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Water Scarcity: Nepal country snapshot



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Country report prepared for the International Water Association and the Food and Agriculture Organization of the United Nations

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Cover Photo: Children queuing for drinking water in Rara Gau, Jumla. Source: RSS Nepal, May 2019. Inset picture of an elderly man who makes a living by selling water in kharpan. Photo Source: Suraj Pradhan

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In Nepal, we faced a rather peculiar situation: although water scarcity in various sectors and places is ubiquitous for a variety of reasons, deeper exploration of the topic itself is almost taboo in public discourse and academia because Nepalis have, over the years, especially at the official and political levels, self-hypnotized themselves into believing that the country is “rich in water resources, second in the world only to Brazil”. This quote of questionable veracity is found in speeches of ministers and politicians right down to school textbooks, no matter that what the country is really rich in is four monsoon months of floods and eight months thereafter of drought.

This state of the national mindset presented a problem for us since there are very few studies and documents addressing water scarcity per se. There are studies of irrigation or urban water supply aplenty and the notion of scarcity is embedded within all projects under them; but it is not explicitly addressed nor is there any drought policy as such. As a result, besides teasing out the issue of scarcity from available reports, methodologically we had to rely on discussions with experts and officials, many of whom spoke on the shortcomings of the scarcity policy on the condition of anonymity but alerted us about existing and forthcoming thinkings on this subject. Of those who were open with their views, we would specifically like to thank Bhaba Prasad Tripathi of the International Rice Research Institute Nepal Office, Executive Director Baidya Nath Mahato of National Agriculture Research Council NARC, Nepal’s leading rice expert Bholu Man Singh Basnet, Under Secretary (Technical) Parashu Ram Adhikari of the Ministry of Agriculture and Madhav Belbase, Joint Secretary of the Water and Energy Commission Secretariat, for their insightful comments. At Nepal Water Conservation Foundation, we would like to thank our staff for their help in conducting a quick survey of water supply tankers and bottled-water suppliers in the Kathmandu Valley.

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Water scarcity: Nepal country snapshot

1. BACKGROUND

1.1 To the study

Given how ubiquitous “water scarcity” is in the media and in political battles, especially at the local level, it is surprising that there is so little research or questioning of its fundamentals, whether from the physical or from the social sciences. Water is a key ingredient – the sine qua non – in all life activities that are natural as well as in the man-made economy. Just as life is richly varied, so are the services that water is put to in the myriad niches sustaining the planet’s rich biodiversity as well as its equally rich human activities. Unlike other resources such as land, forests and minerals, water is very special as it is a fugitive resource: left to itself, water is constantly on the run, something that is obvious in rivers but not quite so in glaciers, reservoirs or the soil, melting silently, evaporating invisibly, flowing inexorably downhill, seeping underground to emerge many miles away as springs and oases, cycling back to the seas and then again to the mountain springs and glaciers. At each step of these processes, some particular property of water and its flow, from physical to aesthetic and spiritual, is critical for life processes and human economy. For the latter, water’s solvent property is used in industrial production, flow property to convey waste in municipalities, low viscosity to facilitate inland transport and so on¹.

When human interventions, more so modern ones, disrupt the water cycle with ever-forceful technologies and ever-increasing demands (“the Anthropocene disruptor”), water stress is experienced most acutely by non-human life and by various groups of humans that compete for the finite water resources for their varying needs. Water is said to be not so much a subject of study as the focal point where various disciplines intersect, from as physical and scientific as atmospheric physics to engineering, economics, law, sociology and aesthetics. Much human ingenuity has been expended over the millennia to arrest its flow, divert it from where it is available to where it is required and to store water for times when nature does not provide it. However, less creativity and political will has been brought to play to cleanse it of man-dumped waste using its flow properties or bring prosperity to selected areas through agriculture and industry using its solvent properties, thereby often unintentionally creating scarcity for those at the downstream end of the process.

This study aims to address that “scarcity” in understanding of the underlying context and drivers of water scarcity as well as in bringing together varied initiatives that have operated autonomously in facing this pervasive problem without benefitting from the synergy that could have saved much time and resources. It is guided in large part by the nexus approach² as well as a critical social science look at how scarcity is

¹ Gyawali, D. 2010. What is special about water? [Box 1.1]. In J. Dore, J. Robinson & M. Smith, eds. Negotiate – reaching agreements over water, p. 16. Gland, Switzerland, International Union for Conservation of Nature.

² Gyawali, D. 2015. Nexus governance: harnessing contending forces at work. Gland, Switzerland, International Union for Conservation of Nature (available at http://www.iwa-network.org/wp-content/uploads/2016/03/1448008531-Nexus-Governance-Harnessing-Contending-Forces-at-Work_Dialogue-Synthesis-Paper-2015.pdf).

not only a physical reality in many cases but, more importantly, is often socially constructed as the famine studies of Sen³ and water–energy–food scarcity studies of Mehta⁴ have shown. The nexus approach is replacing integrated water resource management (IWRM) where the shortcomings arising from viewing water in its silo are corrected through a more intersectoral and interdisciplinary understanding of the cross-sectoral linkages between water, energy and food. Very often, for example, shortage of energy can make it impossible to lift water. There is also the new and critical approach in the social sciences that deconstructs the concept as well as the political economy of scarcity. Studies of the Bengal famine of the twentieth century by Amartya Sen and others after him have shown that in many instances it was not the shortage of food per se but the entrenched political economy that was the primary cause. The newer social sciences⁵ go beyond a narrow, neoclassical economic definition of scarcity to a framing that allows for a more flexible policy approach from institutional and policy perspectives which views water as not just a private or public but also common pool and club goods, each eliciting very different social responses. This brief country snapshot will try and expand on these approaches.

1.2 Nepal country background

The Federal Democratic Republic of Nepal, landlocked between the Republic of India to the south and the People's Republic of China (Tibet) to the north, lies primarily on the southern slope of the middle range of the Himalayas, although some districts such as Mustang fall on the northern side in the Trans-Himalayan Tibetan Plateau, and extends southwards into the Indo-Gangetic plains in a strip of fertile alluvial flatland called the Tarai. With an area of about 147 000 km² and a population of about 30 million people, Nepal is home to enormous physical and social diversity, and even greater biodiversity. Its people come from 124 racial as well as ethnic backgrounds and speak some 103 languages. Within a north–south span of about 150 km, the altitude goes from 60 m above sea level at its southeastern tip 16 km away from the People's Republic of Bangladesh to 8 848 m above sea level in the High Himal. As a consequence, Nepal can be divided geographically into four east–west elongated regions – Tarai, Doon Valley, Mid-Hills, High Himal (including Trans-Himalayan Tibetan Plateau) – with climates ranging from subtropical in the south to alpine and arctic in the north, with almost everything else in between. As a consequence, the flora and fauna including the food crops vary naturally due mostly to elevations where they are grown. The flat Tarai in the south has the highest population density of about 680 people per square kilometre that matches with the population density of the capital city of Kathmandu and other major towns and cities. Most of the hill population is in inverse proportion to the altitude.

³ Sen, A. 1981. *Poverty and famines: an essay on entitlements and deprivation*. Oxford, UK, Oxford University Press.

⁴ Mehta, L., ed. 2010. *The limits to scarcity: contesting the politics of allocation*. London, Earthscan.

⁵ Thompson, M. 2010. A bit of the other: why scarcity isn't all it's cracked up to be. In L. Mehta, ed. *The limits to scarcity: contesting the politics of allocation*, pp. 127-142. London, Earthscan; Thompson, M., 2003. Yes, culture matters, but in what way? In E. Ehlers & C.F. Gethmann, eds. *Environment across cultures*, pp. 39-54. *Wissenschaftsethik und Technikfolgenbeurteilung Band 19* of the Europäische Akademie. Heidelberg, Germany, Springer-Verlag.

The climate of Nepal is essentially dominated by the South Asian monsoon which approaches it from a south-easterly direction and which provides most of the precipitation during the rainy summer months (June to September), more in the east of the country than in the west. Monsoonal precipitation, conventionally said to account for over 80 percent of the annual precipitation, is the most important climatic element for agriculture as well as other water resource uses in the country. However, in the winter months, mostly December to February, it is also subject to the winter westerlies that provide some 20 percent of the annual precipitation, more in west and north Nepal and less in the east.

While there are plenty of sectoral studies of irrigation, domestic and urban water supply, aquatic biodiversity, etc., few of them explicitly address the issue of water scarcity: it is implied, but often not in the social and political context within which they occur. It is assumed that whatever project is being conceived and implemented is addressing any scarcity that might have been there: a hydropower project is addressing electricity scarcity, a water supply project is addressing water scarcity and so on. What is not asked is what the nature of that scarcity is, how it came about, who suffers and who benefits from it.

There is another aspect of water scarcity that is specific to Nepal (and perhaps other mountainous countries) and that is *verticality-induced scarcity*. Hill hamlets (*gaons*) are situated at elevations higher than the river valley bottoms (*besi*), often several hours' walking distance away from the rice-growing agricultural lands. That is mainly because the latter are often malaria-prone and subject to flash floods. These higher settlements have to depend upon nearby springs for their water needs because, while the hamlet located at the edge of a river in a topographic map may look very close to the river and one can probably see the river from the hamlet, in actuality the settlement may be 1 000 m or more above the actual river. A village could be within a few hundred metres of a major river horizontally as the crow flies but that waterbody would be several hundred metres below, making it practically inaccessible. The energy cost of lifting that water to where it is needed either by human or animal muscle power or by modern means of diesel or electrical pumping is unsustainable for the normal mountain village economy. This is the main reason for verticality-induced scarcity of water, which can be understood as a scarcity caused by the vertical distance of the water source from the areas of major domestic livelihood activities. It is endemic to mountain and hill economies.

Another type of verticality-induced scarcity of water is specifically prevalent in the Tarai plains. The impact of overpumping of groundwater over the last century is severe, with the water table in the Nepali part of the north Ganga basin having dropped by over 50 m at some places in the last decade or decade and a half. This groundwater drawdown has made it practically impossible for the rural Tarai dwellers, especially the vast majority who are not large farmers, to pump it using traditional manual pumps especially in the dry season. The National Sample Census of Agriculture⁶ carried out in 2011/12 shows that the landholding size of most of the farms that used tubewells for irrigation was in the range of 0.2 ha to 2 ha with an average of between 0.5 ha and 1 ha (Table 1).

⁶Central Bureau of Statistics. 2013. National Sample Census of Agriculture, Nepal 2011/12. National report. Kathmandu.

An Asian Development Bank (ADB) website document estimated that typical medium-scale farmers cultivated 0.5 ha and earned an average income of around 36 500 Nepali rupees (NPR), which is barely enough for subsistence and too little to even contemplate investing in farm improvement⁷. The average landholding size per household of Karnali, Mahakali and Mohana river basins in the far west of Nepal varies from a low of 0.41 ha in the Karnali basin to a high of 0.54 ha in the Mohana basin. Of the average figure, about 65 percent to 70 percent of the land is non-irrigated. Similarly, the average size of household landholdings varies from a low of 0.26 ha per household in the mountains to a high of 0.55 ha per household in the Tarai plains. The average household income has been found to be in direct proportion to the landholding size; however, the income figures vary dramatically.

Table 1: Number and size of landholdings irrigated by tubewells

Size of holdings	No. of holdings	Total area (ha)
Under 0.1 ha	70 689	2 755.50
0.1 ha to less than 0.2 ha	68 607	8 158.30
0.2 ha to less than 0.5 ha	166 762	43 621.80
0.5 ha to less than 1 ha	163 349	83 977.20
1 ha to less than 2 ha	126 891	115 695.70
2 ha to less than 3 ha	42 701	66 344.60
3 ha to less than 4 ha	14 848	31 907.20
4 ha to less than 5 ha	6 528	18 095.30
5 ha to less than 10 ha	4 987	19 302.50
10 ha and over	271	1 896.20
Total	670 677	391 846.00

Source: Adapted from Central Bureau of Statistics. 2013. National Sample Census of Agriculture, Nepal 2011/12. National report. Kathmandu.

Owners of large farms are mostly what are called “absentee landlords” who live in Kathmandu and are engaged in more attractive work such as professional job, business or politics, and they do not spend much of their time on the farms which are traditionally leased to the tillers. These are either sharecroppers or poor farmers with limited means and poor knowledge of modern ways of farming including the use of government facilities such as access to electricity, subsidies for diesel pumps, credit for diesel to run the pumps, banking facilities, etc. The situation is the exact reverse across the “open” (i.e. poorly regulated) border in India where farmers are encouraged to make further investments on the farm. On

⁷ Asian Development Bank. 2010 November. Economic and financial analysis. Raising Incomes of Small and Medium Farmers Project (RRP NEP 38423-02). Manila (available at <https://www.adb.org/sites/default/files/project-document/62354/38423-02-nep-rrp.pdf>).

the other hand, the poorer farmers of Nepali Tarai generally use traditional means of water extraction with low yield but are subjected to market impacts from farmers who overuse the resource within and outside Nepal's borders but are capable of accessing the government's support systems.

The market considers groundwater a private good: its players are often very far ahead in exploiting this resource compared to the egalitarian activists who protest the loss of common-pool resource as well as the government that needs to manage it as a public good. In north India millions of high capacity diesel pumps are in use, while in Nepal the use of groundwater for irrigation is limited to 150 000 shallow tubewells and only 1 500 deep tubewells, that pump amounts much lower than the estimated 2 billion cubic metres (BCM) of annual replenishment. The Ground water year book published by the Uttar Pradesh government for 2014–2015⁸ shows that the first aquifer has a depth of up to 150 m from the surface, of which the first 50 m are the main source of groundwater in the state. To quote from chapter 4 of the above book:

The upper part of first aquifer down to 50 m below ground level is the main source of drinking water through hand pumps and dug wells and is unconfined in nature. The first aquifer as a whole which is under unconfined to semi-confined conditions is the most potential aquifer group which is the main source of groundwater in the State extensively exploited through private as well as Government tube wells to meet the drinking water and irrigation needs. The deeper aquifers are confined in nature being exploited to a very limited extent. The yield of second aquifer is limited while the third aquifer is potential [sic]. The shallow and phreatic aquifers are under heavy stress.

The National Aeronautics and Space Administration's (NASA) satellite data clearly show signs of overpumping of groundwater in Punjab and western Uttar Pradesh in India, which has led to the decline of groundwater table in the contiguous Terai region of Nepal as well, especially in the western Tarai⁹, which are topographically at a higher elevation than the lower Ganga plains.

This highland/lowland dichotomy-induced scarcity of groundwater – both in the hills and in the plains – can be an interesting topic for future action research and pilot programmes that are closely linked to food production in Nepal. It is made all the more pertinent in view of the fact that there is a complete restructuring of local governance going on in Nepal under the country's 2015 constitution. While the process is rife with uncertainty at the time of writing this report, it does present the possibility of engaging with local bodies at their very inception to push for water policies that address water scarcity in much more scientific and holistic manner.

⁸ Central Ground Water Board. 2015. Ground water year book Uttar Pradesh (2014–2015). Delhi (available at <http://cgwb.gov.in/Regions/GW-year-Books/GWYB-2014-15/GWYB%202014-15%20U.P.pdf>).

⁹ Mukunth, V. 2015. The Indus and the Ganges–Brahmaputra Basins are drying up faster than we'd like. The Wire, 22 June 2015 (available at <https://thewire.in/science/the-indus-and-ganges-brahmaputra-basins-are-drying-up-faster-than-wed-like>). Accessed 7 July 2018.

2. CONTEXT SETTING

In this section, we will examine the context of water scarcity in Nepal in three related areas: meteorological scarcity with precipitation failure; hydrological scarcity when rivers, streams and spring or pond sources as well as groundwater are affected by physical events such as landslides or man-made disasters such as pollution; and agricultural scarcity when crop production is affected by nexused impacts from other sectors (such as overpumping of groundwater), making it impossible to use the water to produce food. Climate change is expected to exacerbate already existing shortages with weather anomalies, increasing them in both frequency and intensity.

2.1 Meteorological scarcity

Climate in Nepal varies from tropical in the southern plains to temperate in the central region, and from arctic in the higher Himalayas to arid cold desert in the Trans-Himalayas. As the monsoon comes from the south and the east, it first strikes eastern Nepal and then it proceeds to the west. While moving west, part of the cloud stream follows a westerly course and part of it follows the river valleys to the north. It takes nearly one month for the monsoon to reach the western border of Nepal. Likewise, the westerlies move from west to east. In both these cases, the intensity of rainfall varies in space and time¹⁰ under normal weather/season conditions and is expected to become more unpredictable with climate change. Extreme events such as failure of winter westerlies, late arrival of the monsoon and shifting of the Gangetic trough during the summer (creating the “monsoon gap” scarcity in the middle of the rainy season with the erratic movement of the jet stream) are some of the causes of meteorological scarcity.

The seasonal variation of precipitation and evapotranspiration in a north–south cross-section of west Nepal is summarized below (Table 2). As can be seen, except for the monsoon months between June to September, evapotranspiration rates are much higher than the available precipitation. Moreover, in the Trans-Himalayan rain-shadow region, evapotranspiration rates are higher in the monsoon, but lower in the winter months due to the cold, even though surplus moisture can be seen to be rather scarce year-round. This is also due to higher evaporation at higher altitudes caused by lower atmospheric pressure.

While these averages are insightful, what they hide (or “average over”) are the tremendous year-to-year and even within-month variations. For example, Bhairawa in the south has an average annual precipitation of 1 673 mm but its yearly annual minimum can be as low as 701 mm. And Jomsom in the cold, arid north has an average annual precipitation of 256 mm but it can be as low as 50 mm in some years. Many non-monsoon months can see no precipitation at all, and even within a monsoon month there can be weeks without precipitation. Much the same thing can be said about cloudbursts, i.e. sudden and intense precipitation that can exceed 60 mm of rain within an hour. Compounding this range of variations are

¹⁰ Department of Hydrology and Meteorology. 2018. Climatological and agrometeorological records of Nepal. Kathmandu (available at <http://www.dhm.gov.np/publications-list/>). Accessed 11 July 2018.

the orographic variations induced by the mountainous terrain: its induced rain-shadow effect means that one side of the hill is generally moist while the other side is considerably dry; and the same applies to river valleys. Traditionally villages physically very close to each other consider themselves either dry or moist/wet areas.

Table 2: Seasonal variation of precipitation and evapotranspiration (in mm) along the north–south transect of mid-Nepal roughly along the 84° east longitude

Station name, location and elevation	June to September (as percentage of annual total)		October to May (as percentage of annual total)	
	Precipitation	Evapo-transpiration	Precipitation	Evapo-transpiration
Bhairawa (Tarai: 110 m)	90.9	35.6	9.1	64.4
Surkhet (Doon: 720 m)	85.9	53.0	14.1	47.0
Pokhara (Hill Valley: 918 m)	81.4	53.2	18.6	46.8
Gorkha (Hill: 1 097 m)	76.2	48.9	23.8	51.1
Jomsom (Trans-Himalayas: 2 744 m)	53.9	59.0	46.1	41.0

Source: Gyawali, D. 2003. Rivers, technology and society: learning the lessons of water management in Nepal. Kathmandu, Himal Books, and London, Zed Books; summarized from various records of the Department of Hydrology and Meteorology, Government of Nepal, and Land Resources Mapping Project. 1984. Water resources report. Kathmandu, HMGN & Government of Canada/Kenting Earth Sciences Ltd.

These anomalies call for more studies of droughts, of which the 2008–2009 failure of winter westerlies was the most severe: more than 30 percent of the rainfall recording stations recorded no precipitation at all and all other stations recorded less than 50 percent. Droughts cannot be avoided but they can be predicted and monitored, and their adverse impacts can be alleviated by regular monitoring of regions potentially at high risk. However, very few studies on droughts in Nepal have been recorded so far, the 2010 study by Shakya and Yamaguchi¹¹ being one of the few. Furthermore, unfortunately no national drought impact database exists and drought impact statistics are not routinely compiled at the state, regional or national level. Without this information and a proper definition of drought in the first place, it is an arduous task to convince policy-makers and other decision-makers of the need for additional investments in drought monitoring, prediction, mitigation and preparedness.

¹¹ Shakya, N. & Yamaguchi, Y. 2010. Vegetation, water and thermal stress index for study of drought in Nepal and central northeastern India. *International Journal of Remote Sensing*, 31(4): 903–912.

What these facts call for are much more nuanced definitions of variations in weather and seasons at a much more disaggregated geographical scale and the point at which a meteorological drought can be declared and the affected population advised/ordered to take relevant protective measures. Some of these ideas will be explored further below.

2.2 Hydrological scarcity

Being located at the southern foothills of the great Himalayas, Nepal's river hydrology is monsoon-centric: monsoon rains are the main source of water in Nepal that includes rivers, lakes, water springs, snow, ice, groundwater and soil moisture. As about 80 percent of the annual precipitation occurs in the 70 rainy days within the roughly 100-day monsoon period between June and mid-September, this volume is what is expected to be distributed among all the sources mentioned above as their discharge for much of the rest of the year. However, replenishment of groundwater, which varies due to the total capacity of the aquifer and infiltration capacity of the material between the recharge area and the aquifer, depends also upon the precipitation rate, i.e. if we get 20 mm of rain in just an hour or during the course of the whole day, the recharge would be an order of magnitude higher for the latter case.

On the other hand, the average river discharge of the major first or second order rivers in the monsoon is generally at least five to ten times their lean season discharges and the peak instantaneous discharge may be up to 100 times the lean season discharge (Table 3 below). The seasonal rivers and rivulets are generally live during the monsoon months only. Contrary to popular belief, snowmelt contributes very little to the flow of the Ganga: the overall annual average snowmelt for the Ganga at Farakka is between 1 percent and 5 percent¹². For the tributaries further upstream in Nepal, the contribution can range from 10 percent to 30 percent depending on the river and the nature of its upstream catchment. While low in terms of the annual average, snowmelt is important for the dry-season months of March to May (in the winter months snow does not melt). As Siderius et al. calculate it, in this period, snowmelt contribution ranges from 39 percent to 77 percent in headwater basins and between 16 percent and 51 percent far downstream where there is no other substantial source of runoff. What flow is in the rivers in the dry season is the backflow of groundwater origin.

Nepal's river network consists of over 6 000 rivers and rivulets that drain the country, with most remaining almost dry and water-stressed during much of the year but flooding excessively in the monsoon. This ground reality is quite at variance with the common perception generated by an "eagle eye" science averaging the high monsoon flood and the dry-season flow to give the impression of Nepal being "rich in water resources". According to G.S. Pokharel, it would instead be more fair to say that most of Nepal

¹²Siderius, C., Biemans, H., Wiltshire, A., Rao, S., Franssen, W.H.P., Kumar, P., Gosain, A.K., van Vliet, M.T.H. & Collins, D.N. 2013. Snowmelt contributions to discharge of the Ganges. *Science of the Total Environment*, 468–469 [Supplement]: S93–S101 (available at <http://dx.doi.org/10.1016/j.scitotenv.2013.05.084> and https://www.researchgate.net/publication/241691733_Snowmelt_contributions_to_discharge_of_the_Ganges). Accessed 5 July 2018.

is water-stressed most of the time by either too much of water or too little of it¹³. The little flow that is there in the non-monsoon months does not come from precipitation runoff but from whatever precipitation was stored as groundwater. Unlike Table 3 above which depicts the flow of major Nepali snow-fed tributaries of the Ganga that originate in the snow- and glacier-covered High Himalayas, Table 4 below captures the hydrological characteristics of three non-snow-fed rivers that originate in the Mid-Hills. While in general Nepali rivers carry most of their flow during the four monsoon months, the variation between historically highest monthly flow to the lowest is 20 to 30 times in the snow-fed rivers but 100 to 170 times in the non-snow-fed rivers. In the streams that originate in the Churia hills just before the Terai plains, the difference can be even more dramatic. Many such Churia-originated streams are also known as khahare, i.e. raging torrents after rainfall but practically dry beds at other times “where ants walk”.

Table 3: Seasonal variation in discharge of the three major rivers nearest to the Indian border

River name/station no.	Mean monthly river discharge (cumecs)		Flow variation between historically highest and lowest months
	Jun-Sep	Oct-May	
Karnali Chisapani Station No. 280	2 866.75	564.37	5 706:233 about 25 times
Sapta Gandaki, Narayanghat Station No. 450	3 364.75	654.25	5 602:189 about 30 times
Sapta Koshi Barahchhetra Station No. 695	3 537.50	673.25	6 982:266 about 26 times

Source: Gyawali, D. 2003. Rivers, technology and society: learning the lessons of water management in Nepal. Kathmandu, Himal Books, and London, Zed Books, summarized from various records of the Department of Hydrology and Meteorology, Government of Nepal.

Between 80 percent and 85 percent of the total runoff of 225 BCM that crosses Nepal’s border with India occurs in the roughly 100 monsoon days and what is left to flow in the remaining 265 days is a meagre 30–35 BCM, equivalent to an average discharge of less than 1 500 cumecs, spread over all the perennial rivers from the Mechi to the Mahakali with most of it flowing through the three major rivers – the Koshi in the east, the Gandaki in the middle and the Karnali in the west – including their tributaries. The quantum of flow in the second order rivers like the Mechi, the Kankai, the Kamala, the Bagmati, the West Rapti, the Babai and the Mahakali remains hardly noticeable for such wide river beds during

¹³ Fraser, S., Shrestha, L., Bharati, L., Gurung, P., Maharjan, L., Janmaat, J., Price, J.I., Sherpa, T.Y.C., Bhattarai, U., Koirala, S. & Timilsina, B. 2014. Climate change, out-migration and agrarian stress: the potential for upscaling small-scale water storage in Nepal. Research report 159. Colombo, International Water Management Institute; Pokharel, G.S. 2018. Quoted in T. Paudel & D.K. Adhikari, eds. Proceedings of seminar on Nepal–Bharat Relations, Economic Development and Cooperation, 3–5 March, pp. 107–110. Simara, Bara. Kathmandu, Niti Anusandhan Pratisthan.

the non-monsoon months. Most of the water seeps subsurface and the surface flow is visible in the Tarai plains only in some of the bigger rivers, others appearing dry unless one dug the riverbed to find the water.

When these “blue waters”¹⁴ are seen in overall yearly aggregate, they give a false picture of the real water stress faced by those who live in these basins with widely fluctuating flows. For example, Gassert et al.¹⁵ rank Nepal 78th among 176 countries for water stress and term it medium-high stress (Nepal scored 2.4 out of a highest possible score of 5), where baseline water stress measures the total annual withdrawals expressed as a percentage of the total annual available blue water. These large average numbers – born of a predilection for “eagle-eye science”¹⁶ – hide the real stress that most of those that live in these basins face and which can be understood only with more disaggregated, at an almost hamlet and season level, values – which can be described as grassroots “toad’s eye science”. They, however, point to the possibility of more blue water withdrawals with appropriate (large dams) technologies that store floodwater in societies that are underdeveloped in the conventional sense.

Table 4: Seasonal variation in discharge of Mid-Hill rivers

River name/station no.	Mean monthly river discharge (cumecs)		Flow variation between historically highest and lowest months
	Jun–Sep	Oct–May	
Babai at Bargadaha Station No. 290	116	27	461:5 about 92 times
West Rapti at Jalkundi Station No. 360	242	43	505:3 about 168 times
Bagmati at Chobhar Station No. 550	37	5	95:1 about 95 times

Source: Gyawali, D. 2003. *Rivers, technology and society: learning the lessons of water management in Nepal*. Kathmandu, Himal Books, and London, Zed Books, summarized from various records of the Department of Hydrology and Meteorology, Government of Nepal

What these numbers point to is that, under natural conditions, Nepal is hydrologically a water-scarce region for most of the non-monsoon months. The policy quest, therefore, in addition to other requisite social means discussed below, is to increase the dry-season flow through storage, whether by artificial dams (where topographically and demographically feasible) or by other means such as enhanced ground-water storage, rainwater harvesting or wetlands preservation.

¹⁴ Available water is divided into: green water which is mostly soil moisture and vital for plants in pastures, forests and rain-fed agriculture; blue water which water in lakes, streams, wetlands, glaciers and groundwater; and grey water generated from domestic activities such as laundry, bathing, dishwashing etc. but excluding black water which is sewerage. See: <http://waterfootprint.org/en/water-footprint/what-is-water-footprint/> [accessed 5 October 2018]

¹⁵ Gassert, F., Reig, P., Luo, T. & Maddocks, A. 2013. Aqueduct country and river basin rankings: a weighted aggregation of spatially distinct hydrological indicators. (available at <http://www.wri.org/publication/aqueduct-country-river-basin-rankings>). Accessed 8 July 2018.

¹⁶ Gyawali, D. & Thompson, M. 2016. Restoring development dharma with toad’s eye science? IDS bulletin. Vol. 47, no. 2A (November), States, markets and society – new relationships for a new development era. Sussex, UK.

There is another aspect of hill and mountain hydrological scarcity that is critical in Nepali hills: spring sources of water which have special significance and are often considered sacred. This is because, in most of the Mid-Hills, water consumed domestically for direct drinking, cooking and religious rituals is only taken from good spring sources. Water from lesser grade springs and the rivulets they give rise to is used for irrigation and livestock. Use of river or stream water for direct drinking, cooking and religious use is mostly prohibited except in special cases where there are no reliable spring sources or no perennial spring sources at a reasonable distance from the hamlet in question.

Nepal Water Conservation Foundation (NWCF) has been at the forefront bringing attention to the slowly unfolding disaster of spring sources drying up across the entire Himalayan range, especially in the Mid-Hills where the bulk of the population lives. In the studies done so far¹⁷, the primary driver behind this is not as yet climate change since rainfall patterns are as stochastic as ever even though temperatures are rising; rather the causes are more developmentally anthropogenic. Spring sources in the Mid-Hills all along the length of Nepal (and even in Sikkim and Uttarakhand in adjacent India) are drying up mainly due to:

- ◆ change in domestic consumption pattern from outhouses to piped water and flush toilets;
- ◆ over-extraction and misuse caused by unregulated use of PVC pipes and electric pumps;
- ◆ poorly regulated deep-borehole pump wells without commensurate thought to groundwater recharge;
- ◆ change in agriculture (for those who have not outmigrated) from dryland farming to more water consuming cash crops such as vegetables for sale in the local market;
- ◆ decline in livestock keeping due to outmigration, resulting in shortage of agriculture labour as well as loss of buffalo-wallowing ponds to sedimentation;
- ◆ improper use of the recharge areas with infrastructure building and bad engineering for road construction.

Modernization has come to the Nepali hills and is much sought after by the villagers as it helps alleviate everyday drudgery; but it has come accompanied by a disdain for, and lack of understanding of, local knowledge and traditional technology such as ponds that are more suited to the local terrain and its hydroecology. This problem of drying up of springs is so serious in a terrain with the challenge of verticality mentioned above that many newspaper reports are emerging that talk of entire settlements being abandoned for lack of water. There is even talk that old district headquarters in the hills such as in Ramechhap and Palpa might have to be abandoned and relocated to valley areas with easier access to water.

In Nepali Tarai, groundwater extracted through shallow dug-wells as well as shallow tubewells is commonly used for drinking, cooking as well as small-scale irrigation. However, growing dependence of irrigation on groundwater motivated the farmers as well as the government agencies involved in this sector to

¹⁷ Sharma, B., Nepal, S., Gyawali, D., Pokharel, G.S., Wahid, S., Mukherji, S., Acharya, S. & Shrestha, A.B. 2016. Springs, storage towers, and water conservation in the midhills of Nepal. ICIMOD Working Paper 2016/3. Kathmandu, International Centre for Integrated Mountain Development.

begin to promote the use of deep borehole pumps half a century ago. Since then, the lack of proper water accounting and the overuse and over-extraction of this precious resource without proper consideration for its replenishment especially in Uttar Pradesh and Punjab in India has led to a fall in the groundwater table and the drying up of shallow tubewells. It is also causing a comparable drop in Nepali Tarai, although the consumption of groundwater in Nepali Tarai started relatively late and the rate of extraction is very low compared with the Indian side.

The recharge area of this resource for the Terai as well as the adjacent Indo-Gangetic plains is the Bhabhar range (commonly called “Inner Tarai”, the strip of land located between the foothills and the Tarai proper further south) which runs across Nepal and parts of the Indian Himalayan foothills as well. This area in Nepal is conserved as a national forest of about 12–15 km width and 1 000 km length. In recent times, the forest cover in this area has been subjected to authorized and unauthorized clearing as it predominantly consists of sal trees (*Shorea robusta*) considered the best variety of wood for various construction purposes due to its resistance to water and decay. Similarly, the area has been subjected to over-extraction of construction material (sand and stone aggregates), which is mostly exported to India. This has led to loosening of the sandy, pebbly material of this area, which is transported by the flooding rivers and streams to the Tarai plains, causing dramatic rise of the river bed as well as silting of the fertile land of the Tarai which leads to an immense production loss.

Nepal’s hydrological scarcity is mostly related to monsoon rains (or failures thereof) and is exacerbated by activities both engineering-related and social. It arises also from a lack of understanding of the local terrain and traditional practices, a situation that can be corrected by a better understanding of the local springs, condition of groundwater, local terrain and engineering practices that are sensitive to such a context

2.3 Agricultural scarcity

Nepal disaster report of 2009¹⁸ uses different studies to distinguish between meteorological (inadequate distribution of rainfall), hydrological (inadequate streamflow), agricultural (low soil moisture leading to crop and plant growth failure), social (reduction in availability of food and income) and ecological (failure of productivity of natural ecosystems) droughts. For the purpose of this snapshot, we have aggregated the last three into one single type of drought – agricultural scarcity – because it is at this juncture that the social drought in its varied manifestations comes to intersect with the meteorological and the hydrological. Furthermore, both formal markets as well as informal subsistence agricultural practices are very dependent on soil moisture and humidity, and the nexus between water, energy and food is explicitly experienced therein. This nexus is also experienced in the sector of cross-border agricultural trade: Nepali farm products face a one-sided quarantine in India whereas highly subsidized Indian agriculture products are allowed to freely enter the Nepali market, pushing out Nepali farmers from agribusiness.

¹⁸ Ministry of Home Affairs & Disaster Preparedness Network Nepal. 2009. Nepal disaster report: the hazardscape and vulnerability. Kathmandu, Ministry of Home Affairs.

Nepal used to be net exporter of rice until 20 years ago but now it is net importer, as a result of which horror stories of declining agriculture production in Nepal have become newspaper staples. For instance, a major Nepali daily reports how Jhapa District in east Nepal, which used to be one of the main producers and exporters of rice, has become a net importer with the imports growing each year. The main reason is the fact that the Nepali farmers cannot compete due to heavy agriculture subsidies across the border in India and none on the Nepali side. The second reason for this reversal is “land plotting”, i.e. conversion of fertile cropland into housing colonies. The driver behind this phenomenon is the need to accommodate the inflow of migrant population mostly displaced from the hills during the ten-year-long insurgency, a migration process which continues to date¹⁹.

Only 2.64 million hectares of land or just about 18 percent of the total land area of the country (14.72 million hectares) is arable, of which only 1.8 million hectares is potentially irrigable (see Table 5). At present 1 392 177 ha is irrigated, which amounts to about 53 percent of the total arable land with the rest being cultivated under rain-fed conditions. Unfortunately, most of the irrigation schemes in Nepal provide only supplementary irrigation for rice production in the monsoon and not for dry-season crops. Year-round irrigation which was available to only 18 percent of the arable land in 1995 has now been extended to about 40 percent mostly through groundwater pumping. Thus, there is still a considerable gap between the potential and existing provision of year-round irrigation which is essential for increasing cropping intensity; but this has to be seen within the larger context of constraints of other inputs as described above. Agriculture Perspective Plan (APP) estimated that 200 BCM of surface water and 12 BCM of groundwater is available for irrigation which indicates a surplus over the amount of water needed for 1.8 million hectares of potentially irrigable land.

Altitudinal variations within a short distance of a couple of hundred kilometres in the north–south transect of Nepal result in temperature regimes ranging from cold-desert-type permanent snow in the Himalayas to subtropical or almost tropical, humid and subhumid climatic conditions in the Terai. This extreme variation in temperature and moisture regimes within a short distance creates numerous agroclimatic niches suitable for cultivation of a large number of agronomic and horticultural crops. Different combinations of the temperature and moisture regimes across the country, thus, produce a number of unique agroclimatic zones suitable for a wide range of agricultural activities. In fact, Nepal has such diverse agro-ecological conditions that a highly suitable niche is available for almost any crop in the world.

¹⁹ Portel, P. 2018. Nikasi hune dhan-chamal paithari huna thalyo: sakindai khetiyogya jameen (निकसि हुने धान-चामल पैठारी हुन थाल्यो: सकिदै खेतीयोग्य जमिन) Translation from Nepali: Exported rice now imported – arable land being destroyed (by housing)]. Kantipur Daily, 3 June 2018.

Table 5: Irrigation Status

Area of the Country	14 718 000 ha
Arable land	2 641 000 ha
Irrigable land	1 766 000 ha
Surface irrigation	775 000 ha
Groundwater irrigation	409 013 ha
New-technology irrigation	5 865 ha
Farmer-managed irrigation canals	202 299 ha
Total irrigated area	1 392 177 ha

Source: Ministry of Finance. 2018. *Economic survey 2017/18*. Kathmandu (available at <http://mof.gov.np/en/archive-documents/economic-survey-21.html>); Agriculture Projects Services Center & John Mellor Associates. 1995. *Agriculture Perspective Plan (APP) 1995/96–2014/15*. Report prepared for the National Planning Commission of His Majesty Planning Commission of His Majesty. *Economic survey-21.html*; Agriculture Projects Services Center, and Washington, DC, John Mellor Associates.

The following sections describe a broad range of temperature and moisture regimes prevailing in different geographical regions of the country that affect the prevailing agricultural practices as well as their limitations, especially water stress, for agriculture in those regions. It must be remembered that this applies mainly to rainfed conditions where even irrigated areas are those that receive supplemental water during the monsoon, useful for paddy in “break monsoon” conditions that result in a week or more of no rainfall.

2.3.1 Temperature regimes

Above the altitudes of 3 000 m temperature is too cold to produce crops: it is only suitable for alpine pastures (called kharka in Nepali) and livestock rearing, so all agricultural activities take place below the 3000 m contour line. Thus, for agricultural purposes, the temperature regimes of the country can be divided into three broad classes: cool temperate, warm temperate and subtropical from higher to lower elevations. Carson and Sharma²⁰ recommend dividing the warm temperate regime into two, resulting in four classes as shown in Table 6. While rainfall is the primary source of water for crops, its consumption is measured by the term “potential evapotranspiration” which is defined as the amount of water consumed when the ground is covered with an actively growing grass without limitations, and this plant uptake is highly dependent on ambient temperature. Thus, potential evapotranspiration (PET) is the maximum volume of water a growing crop can consume. Therefore, the balance of water between rainfall and PET gives an indication of water availability. Analysing long-term (20 years) climatic data from a number of climatic stations, months were categorized as wet, moist or dry depending on such a balance. A particular month is said to be wet if rainfall exceeds PET, moist if it is half of PET and dry if it is less than half of PET. On this basis the numbers of dry months were calculated as shown in Table 7, which shows that the numbers of dry months vary considerably (from 2 to 12), depending on temperature regime, rainfall and PET.

²⁰ Carson, B. & Sharma, B. 1992. An ecological classification system for planning in Nepal. Report submitted to the National Planning Commission, His Majesty’s Government of Nepal, HMGN, Kathmandu, Agriculture Projects Services Center.

Table 6: Temperature and moisture regimes

Temperature regime	Elevation range (metres)	Moisture regime	Mean Annual Temperatur(°C)
Cool Temperate	2000–3000	Semi-arid	10–15
II warm temperate	1500–2000	Humid to per-humid	15–17.5
I warm temperate	1000– 500	Subhumid to per-humid	17.5–20
Subtropical	<1000	Subhumid to per-humid	>20

Table 7: Relationship between average annual rainfall, tempterature regime and number of dry months in a year

Rainfall (mm)	Representative stations Elevation (m) and temperature regime				Number of dry months
	<100 ST	1000–1500 I WT	1500–2000 II WT	2000–3000 CT	
<500				Jomsom	12
500–1 000				Jumla	7
1000–2000	Mahendranagar Nepalgung				8
	Dhangadhi Bhairahawa Janakpur	Salyan Nuwakot Dhankuta			7
	Dipayal Simra Biratnagar	Patan Gorkha Ilam	Okhakhunga Pakhribas	Chialsa	6
		Silgadhi Doti Dailekh	Tamghas Bhojpur	Daman	5
			Dadeldhura		3
2000–3000	Butwal			Musikot	7
	Khairinitar Hetauda		Chautara	Kakani	6
	Syangja		Kanyam	Jiri	5
		Taplethok			3
				Lete	2
>3000	Pokhara	Pansayakhola			5
			Lumle		4
	Khudi Bazar				3

Key: ST = subtropical; WT = warm temperate; CT = cool temperate

Source: Carson, B. & Sharma, B. 1992. An ecological classification system for planning in Nepal. Report submitted to the National Planning Commission, HMGN, Kathmandu, Agriculture Projects Services Center.

2.3.2 Moisture regimes

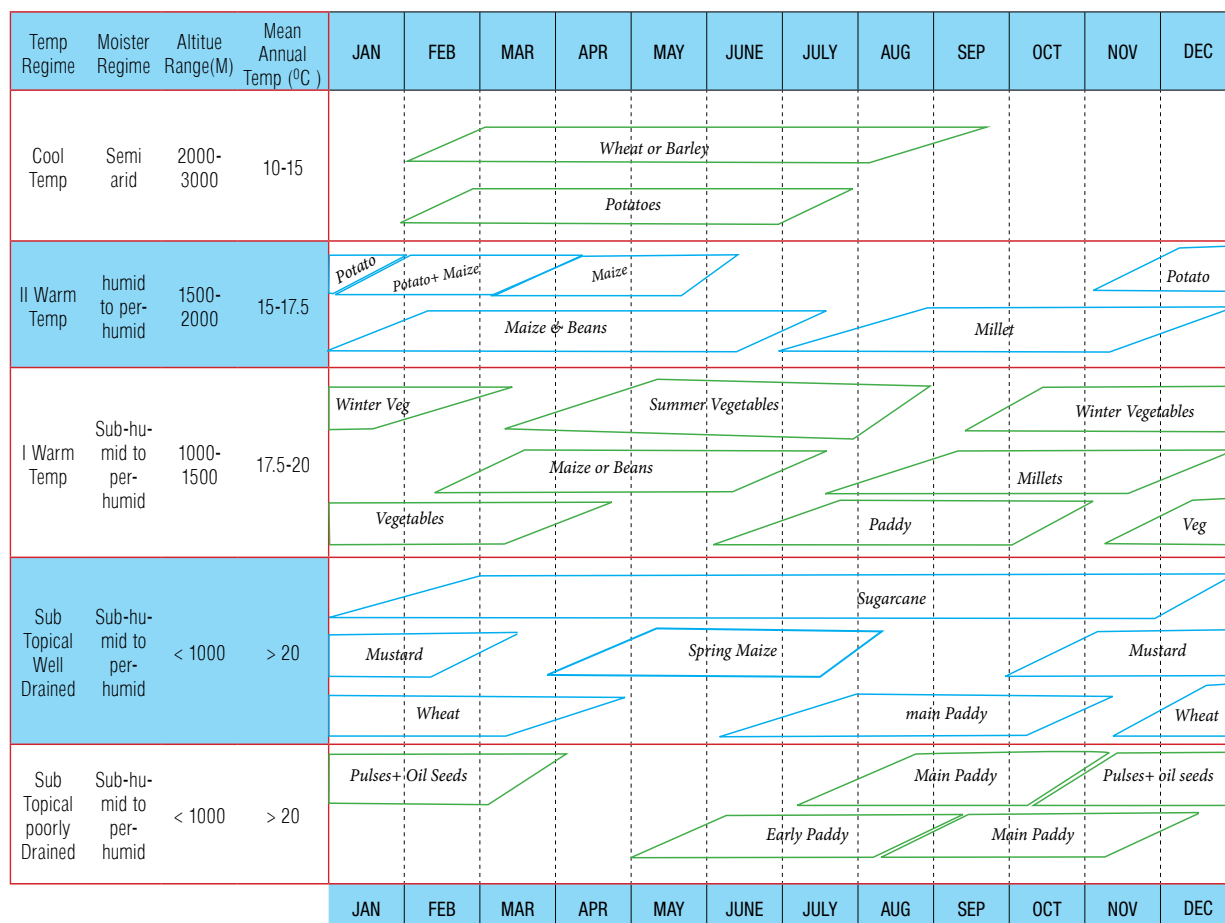
Like temperature, moisture regime also varies widely from semi-arid to per-humid. Based on the analysis of long-term rainfall records, the cool temperate temperature regime in the higher altitudes, in general, experiences semi-arid moisture regime. In II warm temperate regime, the moisture regime varies from humid to per-humid, and in the I warm temperate and subtropical temperature regimes, it varies from subhumid to per-humid. Major characteristics of the moisture regimes are as follows:

- ◆ Semi-arid: Semi-arid moisture regimes are deep river valleys well within the high mountains or High Himalayan physiographic region – Thibru in the upper Karnali River valley and Marpha in the Kali Gandaki occur in the semi-arid regions of Nepal. Juniper and cypress forests are often associated with these semi-arid regions. The driest areas support caragana and lonicera shrubs. Ground crops and temperate fruits do well and represent an important potential export. Agricultural crops require irrigation, even in the monsoon season, in order to be productive.
- ◆ Subhumid: Subhumid moisture regimes occur throughout Nepal from the Tarai up until well within the high mountain physiographic region. The western limit of *Schima wallichii*, a drought-intolerant evergreen tree species, along the Kali Gandaki is apparently associated with the break between the drier western and moister eastern parts of Nepal. Again, it does not appear to be so much total precipitation but the length of the rainy season that is most significant to vegetation and crop growth. Within the Tarai itself there is considerable variability in the moisture regimes, both from east to west and from north to south. However, it is not possible to map out in detail areas of subhumid and humid moisture regimes in the Tarai as the database is too sparse to characterize the noted variability.
- ◆ Humid: Humid moisture regimes are found throughout Nepal in the subtropical, warm temperate and cool temperate areas, in the hills, especially in the river gorges and valleys. Where soils are suitable, these areas are generally highly populated and two rainfed cropping patterns – maize–millet and maize–mustard –with reasonable yields are expected in most years. Benefits are realized by supplemental irrigation during the dry season. Certain horticultural crops suffer due to excessive humidity during the monsoon season.
- ◆ Per-humid: Per-humid moisture regimes are restricted to areas receiving significant orographic rainfall, usually occurring on the upper slopes of the middle mountains and on the southern slopes of the high mountain physiographic region. Per-humid moisture regimes are expected wherever moisture-laden monsoon winds come in contact with high mountain masses. Because of more humid agroclimatic conditions, these areas experience certain agronomic difficulties that are not so common elsewhere, for example fungal diseases.

Based on the varied ecological regimes available in Nepal and the natural water availability or scarcity (especially in terms of soil moisture and PET), its crops and cropping patterns can be described as follows.

In Nepal rice is the most preferred crop and is grown even in places where it is not economically very attractive: indeed, it is even grown where rice should not be normally growing at almost 3 000 m elevation . It is highly suitable in the Terai and in low-altitude valleys and alluvial terraces in the hills and mountains. The cropping patterns in these areas are therefore based on rice, while in rainfed conditions in the hills and mountains, the patterns are based on maize. Due to the large variation in topography, soils and climate, several cropping patterns exist, all based mainly on these two dominant crops. Typical crops and cropping patterns prevailing in the different temperature regimes are depicted in Figure 3 and described in brief afterwards from high altitudes to the lower ones.

Figure 1: Agro climate and typical cropping patterns



Source: Carson, B. & Sharma, B. 1992. An ecological classification system for planning in Nepal. Report submitted to the National Planning Commission, HMGN, Kathmandu, Agriculture Projects Services Center.

In the cool temperate regime, it takes at least six months, if not more, to harvest a single crop of wheat, barley or potatoes. In this region, there is very little cultivable land due to rugged topography, steep slopes and shallow soils and, even in favourable cases, arable land cultivation is not possible without some form of irrigation. As one goes down in elevation, temperature becomes warmer and cropping period becomes shorter so more than one crop is possible in suitable lands. Thus, in the II warm temperate region the dominant cropping pattern is maize based. In addition to maize, millet, potatoes, beans, etc., other crops are grown in this region either by themselves or in mixed and/or relayed cropping systems. The terrain is still very difficult with high topographic variations which limit the extent of cultivable land.

In the I warm temperate region, maize is still the dominant crop, but here, rice cultivation is also very common and is the most preferred crop. The latter is planted on relatively flat land in the low-lying plains, enclosed valleys, alluvial fans locally called tars and man-made flat terraces in gentler slopes. Cropping is more diverse in this region owing to the availability of a variety of agro-ecological conditions because of the existence of a large number of topographical features, climatic variations and soil types.

Altitudes below 1 000 m experience subtropical temperature regime with hot summer and mild winter conditions. All of the Terai, parts of Siwalik foothills, Doon valleys like Chitwan and Dang, and low-altitude alluvial fans in the middle mountains like Panchkhal in Kavre District and Battar in Nuwakot District lie within this region. Carson and Sharma²¹ subdivide this region into two based on soil drainage as well drained and poorly drained. Land at higher elevations within this region is usually well drained and can support diverse crops and cropping patterns and is not severely flooded during the monsoon except for a short period. Wheat, mustard and maize are the dominant crops in this region in addition to rice, which is the most preferred crop. Sugar cane is a popular cash crop in this area.

The poorly drained land within the subtropical temperature regime occurs almost exclusively in the low-lying areas of the Terai and is characterized by frequent flooding for long periods of time in the monsoon. Rice is the most dominant crop in this type of land. Since the soil remains wet and saturated after rice harvest, it is not possible to grow winter crops, except for some pulses and oilseed.

These agroclimatic regions described above are also associated with the production of specific fruit and vegetable crops. Good-quality apples and walnuts are grown in the cool temperate region, for example in Mustang and Jumla. Cole crops like cabbage, cauliflower and broad-leaved mustard grow well in this region. Plums, peaches, pears, oranges and a large variety of summer and winter vegetables like green beans, peas, tomatoes, cole crops, spinach and other leafy vegetables grow successfully in the warm temperate regions. Tea is a traditionally grown cash crop in the eastern part of the country while coffee is gradually gaining ground in almost all of the Mid-Hill districts. Other exotic fruit crops like kiwi fruit, macadamia nuts and avocados have been recently introduced to Nepal and are adapting wonderfully.

²¹ Carson, B. & Sharma, B. 1992. An ecological classification system for planning in Nepal. Report submitted to the National Planning Commission, His Majesty's Government of Nepal HMGN, Kathmandu, Agriculture Projects Services Center.

In the subtropical region mangoes, litchis, watermelons, pineapples and bananas are the common fruit crops. Among the vegetables okra, eggplants, tomatoes, gourds and others are prevalent in this region.

The above diversity in ecological zones and cropping patterns clearly indicates the vast scope for research and pilot activities to understand various types of droughts that affect food production in Nepal, both in the hills and in the Tarai. This is also the focal point where a host of sectoral concerns intersect: meteorology, hydrology, irrigation engineering, changing social practices, laws, investments and changing institutional frameworks. It is on top of all these that the negative impact of decline in the discharge of spring sources and groundwater on which most of the livelihoods in the whole of Nepal depend must be assessed. Climate change adds another layer of uncertainty and risks to those already existing.

3. UNDERSTANDING WATER SCARCITY DRIVERS AND RESPONSES

In light of Nepal's climatic, geographical and social diversities, water scarcity has to be understood in plural terms as well as from both physical and social science viewpoints. As mentioned earlier, while different sectors have been coping with the natural variability in precipitation, there is precious little explicitly stated as policy to cope with scarcity. The sections below will focus on some key areas where scarcity is an issue and how it has been addressed or not. They mainly rely on short key-informant interviews with senior policy-makers, researchers and sometimes political figures and on their views on the recent policy pronouncements of the government.

The most recent policy documents addressing the issue of water scarcity, albeit implicitly, are White paper on the status of energy, water resources and irrigation sectors, and their future pathways²² as well as the National Water Resources Policy (Draft)²³. These documents summarize the contents of evaluations and policy recommendations of previous decades and seek to address the challenges posed by the revolutionary changes in national and local governance envisaged by the 2015 constitution of Nepal. Although the White Paper is devoted in greater part to hydropower, it does make significant admissions regarding water scarcity. While some progress has been made in terms of a modernized hydromet system, the country has only 1 weather radar, 88 automatic rain gauges and 6 automatic flow-measuring stations, which are far from adequate for an orographically diverse country such as Nepal. On the other hand, it admits that hydromet data collected by traditional manual means in the years before are not of satisfactory quality. Its conclusions and prognosis for hydropower and irrigation will be discussed in the sections below.

²² Ministry of Energy, Water Resources and Irrigation. 2018. White paper on the status of energy, water resources and irrigation sectors, and their future pathways. Put out by the Minister of Energy, Water Resources and Irrigation. Kathmandu.

²³ Water and Energy Commission Secretariat. 2018. National Water Resources Policy (Draft). Kathmandu.

The Water and Energy Commission Secretariat's (WECS) draft water policy begins by acknowledging that there is a dearth of water-resource measuring, monitoring and exploiting infrastructure as well as proper legislation and coordination regarding the protection of water sources. It sees the current confusion created by the fundamental restructuring of national governance with the introduction of the new constitution of 2015 as an opportunity to redefine and correct those shortcomings. It bases its proposals on the clear premise that water is both an economic and a social good which needs to be managed in an integrated manner and on the principle that the beneficiaries must pay as per their capabilities and so should the polluters. To address the conflicts between different users as a result of the finiteness of the resource, it proposes the establishment of a "coordinated water accounting system". It has 13 objectives of national water resources development as follows that are expanded upon with appropriate policy and strategy measures:

- ◆ To maximize benefits from different uses and to different users, scientifically transparent and legally enforceable allocation measures will be adopted.
- ◆ to provide unified and common direction and guidance to redefine laws and regulations at national, provincial and local levels of governance;
- ◆ to develop infrastructure to address variable water availability according to time, place and situation;
- ◆ to develop coordinated management system of water-related data and information;
- ◆ to expand the involvement of the public and private sectors, local community, cooperatives, user groups, etc. in the development of different water uses;
- ◆ to conserve water resources for current and future water uses of current and future generations in water-dependent flora/fauna as well as cultural and religious areas;
- ◆ to preserve the quality of drinking-water and water for other uses and to prevent water pollution;
- ◆ to address climate-change-related droughts and floods (including glacial lake outburst floods) and create appropriate mechanisms to address the risks thereof;
- ◆ to promote inclusiveness of women and marginalized communities in decisions regarding water resources especially with respect to rural income generation;
- ◆ to conserve potential sites where water and irrigation projects can be developed;
- ◆ to address resettlement and rehabilitation of the population affected by water-related projects and further development of affected areas;
- ◆ to maximize benefits from water projects that have an international and transboundary dimension;
- ◆ to carry out institutional reforms for effective development and management of water resources.

While all these objectives and the long list of policy and strategic goals geared towards addressing each of the objectives are related to addressing water scarcity even if indirectly, the points of direct interest for water scarcity are the following:

- ◆ Interbasin transfer of water will be promoted as it promises greater benefits.
- ◆ Water use licence will be based on scientific allocation modelling.
- ◆ Strategic environmental and social assessment will be made obligatory for all water-related projects and master plans.
- ◆ WECS will prepare basin master plans for all basins within the coming three years and update them every ten years.
- ◆ If water shortage occurs due to climate change or any other reason, priority for allocation will be in the following order: drinking-water, water for livestock, water for aquatic creatures, irrigation, religious and cultural bodies, hydropower, industrial use, river transport and only then recreation or tourism.
- ◆ Projects with multipurpose reservoirs will be given priority.
- ◆ Enhanced recharge of groundwater will be pursued through ponds, watershed management, wetlands preservation, artificial recharge and other technologies.
- ◆ A common regulatory agency for electricity and water resources will be pursued.
- ◆ Discharge of wastewater into natural waterbodies will be allowed only after appropriate treatment according to the polluter-pays principle.
- ◆ Reservoirs, including groundwater reservoirs, will be designed to address storage during drought years to meet needs on the principle of conjunctive use.

3.1 Water scarcity in agriculture

The White Paper admits that of the total irrigated area of Nepal, less than a third has year-round irrigation and it seems to be mostly from groundwater exploitation that is subject to the constraints of energy shortage. Nepal's government prepared a 20-year Agriculture Development Strategy (ADS) in 2014 which is a successor to the APP described earlier. As argued by Paudel, Bhattarai and Subedi²⁴, while it describes the reasons for failure to achieve previous goals and improves upon the earlier document by recognizing the need for community-based agriculture services centres and the formation of an agriculture development fund as well as a ban on genetically modified seeds, it is still weak on concrete measures. For instance, it uses the term "food sovereignty" but is unable to define it; it emphasizes the need for high investment and commercialized agriculture development without appreciating the fact that in Nepal's context of subsistence farming and massive outmigration of youth this approach is neither sustainable nor productive; and in arguing for a competitive private sector, it fails to understand the

²⁴ Paudel, K.P., Bhattarai, T. & Subedi, Y.R. 2016. Nepal's agriculture development: an analysis of the agriculture development strategy of Nepal (ADS 2015–2035) from civil society perspective. Kathmandu, Alliance of Agriculture for Food with Forest Action Nepal.

damaging impact of an open and loosely controlled border with India where agriculture as well as all supporting measures such as fertilizers and electricity are massively subsidized. Moreover, ADS places rice, Nepal's universal staple, sixth on the priority list after maize, coffee, tea and vegetables!

Although there is no explicit mention of water stress in the plans and programmes of the government, it is addressed directly and indirectly in a number of development projects and research activities of government agencies and parastatals. They are aware of the problem and have efforts underway to address the issue of water scarcity in agriculture. For example, National Agriculture Research Council (NARC) and the Nepal office of the International Rice Research Institute (IRRI) together with the Bill and Melinda Gates Foundation have been working on developing drought- and climate-resilient varieties of rice. While NARC has been working for many years in this sector, its efforts received additional impetus with the world food crises of 2008.

IRRI Nepal developed drought-tolerant varieties of rice such as Sukhadhan 1, Sukhadhan 2 and Sukhadhan 3 (“sukha” means “dry” and “dhan” is “rice”). Flood- and submergence-tolerant varieties like Sambha Masuri-Sub 1 and Swarna-Sub 1 were also developed and tested successfully. Because drought and flood can happen in the same growing season, these latter varieties can withstand submerged conditions for up to two weeks and re-emerge after the flood subsides and produce the same yield at harvest. The rice varieties Sukhadhan 1, Sukhadhan 2, Sukhadhan 3 and another one called Sahabhazi recommended for areas below 1 000 m elevation are also known as climate-resilient mega varieties. The varieties developed by IRRI Nepal are also becoming popular in Bangladesh, India and even the Islamic Republic of Pakistan. According to an unofficial estimate, some 50 trucks of wheat went to Bangladesh last year. There is a high demand for rice seeds from Nepal in Bihar and Uttar Pradesh in India where the varieties Bhrikuti and Gautam are popular. Wheat variety Radha is in demand in Pakistan. Drought-tolerant variety Hardinath-3 also has a high demand in India. Recently released varieties Bahuguni 1 and Bahuguni 2 are also drought and submergence tolerant.

While these are positive measures, they alone will not succeed in addressing the drought problem of farmers. In addition, there are traditional technologies like water recharge through strategically located ponds and use of farmyard manure and straw mulches that help reduce loss of soil water, but these have not been fully evaluated by the government machinery which is more focused on modern methods, and the knowledge is gradually being lost for the lack of their practitioners. The technical wings under the Ministry of Agriculture, however, are aware of the issues and agree that the major causes of water stress are loss of traditional technology like ponds for buffalo wallowing, climate change and migration. When continuously cultivated, grounds retained capacity to infiltrate water to recharge groundwater, but now due to lack of labour force, fields remain uncultivated and lose infiltration capacity. People are gradually shifting from grain crops to less labour-intensive and more profitable fruit crops. They are also experimenting with new small-scale technologies such as cheap flexible plastic pipes instead of open canals to convey water for irrigation which help reduce losses from seepage and evaporation. Another alternative regaining popularity is the reuse of domestic water for irrigation in the kitchen gardens. New technologies

like transplanting 10-inch-long rice seedlings and direct seeding without flooding the field help increase yields and reduce water consumption.

Agro-advisory services are used mainly to inform farmers about weather conditions through mobile apps and bulletins. However, there is still a lack of coordination between various agencies involved in generating and disseminating useful information on a timely basis. For example, in May the meteorological office was aware of an impending storm at least a couple of days in advance. But, they did not communicate with the agriculture office because they did not realize the potential damage to crops that the storm could cause and were not sure who to contact. When the storm finally came, a banana plantation over a big area in Chitwan was totally damaged. Had the information been available in time, the farmers could have protected the crop and minimized losses rather than seeking insurance and other claims after the disaster.

3.2 Water scarcity in hydropower and irrigation

Most of the large hydropower projects in Nepal were till the 1990s donor driven and so were the policies. However, with the entry of the mostly Nepali private sector in electricity generation since then, the size of the private sector's contribution to the total generation is now almost at par with the country's public sector. With the reinstatement of democracy in 1991 and due to pressures from various external as well as internal stakeholders, the first hydropower development policy was promulgated in 1992 to ensure private investment in hydropower. The first important act under this policy was the declaration by the government to fix purchase rates of electric energy from smaller private investors (called independent power producers or IPPs) and promulgation of community electrification policy in 2003 for electrification of the rural areas. As a result, within this year, the total installed capacity of the hydropower projects by IPPs including the ones under construction is expected to surpass the total capacity of the projects constructed by the government over the last century despite over ten years of armed insurgency and an equally long period of volatile social security situation²⁵.

Similarly, community electricity has spread in almost all the districts of Nepal and is serving almost a third of the rural electricity consumers. The most important lesson community electricity has taught is that they have been able to supply electricity with zero theft whereas the average figure for the rural electrification by Nepal Electricity Authority (NEA) is above 50 percent. The rate of new rural electrification too is much faster and at about one-third the cost of government and donor electrification schemes²⁶. Similarly noteworthy is the contribution of mini and micro hydropower plants promoted by the local communities with or without government grants. In terms of the total installed electrical

²⁵ Nepal Hydropower Association. 2017. Nepal hydropower database 2017. Kathmandu.

²⁶ National Association of Community Electricity Users Nepal. 2018. बिद्युत खबर Bidyut khabar [Electricity news]. Kathmandu. Community electricity, like Nepal's earlier success stories of community forestry, irrigation and water supply, is an institutional provision that allows organized formally registered village communities to buy electricity in bulk from the national grid, retail it by themselves and retain the profits for use in other village projects and enterprises.

capacity, the number may look small but its contribution to rural electrification in terms of the number of households served is much higher. Since 1995, over 500 micro hydro plants have been completed and they are serving over 500 000 people across rural Nepal.

A new phenomenon that is arising and the implication of which is not apparent at this stage is the sharp decline in the cost of installing PVC solar panels and their use in water pumping. The positive feature of solar-powered irrigation systems (SPIS) is the very low running cost compared with irrigation systems that run on diesel and electricity, and it provides tremendous autonomy to the farmers. The negative feature is what has been called (in India) “solar tsunami”, the possibility that there will be even more uncontrolled groundwater pumping and the concomitant massive decline in groundwater table. The advocates of SPIS argue that solar pumping is naturally limited by the number of sunlit hours; the opponents argue that bad electricity supply and high cost of diesel limit overpumping even more, and that with the little running and maintenance cost of SPIS and no government controls such as electricity or diesel pricing, eight sunlit hours are more than enough to do even more damage.

These different initiatives are important from a water-scarcity perspective because their main objective of generating cheap and accessible (hydro)electricity and tying it up with rural electrification provides for economic development and prosperity that come about with comfortable access to water. In areas with community electricity, village groups have successfully experimented with pumping water for lift irrigation with drip technology. These schemes also double as domestic water supply sources which obviates the challenge of verticality and provides drudgery-free drinking-water. With the grid-supplied electricity, however, the preponderance of run-of-river schemes means that there is a “flood-drought” syndrome in the system as a whole: there is a surplus of hydroelectricity during the monsoon months and a shortage of supply in the non-monsoon months when, as indicated in Tables 3 and 4 above, the river flow reduces, depending upon the type of river, by 20 to 200 times. The need therefore is increasingly being felt – and currently is being addressed by the draft Water Resources Policy – for multipurpose storage-type hydroelectric projects that store part of the monsoon flow and release it during the dry season both for power generation as well as for agriculture and domestic consumption needs.

3.3 Water scarcity in urban settlements

Nepal is undergoing tectonic restructuring of its governance structure with the new 2015 constitution: where previously there were over 4 000 village committees and about 24 municipalities, the number of village “municipalities” has been reduced to about 460 and the number of urban municipalities has instead been expanded to almost 300. However, from the point of view of the presence of infrastructures that differentiate the urban areas from the rural areas, there are not more than 30 urban municipalities and the remaining are administrative units composed of villages and hamlets with large population density. Most of the urban areas including the capital city of Kathmandu either do not have the required infrastructure or have infrastructures that are in various states of dilapidation including water supply

facilities. Even areas deemed as municipalities are a mix of semi-urban, semi-rural and wholly rural areas. And domestic water supply in these areas, whether considered urban or rural, is very problematic.

Earlier, we discussed how, with the drying up of the springs, water supply was under stress in the villages of Mid-Hill in Nepal and how with the fall of water table through pockets of overpumping it was problematic in the valleys and plains as well. Water shortage in the urban areas has always been an issue of concern since the beginning of modernization in the late nineteenth century: it has been massively exacerbated by the urban population explosion that began sometime in the 1980s and made worse by the Maoist uprising and the attendant insecurity in the villages, prompting rural-to-urban migration. For instance, the Kathmandu Valley has seen an increase in population during this period from approximately 300 000 to currently about 3 million. We will take its case as symptomatic of the problem of urban water scarcity.

The valley of Kathmandu which includes the capital city of Kathmandu is considered administratively to be composed mostly of all urban areas. It has 2 metropolises, 15 urban municipalities and 3 rural municipalities in south Lalitpur. The whole of the valley can be characterized by its unique and strong linkage to the rural areas due to not only its dependence on the rural communities for the daily labour but also the fact that most of the urban elites have farms in the peri-urban rural areas called “kanth” and a significant part of their livelihoods depends on the farms. Other features of the capital city and the municipalities surrounding it are lack of potable water round the year, lack of good transport infrastructures, sewers that mostly feed the trunk river of the Bagmati and tributaries that flow only in monsoon floods and stink as gutters during most of the other months.

Mostly inadequate is the water supply not so much due to lack of water in the system – the valley gets an average annual rainfall of over 1 200 mm – but due to unmanaged leakage in the collection and distribution system, which amounts to over 70 percent of the total supply. As a result, not only is there no municipal water supply in large areas of the municipality, but what is available from the municipal lines is available for only a few hours a day, one or two days a week. (This picture, though not as acute, repeats itself in almost all the municipalities of Nepal.)

A quick survey was conducted by NWCF to assess the status of the drinking-water being supplied in the Kathmandu Valley. Kathmandu Upatyaka Khanepani Limited (KUKL) is the main government utility that (mis)manages water supply. While some 25 years ago there were only a dozen water supply tankers and bottled water was practically unheard of, currently there are (according to some estimates) thousands of private water supply tankers owned by about 150 private water supply companies. They get their water from village spring sources as well as from KUKL deep-boring plants; they are mostly unregulated but recently there has been some attempt by KUKL to provide stickers certifying whether their water is potable or meant only for other uses. There are very few published studies, but some researches under

way and only presented²⁷ show that KUKL's 27 tankers supplied 192 million litres of water in 2016 and more than 90 million litres of groundwater was extracted for bottled water in the financial year 2010/11.

It was found that most of the 3 million (permanent)/5 million (floating) people that inhabit the valley drink bottled water, buying either 20-litre jars or 1-litre bottles. While the information must exist about how much bottled water is consumed in Kathmandu (indeed in Nepal as a whole), there does not seem to be any easily accessible official data. There are many water suppliers around the valley that fill the water tankers for home delivery in capacities ranging from 5 kilolitres to 12 kilolitres from non-KUKL sources such as Taudaha and Godavari springs. One tanker makes as many as five to six trips a day. An 8-kilolitre tanker of water costs about NPR 2 700 and can go as high as NPR 4 000 in the dry season and depending upon the quality of the water. It is also found that the smaller tankers are more popular due to narrow roads. The use of water tankers and the way the business has boomed in the past few years is indicative enough that the urban municipal water supply system in the valley is grossly inadequate from the point of view of quality as well as quantity.

The situation in the surrounding areas which supplied water to the core of the city through water springs is even worse due to the fact that most of the water springs remain dry except in the monsoon. The traditional water supply system from the springs and wells as well as the ancient stone spouts located in most of the populated areas of the past has been neglected and its supply has been disrupted due to construction of buildings over the aqueducts. The areas around the water springs where the spring source used to get replenished have become occupied by either houses or other infrastructures as roads and are in a condition that does not allow easy infiltration of water into the ground. The groundwater table in the valley has fallen so low in the last 20–25 years mostly due to overpumping that it is no more feasible to operate simple handpumps or even shallow tubewells in the urban areas as well as in the surrounding villages and hamlets.

The official attempt to solve this chronic problem is to bring in water through a very large transboundary transfer of water from the Melamchi River to the north of Kathmandu through an almost 30 km long tunnel. Begun in the early 1990s, it still shows no signs of completion, even though one or the other completion date is announced by people in power from time to time. Even with the Melamchi project, optimized 25 years back, the water supply situation in the Kathmandu Valley does not seem to have eased much as the population growth in this period has been almost four times the rate in the years before and the leaking supply system still remains²⁸.

²⁷ Yakami, S. 2017. Tanked water supply in Kathmandu Valley and a case study of Jhaukhel, Bhaktapur. Project on Climate Policy, Conflicts and Cooperation in Peri-Urban South Asia. Wageningen University, the Netherlands.

²⁸ Details in Gyawali, D. 2015. Nexus governance: harnessing contending forces at work. Gland, Switzerland, International Union for Conservation of Nature (available at http://www.iwa-network.org/wp-content/uploads/2016/03/1448008531-Nexus-Governance-Harnessing-Contending-Forces-at-Work_Dialogue-Synthesis-Paper-2015.pdf).

This water scarcity situation also exists in populated areas in other municipalities, submetropolises and metropolises. The urban expansion into surrounding villages by an increased population without any system in place for the management of its wastes has polluted natural waterbodies. The loss of local ponds to urban growth leading to loss of recharge of groundwater is exacerbating the scarcity even more.

3.4 Pollution-induced scarcity

The environmental degradation of the towns and settlements including waterbodies has reached an alarming level: except during the monsoon, sewage instead of water flows in these rivers. As in most of South Asia, this problem is most serious in waterbodies in or near big cities such as Kathmandu's Bagmati, Birganj's Sirsiya and Pokhara's Phewa Lake. What this has done is made such water less useful for irrigation and other uses such as bathing (including that associated with religious rituals) and washing of clothes. It has also led to the extinction of aquatic life in these rivers since, except for the monsoon months, the water in these rivers are mostly sewage outflows. The level of pollution in the waterbodies is in direct proportion to the population increase of the settlements; hence rural areas are cleaner than the urban areas, indicating an absolute absence of environmental governance of the municipalities.

The reduction of aquatic life in many subsidiary tributaries and smaller streams is also exacerbated by the excavation of the river bed for sand and construction aggregates. River-bed mining has reached such a level that the footings of many bridges in locales where this is prevalent have been exposed, leading to instability of structures and their sinking or getting washed away during floods. Conversely, downstream of where such activities are taking place, the river beds are rising due to uncontrolled sedimentation, deforestation of the hills as well as bad engineering practices related to infrastructure development, causing larger flood-inundated areas in the monsoon. The loss of aquatic life from such after-effects of uncontrolled modernization has direct consequences for the marginalized and poor communities who depend on subsistence fishing to meet their protein needs.

The aquatic biodiversity is also greatly affected by water diversion from the rivers for hydropower generation. Theoretically, a downstream release of environmental flow (eFlow) of 10 percent of the minimum monthly discharge is legally binding but none of the hydropower projects have been observing this regulation. This breach is also carried out by hydropower projects owned and operated by Nepal's government utility the Nepal Electricity Authority. Therefore, lack of proper environmental governance has led to pollution, which is creating a different type of water scarcity that is affecting natural or economic life.

3.5 Social science concerns

While this short snapshot is not the apposite place to comprehensively address the issue of water scarcity from a social science perspective, nevertheless many of the recommendations to be made below to address water scarcity must come to terms with those concerns. This report considers Mehta's 2010 book²⁹ as the starting point for such an enquiry, primarily because one of the authors of this report was part of that study team. What various contributing authors do is deconstruct the notion of scarcity from multiple academic perspectives, arguing that scarcity – while real in physical terms (there is after all water scarcity in towns and villages) – is more often than not also socially constructed and used to further particular technologies as well as officially sanctioned patterns of behaviour.

Luks³⁰ shows how scarcity was conceptualized long ago by Thomas Hobbes, but it received its biggest reification with neoclassical economics as the fundamental state of existence, as the economic problem, with efficiency, innovation and substitution as the way out. It results in a contradictory and paradoxical “rat race between the fight against scarcity and the constant creation of new needs and desires” at complete variance with the original fight and with the very concept of sustainability. Thompson³¹ using the new integrative social science called the theory of plural rationalities (of cultural theory) shows how four different social solidarities (i.e. market individualism, bureaucratic hierarchism, activist egalitarianism and voter/consumer mass fatalism) use four different organizing strategies to cope with scarcity. If there is scarcity, then one's needs and resources available to fulfil those needs have to be somehow matched; and there are four possible managing styles: one can manage neither one's needs nor one's resources; one can manage one's needs but not one's resources; one can manage one's resources but not one's needs; and, finally, one can manage both one's needs and one's resources. In the first, there is no degree of freedom (fatalism), in the second (egalitarianism) and the third (hierarchism) there is one degree of freedom and in the fourth there are two degrees of freedom (individualism). Hence the argument is that it is not scarcity per se that we should be worried about but whether one management style and voice is hegemonic and whether it silences other voices.

This is indeed the story of the Kathmandu Valley's water scarcity. The one hegemonic hierarchic solution was transboundary transfer of the Melamchi River's water to the valley through a 30 km long tunnel and heavy engineering that is taking decades. Meanwhile, not everybody is waiting fatalistically for this solution to materialize so they can have sufficient water flowing through defunct municipal pipes again: tankers, bottled-water supplies, sand-filled plastic bottles placed in flush tanks to reduce flush volume and rainwater-harvesting tanks are all competing for the consumer's attention quite successfully.

²⁹ Mehta, L., ed. 2010. The limits to scarcity: contesting the politics of allocation. London, Earthscan.

³⁰ Luks, F. 2010. Deconstructing economic interpretations of sustainable development: limits, scarcity and abundance. In L. Mehta, ed. The limits to scarcity: contesting the politics of allocation, pp. 93-108. London, Earthscan.

³¹ Thompson, M. 2010. A bit of the other: why scarcity isn't all it's cracked up to be. In L. Mehta, ed. The limits to scarcity: contesting the politics of allocation, pp. 127-142. London, Earthscan; Thompson, M., 2003. Yes, culture matters, but in what way? In E. Ehlers & C.F. Gethmann, eds. Environment across cultures, pp. 39-54.

Indeed, as Mehta herself concludes in Afterword³²: looking beyond scarcity, this means recreating what has been erased while interrogating the hidden assumptions behind the so-called neutral term “scarcity”. The danger is that the “scare” in scarcity has led to scarcity emerging as a political strategy for powerful groups to impose solutions that are clearly inequitable to both man and nature. Scarcity is polyvalent with different ways in which problems of scarcity and their solutions can be contested and reconstructed if we want a more just and equitable economic system that creates more wealth than “illth”.

4. POLICY, PROJECTS AND RESEARCH

This section reflects on some of the policy statements of the government as they pertain to the issues of water scarcity, food production and agriculture development as well as the programmes of the foreign aid community. The ongoing institutional restructuring in Nepal, despite creating new challenges, presents a wonderful new opportunity to reflect on past activities, review their strong and weak points, and design programmes to suit the new circumstances. We will conclude with a few research, action research and pilot project recommendations to address the issue of water scarcity in the multihued hydroecology of Nepal, as far as possible geared to the mandate of FAO and possible interlinkages with other development partners.

4.1 Policy

There is no explicit water scarcity policy within Nepali water policy circles, and indeed drought as such was never much of a policy concern except when it became an immediate and short-term (almost ephemeral) political issue with the failure of the monsoon. It is, however, implied and embedded in all water-related programmes of the Nepali government and its development partners, from agriculture and hydropower to domestic water supply and irrigation. The most critical is Nepal’s agricultural policy, which is currently guided by the development vision presented in the Agriculture Development Strategy³³. This strategy for the period 2015–2035 envisages year-round provision of irrigation to 80 percent of the irrigable land and reduction in degraded land from 3.2 million hectares to 1.6 million hectares. Rather than building new big schemes, the ADS recommends expanding the irrigated area by most feasible means like completing already commenced surface-water schemes, pilot construction of medium pond/recharge basins, repairing damaged surface systems and tubewells based on farmers’ demands, constructing new tubewells and developing non-conventional irrigation (NCI). NCI in hill areas seeks to tap small, local water sources and use water-harvesting techniques and small-scale pump systems based on drip or sprinkler systems to irrigate high-value crops. In the Tarai, ADS recommends continued support to the treadle pump programmes and small lift pumping systems using water from

³² Mehta, L. 2010. Afterword: Looking beyond scarcity. In L. Mehta, ed. *The limits to scarcity: contesting the politics of allocation*, pp. 253–256. London, Earthscan

³³ Ministry of Agriculture Development. 2014. *Agriculture development strategy (ADS) 2015–2035*. Kathmandu.

nearby streams and other water sources. In addition, the strategy recommends increasing irrigation efficiency to increase the effective area of existing schemes.

ADS also proposes addressing food security by mobilizing sufficient consensus, resources and effective management through its flagship programmes that include Food and Nutrition Security Program (FANUSEP), Decentralized Science, Technology, and Education Program (DSTEP), Value Chain Development Program (VADEP) and Innovation and Agro-entrepreneurship Program (INAGEP). With this strategy, ADS hopes to reduce current “food poverty” of 15–24 percent affected people in the short term (5 years), 11 percent in the medium term (10 years) and 5 percent in the long run (20 years)³⁴.

4.2 Programmes of development agencies

As this country snapshot is being finalized (August 2018), Nepal’s overall development programme, including those of its foreign aid partners, is undergoing some significant restructuring. The decade following 2006 – when the Comprehensive Peace Agreement was signed between the Maoist combatants and the Nepali state which included the Nepal Army and the parliamentary political parties – saw much of the foreign aid attention concentrated on assisting the peace process and constitution-making which was contingent on it. However, with the arrival of the new constitution in 2015, the peace process is seen as having been logically concluded, and the focus now is *sambhiddhi*, the Nepali government’s term for prosperity and development. In the meanwhile, much has changed in Nepal with its society, demographics and economy. The erstwhile premise of development assistance, thinking of Nepal as a poor country with scarce capital resources, is no longer valid. The country has shifted to a “remittance economy” with remittances accounting for almost 30 percent of its GDP (concomitantly with almost a fifth of its population [mostly working-age youth] working in the Persian Gulf, Malaysia and the Republic of Korea). The government’s revenue has increased dramatically with indirect tax on the increasing health, food and education expenditure these remittances make possible.

In addition to this state of programmatic and orientational flux, the development community is also faced with an immediate institutional flux in Nepal’s local governance. The 2015 constitution did away with the erstwhile units of local governance – the roughly 4 000 Village Development Committees (VDCs), 58 municipalities and 75 District Development Committees (DDCs) that were the administrative basis and data consolidation units – and replaced them with a three-tier system of governance with 756 town and village municipalities (of which 217 are town municipalities) at the lowest level. In addition, there is a middle layer of seven provinces between the national government and the municipalities. There is little clarity as of now on the roles and limitations of these bodies, hence some confusion regarding their role in resource management, taxation and development activities. It is assumed that the democratic process will eventually iron out these issues.

³⁴ Ministry of Agriculture, Land Management and Cooperatives. 2018. Status report on food and nutrition security in Nepal. Kathmandu.

The largest bilateral donors (i.e. between Nepal and another donor country as different from multilateral institutions) in agriculture, irrigation and food include the governments of Japan, India, the United Kingdom of Great Britain and Northern Ireland, the Swiss Confederation, the Federal Republic of Germany and the United States of America. Similarly, the top multilateral donor agencies include the World Bank, ADB, and United Mission to Nepal (UMN). Bilateral agencies also include Japan International Cooperation Agency (JICA), Department for International Development (DFID), CIDA, United States Agency for International Development (USAID), GIZ, Kreditanstalt für Wiederaufbau (KfW), Swiss Agency for Development and Cooperation (SADC) and FAO. Using basket funds (where different donors pool their resources for a common project) and other mechanisms, many international non-governmental organizations (INGOs) such as Oxfam, Cooperative for Assistance and Relief Everywhere (CARE), the Asia Foundation, International Development Enterprise (IDE), International Water Management Institute (IWMI), etc. work in rural development, water supply and irrigation. They also contribute towards funding for fertilizers, pesticides and purchase as well as transportation of rice and other foodstuffs from the main stores in the cities to the rural as well as remotely located food-deficit areas. (Chinese non-governmental organizations have just begun making a foray into Nepal under the Chinese government's new cooperation policy and it is unclear as yet what direction that will take.) In the same manner, the South Asian Association for Regional Cooperation (SAARC) has a food security programme under which each member country is supposed to have some food reserves. However, given that Indo-Pakistan rivalry has put SAARC in near-comatose state, this programme – though approved by eight heads of state – may have a questionable future.

Each donor country as well as donor agency has committed funds for particular projects located in particular areas of Nepal and the funds are generally disbursed on the basis of physical as well as financial conditionalities and the progress achieved in the past cycles of that or related projects. Apart from the projects directly under the Government of Nepal's programme under different water-related ministries, there are large donor-assisted projects on irrigation, hill irrigation, farmer-managed irrigation, etc. as well as projects on energy that support irrigation projects at various scales and therefore are closely linked to food production and food security.

In the list below, we will try and summarize the current development priorities of some of the different development agencies that deal with water, excluding those of China and India which function with more direct political understanding than the others. We also will not summarize the work of multilateral agencies such as the World Bank and the Asian Development Bank that, though very much involved in the water sector, have more to do with infrastructure loans than the social and institutional construction of water scarcity. This summary is based on interviews with concerned key informants as well as information from documents and websites; and it is limited to those programmes and activities that have a bearing on water and (where possible) water scarcity although this is mostly implied and not explicitly stated.

- ◆ **Danida:** The Danish aid programme has strong support for university-led research with activities focused on poverty and its dynamics, climate change and rural livelihoods, biodiversity and community forestry as well as labour migration. Its Unnati (meaning “progress”) programme a USD 70 million inclusive growth and poverty reduction set of activities is focused on market-based growth and value chain in agriculture, especially in east Nepal. In achieving increased agriculture growth, water and its scarcity are critical but only implied and not separately addressed.
- ◆ **FINNIDA:** Finland has been a major donor in Nepal since the mid-1980s with a major focus on commercial forestry and rural water supply. Its Rural Water Supply and Sanitation Project is concentrated in 14 districts of western Nepal and is now in its second phase. Because it is about domestic water supply which is dependent on spring sources – which are drying up all across the Himalayas as discussed earlier – water scarcity is implied but not explicitly addressed as such.
- ◆ **USAID:** The United States of America has the longest history of development work in Nepal, starting with Truman’s 4-H programme after the Second World War. It worked mostly in agriculture and infrastructure development in its early years but ceded infrastructure to other multilateral agencies such as the World Bank and the Asian Development Bank until recently when it re-entered the infrastructure sector through the Millennium Challenge Corporation (MCC). The first big MCC project in Nepal is a USD 500 million project for electricity transmission line. USAID’s two programmes more directly concerned with water are Paani (meaning “water” in Nepali) and Kisan (meaning “farmer” in Nepali). Paani is a four-year (till 2020), USD 25 million programme to enhance Nepal’s ability to manage its water resources through climate change adaptation and the conservation of freshwater biodiversity. Kisan is a five-year, USD 33 million agriculture sector programme that includes climate-smart intensification of staple crops and strengthening of value chains of local market systems. Both these projects are focused in west Nepal and around the issues of water, which means they are aware of water scarcity but are trying to address it in the hitherto conventional manner. It was with USAID Paani’s support that Nepal Water Conservation Foundation and International Water Management Institute conducted a large-scale, actual water use survey of households in western Nepal.
- ◆ **JICA:** Japan’s development agency has three priority areas in Nepal infrastructure (roads, electricity and water supply), consolidation of peace and democracy, and rural poverty reduction. Water issues are dealt with under urban water supply (the Kathmandu Valley as well as some other urban areas) as well as in agriculture development (primarily in the Terai region around Janakpur). As with other aid agencies, water scarcity is a challenge JICA projects face but it is addressed implicitly, not explicitly.

4.3 Suggested programmes

Some suggestions have already started emerging in the sections above. Here we will highlight more interesting programmes that would concretely address water scarcity in the Nepali context. They would be of intrinsic interest from previous work and experience of NWCF and for what we see as possible or promising from the perspective of the Food and Agriculture Organization of the United Nations. The consultative process of the five-year assistance programme of FAO ending in 2017 saw the formulation of priority areas based on two key policy and investment frameworks – National Agriculture Sector Development Priority 2010 and Nepal Agriculture and Food Security Country Investment Plan 2010. The four priority areas are food and nutrition security and safety, institutional and policy support, market orientation and competitiveness, and natural resource conservation and utilization. Focused as they are on agriculture and food including related topics such as crop diseases, access to markets, etc., they do mention irrigation, infrastructure, deteriorating watershed services and climate change, all of which imply water scarcity but do not explicitly address it. If water scarcity is to be specifically built into this programme, the following new approaches weaved into it, perhaps in consultation with other like-minded development partners, might be relevant.

In experimenting with new possibilities that arise from trying to define a water scarcity programme, it might be useful for FAO to begin with a “hydro diplomacy” approach: significant advance work needs to be done discussing with both in-country and international partners, convincing them of the need to address water scarcity from an FAO perspective, as well as the need to weave such concerns and activities into their own ongoing and planned activities. This work might be a separate project by itself, but it would be much required, and useful, in the changing Nepali and global development context. At the FAO end, there might be a need to flesh out and define what water scarcity means in the context of the Millennium Development Goals (MDG) till 2015 and its successor, the Sustainable Development Goals (SDG) that define the focus of development cooperation till 2030.

- ◆ Rejuvenating drying springs: Study and research on water springs as they are the source of most of the water used for practically all economic purposes including agriculture and water supply for urban as well as rural areas. Water from snowmelt is important as a resource but as it flows down in the first-order rivers and their tributaries, its impact on local economic activity within Nepal is limited. The first task is for the government to embark on a programme of spring mapping across the nation as has been done to the east by the Government of Sikkim in India. The second task, partly begun by NWCF in east Nepal, is to convince hydropower operators to “adopt” a few spring sources upstream of their water diversion dams and thus be in a position to predict energy output based on the health of the spring in the previous monsoon. Such knowledge would have tremendous benefit for other sectors of the economy such as agriculture, livestock and horticulture in ameliorating the impact of water scarcity.
- ◆ “Storage, not dams!”: Dams, especially large dams, though much needed given the poor level of economic development, have become political lightning rods because of their social consequences. Policies should focus on storage and talk more about that rather than talk in terms of dams. Such

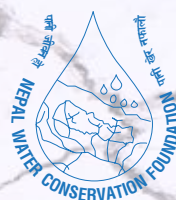
storage policies should highlight four types of storage that different social solidarities veer towards (also highlighted by IWMI). Storage in wetlands, village ponds and groundwater is much appreciated by activist egalitarians because water then is treated as a common-pool, human rights friendly good. Markets are happy with storage in small systems that can be easily treated and used by individuals, viz. household storage tanks that tankers can fill, storage in jars, etc. Large hydrocracies naturally veer towards big dams which may be necessary (mostly for those downstream of the dam and not upstream) but not before other possibilities have been exhausted. And such large storage structures should, unlike currently in Nepal, consider multiple use of stored water so that the costing is done on the basis of the benefits to each of the beneficiary sector and not just lumped on one. (Currently, such storage is considered – even in transboundary discussions – only for hydropower with other beneficiaries such as irrigation, navigation, fisheries and flood control as free-riders.) Such plural choices are necessary to avoid technological lock-in with (later) highly inflexible systems that cost too much to rehabilitate if damaged by floods, landslides or earthquakes.

- ◆ Data democratization: The official governmental department of hydrology and meteorology is always strapped for cash and has not been able to properly run its network of far-flung stations. While standard-setting government-controlled stations are necessary, it might be more practical to start a programme of citizen science in tandem that we have chosen to call “data democratization”. A small programme run by Nepal Water Conservation Foundation with small grants from supportive donors was able to establish rain gauges and temperature reading in schools in the Marchawar area of Nepali Tarai as well as around the Kathmandu Valley and in the adjacent district of Kavre. The data from these school stations were linked with local FM radio stations and broadcast daily. It was hugely successful and brought about much public interest as well as the training of a new generation of children who could tell what a heavy rainfall or drought was in numerical terms. The advantage of expanding such networks to all the schools and irrigation/hydropower offices is that they would expand hydromet data points dramatically by orders of magnitude. They would also provide additional checkpoints for the Department of Hydrology and Meteorology in addition to freeing their resources to do high meteorological science with radar and Doppler systems.
- ◆ Transect study: Nepal is the ideal location for doing a transect study for climate change impacts on water scarcity since the country, having areas with elevations ranging from 60 m above sea level to over 8 000 m, changes from tropical to arctic as one moves northwards from the southern border. Establishing monitoring stations along such a transect would allow understanding of not just species succession but also actual climate impact with global warming. A good beginning has already been made with the Lobuche Photovoltaic-powered Pyramid lab at 5 000 m elevation near Mt Everest.
- ◆ Changing dietary habits: It has been said that a shift from heavy water consuming rice and wheat to non-rice/wheat cereals such as millet, barley, etc. would reduce water consumption in agriculture by significant amounts. While white rice and bread had become the hegemonic cereals with people requiring them even in places that did not grow these crops, and thus adding food-miles to the overall water and energy footprint budget, there is a positive trend emerging from tourism. Because of Nepal’s ethnic diversity, ethnic dishes, many of them dependent on dryland cereals, are becoming popular again. They have the added advantage of being healthier in comparison with

white rice. A part of the water scarcity reduction programme might be to make this trend more popular among the local population and not just exotic tourists.

- ◆ Survey of actual water use: Last, but perhaps the most important, might be a survey of nationwide water scarcity conditions and coping mechanisms in comparison to the overall water and energy footprint and non-functional water infrastructure, etc. NWCF together with IWMI conducted such an “actual water use” survey –for west Nepal with IWMI through USAID’s Digo Jal Bikas (DJB) programme last year and the results are being processed for understanding the implications. Such a scientific statistical survey, complemented by in-depth key informant interviews and focus group discussions, would provide national and international policy-makers with insights and factual data with which to devise appropriate policies to deal with water scarcity. It may also cover perceptions of what within- and outside-country overpumping is doing to the water sources people have been traditionally dependent on.





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