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Groundwater Policy and Ground Water Dependencies: Reflecting on the Evolving Socio-Environmental Dynamics in Peri-Urban Kathmandu Valley

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GROUNDWATER POLICY AND GROUNDWATER DEPENDENCIES: REFLECTING ON THE EVOLVING SOCIO-ENVIRONMENTAL DYNAMICS IN PERI-URBAN KATHMANDU VALLEY

Anushiya Shrestha[1]

ABSTRACT

Groundwater is an increasingly important source of water supply in Kathmandu Valley, 'the hub of Nepal's urbanisation'. Past studies have revealed that groundwater extraction in Kathmandu Valley exceeds its recharge, thus having negative consequences like drying of traditional water sources, decreasing yield of wells, and declining groundwater levels. The groundwater policy 2012 was formulated with the aim of managing groundwater use in the valley. Yet, with rapid urban growth, groundwater exploitation has continued increasing in the city and the peri-urban areas in Kathmandu Valley. But little is known regarding how urbanisation shapes increasing groundwater exploitation in the peri-urban settings. This study unfolds the underexplored socio-environmental dynamics underlying groundwater exploitation in peri-urban areas of Kathmandu Valley. The findings from the case study using qualitative research methods, conducted in peri-urban locations of Kathmandu Valley show increasing competition for water and growing use of as well as dependence on groundwater in these rapidly evolving peri-urban spaces, despite growing protests and worries about its consequences. However, the existing groundwater policy lacks attention to peri-urban dynamics of change and growth and does little to address the increasing groundwater use in peri-urban locations in the valley. The polarised views and local conflicts around groundwater exploitation emerging in peri-urban spaces are the outcome of multiple entanglements:

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sectoral divides and overlapping responsibilities in water institutions, weak governance and management, socio-economic transformations in peri-urban spaces, the invisibility of groundwater and ambiguity in the hydrological dynamics of conjunctive water use. Based on my findings, I stress on the need for addressing the existing macro-micro gaps in (ground)water management by improving the understanding of local hydro-geological complexities and paying critical attention to the socio-economic, political and institutional drivers of increasing groundwater use.

Keywords: Groundwater, institutions, peri-urbanisation, policy, Kathmandu Valley, Nepal

INTRODUCTION

Located in central Nepal, Kathmandu Valley has a sub-tropical climate with over 1,500 millimetres average annual rainfall, 80% of which occurs during the monsoon period (UN-Habitat, 2015).[2] With the capital of the country located within it, Kathmandu Valley is rapidly urbanising. Between 1971 and 2011, the population of the valley increased from 0.6 million to over 2.5 million, with an annual growth rate ranging between 2.3% to 5.8% (Rimal et al., 2017). The built-up area in the valley has increased from 5.1% in 1989 to 26.06% in 2016, showing a tremendous increase of 412%, mostly at the expense of agricultural land (Ishtiaque et al., 2017). Urban expansion in the valley is generally spontaneous and haphazard, driven by private sectors than by planning or intervention by the government and its agencies (ICIMOD, 2007; Shrestha, 2011a; Shah, 2013).[3] This trend of unplanned urbanisation has continued deeply transforming the rural agricultural landscape of the valley into peri-urban spaces characterised by a co-existence of agricultural and non-agricultural land and water uses, economic activities and livelihood practices (Allen, 2003; Narain and Nischal, 2007).

In addition to declining agricultural land, urbanisation in the valley has led to significant deterioration of surface water sources while water demand has continued increasing (ICIMOD, 2007). Although water sources in Kathmandu Valley include both groundwater and surface sources, increasing water demand and deteriorating surface water sources has resulted into increasing use of groundwater. The valley has two major aquifers: shallow and deep, separated by an impermeable clay layer that acts as

[2] From June to September. Average annual temperature in Kathmandu Valley is increasing (0.033^{0}C/year), while annual rainfall is decreasing (-5.9 mm/year) (UN-Habitat, 2015).

[3] Implementation of various plans for urban development of Kathmandu Valley formulated at different times has been poor (MoUD/KVDA, 2015).

a barrier for direct recharge of the deep aquifer layer (Pandey and Kazama, 2012; Pradhanang et al., 2012). Total groundwater extraction which was less than 0.04 million m^3/year in the early 1970s, exceeded recharge by mid-1980s and further went over 25.5 million m^3/year by 2009 (Pandey et al., 2012). Over the decades, urban expansion, increasing gaps between water demand and supply, and ineffective rules and regulations have resulted in increasing use of groundwater as for community, public, private and commercial purposes. Yet, with water demand 377 Million Litres per Day (MLD) and supply 120 MLD in wet season and 73 MLD in dry season, the valley is increasingly water deficit (KUKL, 2017). Over 90% of the private water tanker supplies that have emerged as a result of this increasing water demand-supply gap is based on groundwater extracted from peri-urban areas of the valley (Shrestha, 2011b).

In 2006, the government established the Kathmandu Valley Water Supply Management Board (KVWSMB), aiming to improve drinking water supply services in the valley. KVWSMB has the authority for groundwater regulation and management in the entire valley and the Groundwater Policy for Kathmandu Valley has been formulated. Yet, its implementation has remained weak and largely limited to issuing licences and legalising deep groundwater extractors.[4] Due to unclear roles and responsibilities for groundwater regulation and management, this has remained 'nobody's responsibility (Pandey et al., 2012). In addition, as Dhakal (2012) notes, lack of scientific knowledge on groundwater has adversely affected its development, management and protection.

The Melamchi Water Supply Project (MWSP), the first phase of which is underway since the 1990s (Domènech et al., 2013), is expected to improve water supply, thereby decreasing groundwater extraction in Kathmandu Valley (Shrestha, 2012). However, this supply is limited to urban areas (GoN, 2016), while peri-urban areas of Kathmandu Valley are urbanising at rate higher than that in its cities (Muzzini and Gabriela, 2013).5 In the context of increasing peri-urbanisation, this paper aims to unfold the ground realities of evolving socio-environmental dynamics in peri-urban Kathmandu Valley and reflect on how these shape groundwater use and dependencies in the face of existing institutional mechanisms for groundwater management. This study was inspired by the question: How socio-environmental dynamics shape groundwater use and dependencies in peri-urban areas of rapidly urbanising Kathmandu Valley in the face of existing institutional mechanisms for groundwater management?

[4] KVWSMB estimated there are around 1000 deep tube wells, only 414 of which are licensed (interview, 03/02/2016).

[5] Annual population growth rate in urban Kathmandu Valley is 3.9% and that its peri-urban areas is 4.8% (Muzzini and Gabriela, 2013).

It has been increasingly accepted that "environment" is a co-creation of nature and society and that these inextricably co-determine each other through continuous and interconnected social, political, economic, and ecological processes. These relational processes of socio-environmental change are never socially and ecologically neutral and produce differential socio-environmental impacts over time and space (Swyngedouw et al., 2002; Swyngedouw and Heynen, 2003; Budds et al., 2014). This research uses changes in use of and access to groundwater as a lens to understand the processes and implications of socio-environmental changes in an urbanising context where policy interest to regulate groundwater use is growing. In presenting the policy-practice discrepancies around groundwater use, the concept of 'access' as theorized by Ribot and Peluso (2003) as 'the ability to actually derive benefits from resources' forms an overarching framework for analysing my empirical findings. Actors gain, control, maintain, or lose their resource access in many ways, including legal and illegal rights-based mechanisms. Other mechanisms of access are mediated by technology, capital, markets, labour, knowledge, identities, and social relations, or their combinations.

Following this introduction, next section presents research methodology and introduce the case locations: Jhaukhel, Dadhikot and Lamatar. This is followed by short case studies on the changing water use and management practices and challenges in these locations, illustrating how groundwater use continues to increase, despite growing protests and worries about its consequences. This is followed by a discussion on how peri-urban socio-environmental and institutional changes influence water (in)securities, thereby shaping groundwater use, access, management, and related conflicts followed by conclusion.

RESEARCH METHODOLOGY AND RESEARCH LOCATIONS

This research was designed as an ethnographic case study (LeCompte and Schensul, 2010), using qualitative research methods. The fieldwork at the above mentioned three study locations was conducted between 2015 and 2018. The research approach involved identifying the relevant actors around changing water use and interacting with them, often more than once, as well as using snowball sampling technique to interview and meet other relevant contacts/ informants/ actors. The empirical findings presented in this paper are generated from over 70 open and semi-structured interviews and informal talks and interviews with over 90 individuals at the above mentioned three urbanising villages. The informants included farmers, water users (both local and in-migrants), community-level water suppliers, local leaders, water vendors, brick entrepreneurs, sand mine operators, community-based

forest users, CFUG committee members, relevant government and non-government officials, including ward secretary and elected ward chairperson.

Next section presents some main insights emerging from research in peri-urban locations of Kathmandu through short case studies in Jhaukhel, Dadhikot and Lamatar Village Development Committee (VDC).[6] Although administratively these urbanising villages now belong to new municipalities (declared in 2014), agriculture continues to be an important livelihood for the population in these villages.[7] With co-existing agriculture and non-agricultural based population and their diverse and dynamic needs, interests and priorities, competition for water is increasing groundwater dependencies in all these locations. Jhaukhel is known for groundwater based commercial water supply, Dadhikot, is undergoing rapid urbanisation. Although urbanisation has been more gradual in Lamatar, it is increasing here as well. Together, these cases provide important insights into the socio-environmental changes in peri-urban context and how these shape – and are shaped by – groundwater extraction, and related conflicts and management challenges in rapidly urbanising areas such as Kathmandu Valley.

GROUNDWATER USE AND DEPENDENCIES IN A PERI-URBAN CONTEXT

Jhaukhel

Jhaukhel (VDC)[8], situated in the north-eastern part of Kathmandu Valley has an area 5.41 km^2 and its population is increasing by 1.6% annually (CBS, 2012). Built-up area increased by over 80% between 1992 and 2010 and is expected to increase by more than 110% between 2010 and 2030 (Sada et al., 2016). Groundwater has always been a source of water for residents in Jhaukhel, both for domestic and irrigation purposes. Brick factories operating in Jhaukhel since 1990s also depend on groundwater. In addition, mining of sand from terraces started in Jhaukhel in late 1970s and was largely uncontrolled. Rapid urbanisation, increasing water demands and poor water supply services in Bhaktapur Municipality turned to be an incentive for initiation of water vending in Jhaukhel. Commercial

[6] Prior to restructuring of the local government units in 2017, the Village Development Committee was the lowest local government unit.

[7] Between mid-2014 and 2017, the number of municipalities has increased from 5 to 18 in Kathmandu Valley and from 58 to 293 in Nepal. The municipal declaration, as in the past, involved the clubbing of VDCs, rural administrative units, without considering the minimum criterion for designation of an administrative unit as urban centre – as proposed in the national urban policy (MoUD, 2017).

[8] Administratively belongs to Changunarayan Municipality declared in 2014.

extraction of groundwater for urban supply started in Jhaukhel in 2001 to serve residents in Bhaktapur Municipality. Within short time, commercial extraction of groundwater increased profoundly as tanker and bottled water supplies. Over the years, market for commercial groundwater supplies from Jhaukhel has expanded beyond Bhaktapur Municipality. 14 commercial water suppliers have been formally registered at the Department of Cottage and Small Industries (DCSI) to operate water-bottling factories in Jhaukhel. Although registered as water-bottling factories, most of these also supply tanker water. Additionally, there are many unregistered private tanker water suppliers and brick factories extracting groundwater for commercial uses. Over-extraction of groundwater and the mining of sand have led to a rapid decline of the groundwater level, increasing the drying up of traditional[9] water sources and the need for deeper wells to access water. Although groundwater depletion and deterioration of water quality have increased, open opposition has remained rare. This can be related to an earlier event: Jhaukhel residents had encountered violent conflict in 2002, when a campaign against the brick factories, organised by a group of environmentally proactive local residents to sensitise villagers not to lease out their lands, turned violent. Leaving some injured, this conflict made residents avoid open conflicts until today. Other issues play a role as well: protests often create antagonisms with friends and relatives involved in these businesses. Hence, people seldom report or oppose such practices.

Nevertheless, in 2009, Jhaukhel residents had demonstrated at the VDC office, demanding a stop to water sales and to regulate increasing groundwater extraction. Following this demonstration, the village government issued a public notice declaring water tanker operations illegal. As implementation was poor, in 2012, local people demonstrating against water vending blocked the main road. However, except some temporary halting of operations, no major action has been taken to control this. Such commercial users have continued largescale groundwater extraction for commercial uses by investing in accessing (often leasing) land, sinking deeper wells, and the water pumping (generators) and filtration technologies. They also supply water to local people, mainly as a strategy to avoid resistance and secure continued access. Unregistered water vendors from which the municipality collects road tax are commonly said to be illegal. However, with or without an extraction permit, the common perception is that the right to groundwater comes with the right to land, either by permanent or temporary land control. Local residents often complain,

> Accessing water is not a problem for them (commercial users). They invest and easily earn profit by selling resources. The problem is for us. But we cannot raise the

[9] Hitis (stone spouts), kuwa (shallow wells), ponds, spring sources.

voice against these exploitations. They are powerful and consider those who raise voice their enemies.

With such underlying differences, groundwater extraction has continued, and even new water vendors have emerged in Jhaukhel. On the other hand, a community-managed drinking water supply system announced in 2009 under the support from District Water Supply Division is still incomplete. Although a deep bore well has been sunk for this water supply system, water supply has not yet started. According to local people, this delay is driven by power and politics exercised by commercial water users who fear that initiation of this deep groundwater-based public water supply system will result into drying of their commercial wells.

Dadhikot

Dadhikot (VDC)[10], spread over 6.27 km^2 is rapidly urbanising. Its annual population growth rate increased from 1.17 (1981-1991) to 6.05% (2011). The built-up area has increased by over 250% between 1992 and 2010 and is expected to grow by about 110% between 2010 and 2030 (Sada et al., 2016). Nonetheless, agriculture is still a major livelihood for many inhabitants and depends on traditional surface irrigation sources, a stream in Dadhikot VDC. Like in most of the peri-urban areas in Kathmandu Valley, water for drinking and domestic uses is provided by community-managed drinking water supply systems with funding and technical support from the District Water Supply and Sanitation Division (under Department of Water Supply and Sewerage).[11] Initially based on spring water sources, with increasing water demands, these have largely based on groundwater resource. An official from DWSSD explained, "*River water is polluted. Even a bore well we drilled along the Bagmati River showed very poor water quality (with high ammonia concentration). To the extent possible we do not use surface water sources*".

Increasing preferences for groundwater can also be clearly among the community-level water suppliers. The largest of such community-managed water supply systems in Dadhikot is Uttisghari Drinking Water Supply and Sanitation Consumers' Committee (UDDWSCC). Registered at District Water Resources Committee, it started water supply via public taps, and with increasing water demands, soon switched to household-based supply. Driven by the rapidly increasing demand for new tap connection, mainly due to increasing in-migration, in 2006, in co-ordination with the local government and DWSSD, it tried to make a well upstream to the intake

[10] Administratively belongs to Suryabinayak Municipality.

[11] DWSS is the lead agency for the drinking water supply and sanitation sector of Nepal (Rural Water Supply and Sanitation Sector Policy, 2004). www.dwss.gov.np/?lang=en

of the above-mentioned irrigation canal system. But this was strongly opposed by the farmers. After this opposition, UDDWSCC bought a plot of land, added a deep borewell with support from DWSSD, and expanded its services. However, water quality of the borewell dropped within a few years, showing a high sediment load. Aiming to resolve the problem, the committee purchased land and, supported by DWSDD, it added a water treatment plant, but water quality of the borewell continued degrading. Additionally, the yield of its spring water sources and the water level in the well also declined, leading to increasing consumer complaints. While sources were declining, applications for new tap connections increased. By 2014, the committee had bought a plot of land upstream to the canal intake and reattempted to make a well on it. This again led to overt farmer resistance and added water management challenges for the committee. After this resistance, it had the second (deep) borewell drilled and started water supply from this second borewell. However, within a few months the yield of this second borewell also declined.

With declining spring water sources, opposition from rights-holding farmers and need of an additional source to continue supply, it has recently added a third borewell on public land, approved by the newly elected local representative for management of drinking water services and with assurance of technical and financial support from DWSSD. While the drinking water supply committee is struggling to supply water to its current users, the rising number of applicants for tap connections is increasing the pressure for accessing additional groundwater sources. In contrast to expanding drinking-water demand and supply, with poor management and maintenance, the canal irrigation in Dadhikot has become limited to the upper reach. Downstream farmers only have canal water during the monsoon. This unreliability of canal irrigation has made farmers less concerned for the canal and many farmers have switched to the groundwater as a reliable alternative for irrigation.

Lamatar

Lamatar (VDC)[12], covering 13.65 km^2, is urbanising with an annual population growth rate of 0.8%. Nonetheless, conversion of agricultural land into residential plots is widespread. Spring sources originating in its forests feed into traditional water sources like stone spouts, are still the main water sources. Tapping of springs for various local community-managed piped water supply systems in Lamatar started in the 1990s. One of them is the Shashambhu-Thulaghar Drinking Water Supply and Sanitation Consumers' Committee (STDWSSCC). STDWSSCC supplies water via private taps and is trying to improve and expand its

[12] Administratively belongs to Mahalaxmi Municipality.

services by extracting groundwater through a deep borewell.

STDWSSCC started in 2005 by negotiating rights to use a seasonal stream originating in a community forest in Lamatar. Starting with 40 private taps, it currently supplies 109 taps while demands for new connections are increasing. However, flow in the stream source has been declining. Water scarcity peaks during the dry seasons, while discharge is low, this is also used by the upstream farmers, the prior users of the stream for irrigating their crops. In the face of declining water supply, many households served by STDWSSCC have dug private wells and use shallow groundwater. The quality, however, is poor, making the settlement dependent on STDWSS despite the decreasing of the source and supply of its water. The earthquake in 2015 further reduced its water source. This led to the decision by the STDWSSCC to bore a deep borewell and access groundwater to improve and extend service.

Like most other community-managed committees in Lamatar, STDWSSCC is not formally registered. In 2017, STDWSSCC publicly announced its decision to register at the District Water Resource Committee (DWRC) and expand services through sinking of the borewell. However, drilling a deep borewell became a major factor of conflict. The villagers at the source area were unwilling to agree because of the potential impacts on the availability of, and access to, water, and submitted a petition against STDWSSC at the DWRC. This opposition resulted in uncertainty about groundwater access of this supply system and thus also of water access for those who depended on its services.

On the other hand, the commercial housing project in Lamatar sunk a deep bore well in 2016 and used groundwater for its construction and water supply to its customers. In 2017, another group of villagers submitted a petition at the ward office requesting action against this deep borewell. The protesting villagers argue that this drilling resulted in the complete drying up of a spring located uphill. Its flow had been declining over the years, and further declined after the earthquake, to run completely dry by late 2016. The commercial housing had not obtained a KVWSMB licence, nor conducted a public hearing or obtained approval from the ward office, while all are required for licensing. The villagers explain that the political and economic power of the commercial housing owners enabled them to ignore formal requirements of approval, while this power reach compelled villagers to refrain from protesting until local representatives were elected in 2017.

Following the local elections, ward-level meetings were conducted to discuss these issues. The ward chairperson clarified "*Drinking water was one of my priorities in […] the local election. [..] Considering the increasing water needs, our springs and streams are not going to be sufficient.... As the housing already has inhabitants, while we will ask them to obtain the*

required permit, we do not have any plan to restrict it from using its deep borewell. ... With expanding settlement, we have no option but making a deep borewell. The district drinking water division will soon be conducting a study to explore the possible ways to manage the water supply [..]". As these debates continue, it is likely that groundwater extraction in Lamatar will increase.

ANALYSIS AND DISCUSSION

The above cases show how increasing urbanisation is shaping increasing use of, and dependency on groundwater in peri-urban Kathmandu Valley, despite that mechanisms to regulate groundwater exploitation has been formulated and protests and worries about its consequences are increasing. With changing land and water use and management practices, and increasing competition for water, groundwater has emerged as the alternative water source. In addition to the shallow wells used at household level, groundwater extraction from deep aquifers by new and deeper wells has emerged and is still increasing.

Increasing groundwater exploitation and related socio-environmental issues are prevalent in peri-urban areas of rapidly urbanising South Asian cities. In Chennai (India), continuous water transport to supplement the city's drinking water needs, drastically dropped and even dried groundwater table in these villages. These created serious livelihood problems in these villages and resulted into water-related conflicts (Janakarajan et al., 2007). Further, the 'tripartite agreement' in seeking recourse to peri-urban groundwater resource in fulfilling ever increasing urban water demand led not only to changes in land use practices, the resulting perception on the water as private property distorted social relations and reproduced inequities among peri-urban farmers (Ruet et al., 2007). In addition to direct water transfer to cities, increasing appropriation of groundwater for increasing urban-oriented activities within peri-urban areas are also leading to lowering of groundwater table and reproducing social injustice (Narain, 2014). Similar cases have been seen in Goa, where large scale withdrawal of groundwater for tourism-based industries are increasing opportunities for some while same is resulting into loss of livelihood option for many others (Dongre and Poteker, 2008). In an urbanising village in Balochistan province of Pakistan, groundwater use far exceeds recharge and the province government imposed all-out ban on new connections to regulate accelerating intensive use of groundwater. This ban, however, triggered an informal groundwater market rather than the intended regulated use of groundwater (van Steenbergen et al., 2015). Diverse activities and socio-environmental dynamics associated with increasing groundwater exploitation and efforts to regulate these suggest the importance of contextualising the issue and analyses of the macro-micro gaps in the existing water governance

mechanisms. This paper is such an attempt to unfold the socio-environmental and institutional dynamics around increasing groundwater use and dependencies in Kathmandu Valley.

Groundwater extraction in Kathmandu Valley ever more exceeds its recharge, with negative consequences like drying traditional water sources, decreasing yield of wells, and declining groundwater levels (for example, Shrestha et al., 2012; Pandey et al., 2012). The 1992 Water Resources Act (WRA) of Nepal provides water use rights while it vests ownership of water resources in the State. However, in practice, as prominently seen in Jhaukhel, access to land is widely accepted as giving a right to water. In addition to the Groundwater Policy of 2012, KVWSMB has also formulated the guidelines for licensing the extraction and use of groundwater (KVWSMB, 2015). These policy documents state groundwater resource in the valley can be extracted and used only with a permit from the KVWSMB, except for domestic uses of shallow groundwater (within 98 ft [30 m]). The guideline defines five other uses of groundwater which require permit from the KVWSMB for extraction and use of groundwater (i) personal (ii) industrial (iii) commercial (iv) public and (v) others. It specifies the documents required and processes to be followed for applying for such a permit and also includes the conditions to allow or refrain from granting such permit and divides areas in Kathmandu Valley as safe, semi-critical or critical for groundwater extraction, including the maximum volume of water that a given permit allows to extract in the given area (KVWSMB, 2015). Under these specified requirements, a permit from KVWSMB is required for any use of deep aquifers, including commercial as well as community water supplies. In practice, commercial extraction of groundwater in the valley, as seen in Jhaukhel, has been ongoing based on their registration at the DCSI, using the argument that the water factories started operating before KVWSMB was established. KVWSMB, however, has limited its interventions because commercial water suppliers are important in filling the increasing gaps between urban water demand and supplies. Thus, commercial water users gain legal access to water through overlapping and weak government registration. This is one of many examples as I will discuss further below that access to groundwater resources is based on diverse mechanisms, which are not necessarily based on rights.

WRA promotes 'Beneficial Uses'[13] of water, 'within the available means and resources', 'without causing damage to other'. Nonetheless, as the cases show, access to the socio-technical means and resources to access groundwater are largely

[13] Beneficial Uses' means rational uses of the water resources within the available means and resources (WRA, 1992).

unequal in the heterogeneous and fluid peri-urban spaces. Although exploitation of groundwater has economically benefited some, such as commercial users, these are adding water insecurities for larger population. These inequalities in socio-environmental benefits and burdens from uncontrolled exploitation of groundwater and related resources are increasing water insecurities and conflicts in the peri-urban settings.

As seen in peri-urban Kathmandu Valley, such conflicts are less manifested, given the underlying socio-political and economic power differences, indifference of governing bodies. Furthermore, as in Jhaukhel with increasing cost of access to groundwater, increasing is the dependency on those exploiting the resources, irrespective of them being formally legal or illegal. In contrast, local opposition against groundwater exploitation has added challenges in managing basic water needs for the peri-urban population that depends on community water services, as experienced by the Shashambhu-Thulaghar DWSS. Irrespective of resistances and growing awareness of the dark sides of groundwater exploitation, with the diverse and growing urbanisation-driven needs and interests in water (and land) uses, peri-urban groundwater exploitation is likely to continue increasing. This trend is reaffirmed by the increasingly strong social, institutional and political priority-setting for deep borewells to improve drinking water services.

The Government of Nepal has the national target of 'universal access to safe drinking water and sanitation for all'.[14] WRA has prioritised drinking and domestic water uses over other forms of uses, including irrigation. However, as the cases show, with uncontrolled urban expansion, drinking water demand continues to increase rapidly, triggering largescale groundwater extraction for commercial supply as seen in Jhaukhel and competing with prior rights-holders as seen in Dadhikot and Lamatar. These two latter sites drastically differ in terms of their population growth trends. Nonetheless the threat of disturbances to the local hydro-geology and potential loss of water access and rights and water insecurities united the prior rights-holders to contest groundwater exploitation in both sites. On the other hand, decline of traditional water sources, growing opposition from prior rights-holders, and increasing water demands have stimulated drinking water suppliers to take recourse to groundwater, which is perceived to be a reliable water source free from prior rights issues. The Groundwater Policy has also encouraged such community-managed drinking water supply initiatives. However, as illustrated above, use of deep groundwater for such supplies also requires permit from KVWSMB. This implies the borewells made

[14] As per the census data 2011, 85% of the households have access to water supply and 61% of households have sanitation (CBS, 2014).

for the community-managed water supply systems in peri-urban areas of the valley, developed with support of DWSSD, should have been registered, received a permit and regulated under KVWSMB. However, none of these systems in Dadhikot have such a permit. Furthermore, these community-managed drinking water supplies are financially and technically supported by DWSSD, a government body, whose responsibilities overlap with KVWSMB, the formal authority to regulate and manage groundwater use in the entire valley. These overlapping institutional arrangements, together with growing pressure to mobilise new water sources for the rapidly increasing population and to avoid more contestations around declining surface water sources have led to the emergence of water-mining practices that transgress the groundwater management policy. These socio-environmental and institutional dynamics illustrate poor coordination, not only between these government agencies responsible for drinking water supply in the valley, but also between and among different bodies responsible for planned land and water management.

Although the MWSP is expected to reduce pressure on the groundwater resource in Kathmandu Valley, the peri-urban areas of Kathmandu Valley are not included in this long-awaited water supply system. This implies access to water for multiple water needs in peri-urban areas such as Jhaukhel, Dadhikot and Lamatar will continue to depend on the groundwater sources. However, changes in the land and water use in these urban-oriented dynamics, groundwater resource in peri-urban areas have continued degrading and aggravating water insecurity for the larger group of peri-urban population, contrary to the national policy aim of ensuring access to water for all. Furthermore, the groundwater management policy is silent about the increasing groundwater-based irrigation as the best alternative to the unreliable stream-fed canal irrigation systems. This again raises questions on the effectiveness of groundwater policy in addressing the complex realities of groundwater uses, particularly in the peri-urban areas of Kathmandu Valley.

Although the guidelines for licensing groundwater extraction and use aims at imposing volumetric restrictions on groundwater extraction and has categorised areas within Kathmandu Valley as safe, semi-critical and critical areas for groundwater exploitation from deep aquifers, little is known about the local hydro-geology and its relation to changing land and water uses. For instance, the borewells in Dadhikot although considered feasible, these failed to provide the expected water services, leading to additional borewells, and private household wells, to deal with the poor water quantity and quality services. These examples highlight existing knowledge gaps on hydro-geological complexities and related socio-institutional processes that justify and compel continued extraction of

a resource that has already been pointed as over-exploited.

The groundwater policy promotes groundwater recharge in the valley. Although the shallow aquifer is characterised by a high recharge rate, the high rate of urbanisation has increased the area of impervious surface and radically reduced groundwater recharge (Shrestha et al., 2012).[15] The potential for recharge into the deep aquifer is already low because of the widespread impervious clay layer in Kathmandu Valley (Pathak et al., 2009; Pandey and Kazama, 2012), which further decreases with urbanisation. The project piloted to artificially recharge the deep aquifer pointed such an alternative is not only costly and technically complicated, but also are not encouraging either (Dixit & Upadhya, 2005). Opportunities for using groundwater in Kathmandu Valley depend heavily on the ability to regulate haphazardly changing land uses and prevent pollution in key recharge areas (Shrestha et al., 2012; Pathak et al., 2011). Considering that the priority of the GoN in recent times has invariably been urban development (MoUD, 2016), with urban expansion in Kathmandu Valley, 'the hub of Nepal's urbanisation' (MoUD, 2017), these processes are likely to continue in the future. Consequently, existing open spaces potential for groundwater recharge can be expected to get converted into built-up areas (Thapa and Murayama, 2012).[16] In this context, despite the initiatives to improve urban water supply services and the formulation of groundwater policy guidelines, groundwater governance in Kathmandu Valley is likely to remain a major challenge.

CONCLUSION

In this paper, I presented the increasing, yet underexplored, complex realities of increasing groundwater use, exploitation and governance in the peri-urban Kathmandu Valley. I admit these findings are context specific. Nevertheless, the macro-micro view of the situation presented in this paper provide important insights about how and why groundwater exploitation and related disputes are increasing despite policy documents to regulate groundwater exploitation. These insights can be useful in understanding and addressing the complex issues that need consideration in (ground) water management.

With rapid urbanisation, public water demand and supply gap is increasing every year and groundwater pumping wells from shallow or deep aquifers continues to play an important role in managing

[15] Furthermore, climate change is noted to have adverse impacts on water resources in Nepal (WECS, 2011).

[16] The Kathmandu Valley Development Authority (KVDA), the urban planning authority for Kathmandu Valley, aims to develop infrastructure to accommodate a population of 10 million in the valley (Interview, KVDA, 21/11/2016; Abhiyan National Daily, 07/11/2016).

water needs of Kathmandu Valley. Under the current socio-institutional conditions, groundwater in Kathmandu Valley, is still largely an 'open-access' resource (Pandey and Kazama, 2014), at least for those who can mobilise the required capital, social relations and technology to get access. Although those able to invest the increasing cost of accessing water are able to gain and maintain their water access and thereby overcome increasing water scarcity through increasing groundwater exploitation, this practice is leading to water insecurity for many others in this rapidly urbanising valley. In line with the government's priority for urbanisation as "the best way to sustainable development" (MoUD, 2016: 3), Kathmandu Valley has been made a rural area-free municipal zone. However, as the case studies in peri-urban villages, located in three of the newly declared municipalities, show these areas lack basic water services while water demand is increasing. With the focus of municipalities on promoting non-agricultural economic activities for 'development', water demand is likely to increase faster, adding dual pressure on groundwater: increasing exploitation while recharge area is declining with rapidly increasing urban expansion. While their population is rapidly growing, peri-urban areas remain excluded from surface water-based urban water service improvement initiatives, the (first phase of) Melamchi water supply project.

In the current national context increasing priority for urbanisation and on-going efforts to formulate a national water policy, it is important to acknowledge competition for water in peri-urban areas is likely to increase with urbanisation and the adverse impacts from climate change (WECS, 2011; UN-Habitat, 2015). In such a context, rather than mere focus on groundwater exploitation or regulation, the need is addressing the existing macro-micro gaps in (ground)water management by improving the understanding of local hydro-geological complexities and paying critical attention to the socio-economic, political and institutional drivers of increasing groundwater use. More clearly, studies for advancing knowledge on the micro-level hydro-geological compositions are crucial for improving the understanding of the groundwater dynamics in Kathmandu Valley. Equally important are better coordinated initiatives and incentives for conserving existing surface water sources, promoting groundwater recharge and controlling pollution of the water sources. These could re-create opportunities for conjunctive use of groundwater and surface water in dealing with the severe groundwater management and water provision problems experienced in Kathmandu Valley. Furthermore, as this study has shown, groundwater exploitation in Kathmandu Valley is largely driven by urbanisation-induced increasing population and their water demands. It is, therefore, important, that governing bodies at all levels acknowledge the inter-linkages between different resources, their uses, users and related policies. This can be a starting point to overcome the sectoral focus-driven

working practices and to set, and act upon, clear and coordinated long-term priorities to regulate uncontrolled urban expansion and improve the current quantity and quality conditions of surface water bodies, as a necessary condition for improving (ground) water management.

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