start adapting. In general, adaptation to water scarcity involves augmenting supplies from new sources and introducing conservation practices, which can improve water availability. Additionally, it may also help to reduce the damage from extreme climatic events which usually affect spring sources and increase surface runoff in the mountains. Most households in the HKH region, particularly in Nepal and India, have turned to groundwater sources, which they access through installing personal pumps. In Kathmandu, anyone who can afford it, digs a groundwater well (Raina, 2016). Kathmandu Upatyaka Khanepani Limited (KUKL), the government water utility in Kathmandu, also has invested in a large number of deep bore wells to supply water to the city (Dolma *et al*., 2015). At this point, one can say that adaptation techniques of this kind to counter water scarcity by any household depend on the economic status. Further, rampant use of such technologies may also have an impact on the groundwater table and possibility of premature failure of wells, due to over-abstraction (Pandey *et al*., 2016). As Shah (2016) correctly puts it, such pressures not only generate competition between springs and groundwater from 'common' aquifers, but water that was allocated to agriculture in the peri-urban pockets is also affected, when infrastructure interferes with 'natural recharge zones'. Conservation strategies have received much attention over the years, as they help to preserve the resources from being overexploited. Several households in parts of north-eastern Himalayas have pro-actively developed rainwater harvesting systems, a mission that was government supported through policies. Although knowledge about these systems is unknown to many people in other parts of the HKH, it has been considered a viable option which can be replicated by local governments. Such policies not only enable communities to adapt to water shortages, but also protect local surface and groundwater resources (Singh & Kandari, 2012).

Other planned adaptations by governments could secure water futures for urban residents in the HKH. For example, in Nepal, watershed management, afforestation programmes (by the UK's Department for International Development) and the construction of gabions and check dams (Government of Nepal, 2010) have helped improve the health of urban watersheds, improve groundwater recharge and reduce the frequency of flash floods. Although these are useful means of adaptation, they may not always be successful if not planned carefully. However, alongside strengthening local governments' capacities to prepare and implement integrated plans for urban areas (Nepal *et al*., 2007), developing sustainable projects for augmenting water supplies can be an essential means to counter haphazard planning. The National Mission for Sustaining the Himalayan Ecosystem in India stresses the need to follow building codes and norms (SANDRP, 2013) while the Housing Policy of 2011 further strengthens this move. The National Action Plan for Climate Change (NAPCC) of India is also focused on sustainable urban development in mountain regions.

Pakistan has been successful in providing water and sanitation facilities in the rural areas of Gilgit-Baltistan through the Sanitation Extension Program by the Aga Khan Foundation, which could now be successfully replicated in the urban centres of Gilgit and Hunza. Augmentation of water supplies is an important aspect of adaptation by the national governments involving projects to draw water from alternative sources, although the scale varies. In Bangladesh, a BDT 400 million project (USD 4.9 million) has been developed for Rangamati to develop a water supply system by constructing a surface water treatment plant which uses Kaptai lake water. More recently, with Asian Development Bank funds, Local Government Engineering Department of Government of Bangladesh improved drainage networks (Asian Development Bank, 2015).

Only recently, Shimla has received funds from for the AMRUT project for integrated development of Shimla town, which includes most importantly, a water supply system under the State Annual Action

Plan (Government of Himachal Pradesh, 2015). These include progressive steps towards improvement and augmentation of the existing water supply schemes for Giri, Chair, Ashwini Khad, Gumma, Churat, Jagroti and Seog catchments, provision and rejuvenation of water supply lines, pumping machinery, leak detection machine, sluice valves, four water tankers and water meters (AMR), providing water ATMs in 25 wards of the city and filtration plants at natural springs to enhance the water quality and to provide citizens with good quality water along with rejuvenation of existing natural springs. Notwithstanding this, unfortunately, Shimla town recently saw the worst water crisis during the summer season in 2018, where supply from all the sources declined drastically from their capacities (Correspondent, 2018, May 26). Adaptation to urban water crisis requires a balance in the use of resources between the upstream and downstream users within and outside the urban watershed. In this context, suggestions indicate that those living in the immediate upstream of urban centres be encouraged to conserve natural ecosystems and be given financial assistance for doing so and that the concept of payment for ecosystem services (PES) be operationalised. Experiments, such as willingness to pay for water services, have been conducted in Nepal and India (Karn, 2008; Rai *et al*., 2016b). However, so far, to the best of our knowledge, there are no urban centres in the entire HKH that incentivise and compensate their upstream neighbours for conserving springs and other water resources. In the fragile HKH region, adoption of a PES approach for proper management of water services may lead to a win–win situation for both water managers and users (Wunder, 2008), but is yet to be tested anywhere.

While several efforts are in place to improve the water security of people living in the mountains, Tortajada (2014) identifies that there is a need for constant accountability from users, donors, government and non-governmental organisations for their decisions and actions. With good information networks (Rouse, 2014), planning can be more precise and can yield better results.

Conclusions: towards a water-secure urbanisation process in HKH

This paper presents an outline of the current status of urbanisation as well as water insecurity in the HKH region of Bangladesh, India, Nepal and Pakistan. All these four countries are undergoing rapid urbanisation. This paper highlights three major points.

First, as the mountain sub-region is much smaller than the plains, globally, the urban population is also lower than in the plains, and attributed to differences in the terrain of the two regions, the former offers unfavourable conditions for human settlements to grow and prosper. Additionally, the uniform definition of urban centres applied with equal weight across plains and mountains, often tends to ignore important strategic locations as ‘urban’ in the mountains, although in terms of water security, the capacity of mountains is much lower than that of the plains. In the mountains, smaller settlements like district headquarters or market towns perform a number of functions typical of an urban centre. However, they are not formally classified as urban centres because they do not meet the nationally set criteria. This calls for a mountain-specific definition of urban areas, which takes into cognisance mountain specificities like fragility, limited water sources and remoteness. One exception is Nepal, which has a mountain-specific criterion for demarcating urban centres and which may also be followed in other countries.

Second, within each country and its mountain areas, the pace of urbanisation varies, with higher urban growth noted in lower elevations and valley bottoms, again implying the importance of

geographical factors in creating urban centres. While historical and geographical factors explained urbanisation in the mountains in the past, in recent decades, the economics of migration and tourism have been the major drivers of urbanisation. While urbanisation in the mountains offers huge opportunities for people from rural hinterlands, the haphazard growth of these mountain urban centres coupled with their fragile geography makes them particularly vulnerable to water stress and insecurity. The majority of urban centres in the HKH cannot meet water demand from municipal sources. Some of these mountainous urban centres are of historical importance while some are popular tourist destinations. Therefore, there is seasonal flow of population in many urban centres. The present planning process has failed to provide alternative systems incorporating seasonal influx of population in these urban centres leading to acute water scarcity, congestion and pollution.

Third, there are many strategies undertaken by people in coping and adapting to water scarcity. This paper found that the most frequent practice is to tap groundwater, either from spring sources or through dug wells and bore wells. However, unless supplemented with adequate and well-planned recharge programmes, excessive reliance on groundwater will lead to further potentially deleterious consequences in the future, given that aquifers in mountainous regions are inherently fragile. Therefore, long-term strategies are needed, such as mountain-specific urban planning, that take into account the myriad fragilities of mountain ecosystems and ecological restoration of forested uplands that feed the urban water systems. Without long-term and sustainable urban planning and accountability of the stakeholders, many of these urban centres in the HKH are poised for a grim water future, which will only be exacerbated by climate change.

This paper has been able to identify critical issues around changing conduct to water demand of urban centres, seasonally, accounting for floating populations, water inequities arising from socio-economic factors, impact of governance practices and water budget of cities. Urbanisation provides multiple livelihood options and pointed research in the gap areas can improve urban and regional planning and help achieve the goal of building sustainable urban centres in the HKH region.

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