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Working Paper

Gender Equality and Social Inclusion in Community-led Multiple Use Water Services in Nepal

Barbara van Koppen, Manita Raut, Alok Rajouria, Manohara Khadka, Prachanda Pradhan, Raj K. GC, Luke Colavito, Corey O'Hara, Sanna-Leena Rautanen, Pallab Raj Nepal and Parikshit Kumar Shrestha

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Acronyms and Abbreviations

AEC	Agro Enterprise Centre
AEPC	Alternative Energy Promotion Centre
BRACED	Anukulan/Building Resilience and Adaptation to Climate Extremes and Disasters
CBO	Community-based Organization
CEAPRED	Center for Environmental and Agricultural Policy Research, Extension and Development
CIUD	Centre for Integrated Urban Development
CWN	Concern Worldwide Nepal
DWSSM	Department of Water Supply and Sewerage Management
FMIST	Farmer Managed Irrigation Systems Promotion Trust
GEF	Global Environment Facility
ICIMOD	International Centre for Integrated Mountain Development
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KISAN	Knowledge-based Integrated Sustainable Agriculture in Nepal
LAPA	Local Adaptation Plan of Action
Lpcd	Liters per capita per day
MoWSS	Ministry of Water Supply and Sanitation
MUS	Multiple Use Water Services
NAPA	National Adaptation Programme of Action
NEWAH	Nepal Water for Health
NGO	Nongovernmental Organization
NITP	Non-Conventional Irrigation Technology Project
O&M	Operation and Maintenance
PV	Photovoltaic
RERL	Renewable Energy for Rural Livelihood
RVWRMP	Rural Village Water Resources Management Project
RWSSP-WN	Rural Water Supply and Sanitation Project in Western Nepal
SAPPROS Nepal	Support Activities for Poor Producers of Nepal
SDG	Sustainable Development Goal
SIMI	Smallholder Irrigation Market Initiative
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WARM-P	Water Resources Management Project
WASH	Water, Sanitation and Hygiene
WEF	Water-Energy-Food
WOCAT	World Overview of Conservation Approaches and Technologies
WSUG	Water Services User Group
WUA	Water Users' Association
WUMP	Water Use Master Plan

Summary

The Constitution of Nepal 2015 enshrines everyone's right of access to clean water for drinking and the right to food. The common operationalization of the right to water for drinking is providing access to infrastructure that brings water for drinking and other basic domestic uses near and at homesteads. Challenges to achieving this goal in rural areas include: low functionality of water systems; expansion of informal self supply for multiple uses; widespread de facto productive uses of water systems designed for domestic uses; growing competition for finite water resources; and male elite capture in polycentric decision-making. This paper traces how Nepali government and nongovernmental organizations in the water, sanitation and hygiene (WASH), irrigation and other sectors have joined forces since the early 2000s to address these challenges by innovating community-led multiple use water services (MUS). The present literature review of these processes and field research, supported by the Water for Women Fund, focuses on women in vulnerable households.

Overcoming sectoral silos, organizations support what is often seen as the sole responsibility of the WASH sector: targeting infrastructure development to bring sufficient water near and at homesteads of those left behind. Women's priorities for using this water are respected and supported, which often includes productive uses, also at basic volumes. In line with decentralized federalism, inclusive community-led MUS planning processes build on vulnerable households' self supply, commonly for multiple uses, and follow their priorities for localized incremental infrastructure improvements. Further, community-led MUS builds on community-based arrangements for 'sharing in' and 'sharing out' the finite water resources in and under communities' social territories, realizing the constitutional right to food and the Nepal Water Resources Act, 1992, prioritizing core minimum volumes of water for everyone's domestic uses and many households' irrigation. Evidence shows how the alleviation of domestic chores, women's stronger control over food production for nutrition and income, and more sustainable infrastructure mutually reinforce each other in virtuous circles out of gendered poverty. However, the main challenge remains the inclusion of women and vulnerable households in participatory processes.

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Introduction

The Constitutional Right to Water

Nepal's constitution enshrines everyone's right of access to clean drinking water and sanitation (GoN 2015, Article 35[4]).[1] This commitment by the government – as duty bearer to progressively realize this right – operationalizes Nepal's signing of the United Nations General Assembly's adoption of the human right to water and sanitation (UN 2010) and the Sustainable Development Goals (SDGs), including Target 6.1 – by 2030, achieve universal and equitable access to safe and affordable drinking water for all (UN 2015). According to MoWSS (2015) and DWSSM (2019), this commitment translates to reliable access to water at premises in quantities of at least 5 liters per capita per day (lpcd) for drinking and a total of 45 lpcd for all basic personal and food hygiene as a basic level water service (20 lpcd in drought-prone areas). This basic level water service is comparable with those of the World Health Organization (Howard et al. 2020). Accessibility, affordability and reliability of water imply a right to both water infrastructure for storage and conveyance near or at premises, and a priority right in the allocation of the naturally available water resources (runoff, rivulets, streams, springs, wetlands, or shallow or deep groundwater sources) that flow into that water infrastructure.

The constitution also commits to a right to food[2] (GoN 2015, Article 36). The duty of the state to provide infrastructure to enable productive uses of water, whether near or at premises or in distant fields, or all these, has not been clearly operationalized. However, with regard to the allocation of naturally available water resources falling on fields, or flowing into infrastructure, the state's commitment is unambiguous: water resources that enable realizing this right to food have a priority.

Both commitments of the Nepali government – to realize a right to water for domestic uses near or at premises, and a right to food – are reflected in the Water Resources Act of 1992 (GoN 1992). The Act governs the utilization of naturally available water resources. In the allocation of water resources, water for drinking and other domestic uses is given the highest priority. The second priority is for irrigation, followed by animal husbandry and fisheries; hydroelectricity; cottage industry (e.g., water mill or grinder), industrial enterprises and mining uses; navigation; recreational uses; and other uses (GoN 1992).

These two complementary policy commitments are vital for women in the many rural resource-poor households that are still 'left behind', especially in the poorest areas but also within heterogenous communities elsewhere. They still need to collect water from far, unsafe sources. Women and girls are disproportionately burdened with this daily drudgery. They contribute nearly 84% of the total labor for households' water provision (CBS 2020). When travelling long distances in search of water, women and girls risk facing rape and sexual assault (Pommells et al. 2018; Fisher 2006).

The constitution also commits to broader principles of equality, inclusion, justice and non-discrimination. This further implies the narrowing of the gendered inequalities in technical knowledge and control over water infrastructure. When male kin share in the efforts to provide water for domestic uses, they tend to carry out technical maintenance work on the water system, as identified for 89% of the surveyed households in two wards in Nepal – Dailekh and Sarlahi (IWMI 2020). Also, local artisans, holding specialized hydrological and technical engineering knowledge, are primarily men.

The challenge is the realization of these rights at the intersection of current discrimination along gender, age, disability, caste, wealth and ethnicity lines (Leder et al. 2017; SNV and CBM Australia 2019). This paper focuses on emerging pathways to address these implementation challenges.

This Study

Aims

This study in Nepal had two main objectives. First, to identify key problems faced by the water, sanitation and hygiene (WASH) sector in its efforts to realize the constitutional rights of all citizens to water and justice. Second, to examine innovative alternatives that have proven, or are plausible, to address these problems.

[1] Article 35(4): 'Every citizen shall have the right of access to clean water and sanitation' (GoN 2015). This paper focuses on the first part: access to water.

[2] Article 36: (2) 'Every citizen shall have the right to be safe from the state of being in danger of life from the scarcity of food'; and (3) 'Every citizen shall have the right to food sovereignty in accordance with law'.

The study identified the following five implementation challenges.

(1) Externally financed WASH infrastructure is often dysfunctional.

(2) Self supply is expanding. Partly in response to failing public infrastructure, there is an increase in water users constructing and installing their own infrastructure for self supply, mostly by the relatively wealthier people.

(3) De facto multiple uses. Self supply is often for multiple purposes. Similarly, people use public schemes that are designed for domestic use for productive use as well, which may deprive some from accessing water even for basic domestic uses.

(4) Competition for finite water resources is increasing.

(5) Male elite capture in polycentric decision-making. Last but not least, the most marginalized, in particular women, are still excluded from decision-making in their communities and in the newly established local government structures that develop and manage water infrastructure and mediate in conflicts.

The literature about responses to these challenges points to participatory water services that take communities', especially women's, multiple water needs, embedded in age-old community-based water tenure, as a starting point (Polak et al. 2004; Mikhail and Yoder 2008; Basnet and van Koppen 2011; Rautanen et al. 2014; GC et al. 2021a). This so-called 'community-led multiple use water services (MUS)' approach maintains a priority for everyone's access to water at or near premises, leaving no one behind, but respects and supports women's (and men's) own priorities for any use of water available.

Definitions

Community-led MUS considers the context of an entire community. This typically includes self supply, in the sense of infrastructure that is largely or fully financed by community members, either as a subgroup or as individual households (Sutton and Butterworth 2021). When community members in Nepal, and indeed worldwide, design, finance, construct, operate and maintain infrastructure for self supply at or near premises, they use water for domestic purposes and also for productive uses, e.g., poultry or livestock; irrigation of crops, vegetables or trees; crafts; brickmaking; and small-scale enterprises; and at larger scales, also fisheries; milling; hydropower; biogas; or ceremonial uses. Even infrastructure that supplies water to isolated, distant fields or other sites of use, such as rivers or cattle dams in grazing areas, can be multipurpose. Moreover, rural communities typically access a combination of two or more surface water and/or groundwater sources within that community's socially defined territory. Combinations of water sources also provide resilience to the natural or human-induced variability in water availability. In line with global definitions (FAO 2020), we call the ways in which community members relate to each other and external parties with regard to water: 'community-based (or customary) water tenure'.

Methods

Two sets of data sources inform our analysis. The first set of data consists of a review of literature since the late 1990s, when policy makers, donors, international and national nongovernmental organizations (NGOs), and research organizations innovated community-led MUS and organized in a Nepal MUS Network.[3] The second set of data is derived from field research conducted in selected wards in two districts. One district was Dailekh (in Ward 8 of Gurans Rural Municipality) in Nepal's middle hills where springs, rivers and rivulets are the main water sources. The other district was Sarlahi (in Ward 6 of Chandranagar Rural Municipality) in the Terai where groundwater is the main water source. We conducted household surveys, participatory rapid assessments, transect walks and focus group discussions with single and mixed gender groups, including disadvantaged castes and ethnicities, and interviews with resource persons. This was followed-up by phone interviews during the Covid-19 pandemic. Participatory videos were also made (IWMI 2021a).

Structure of This Paper

In the following section, we start with a presentation of the five above-mentioned challenges to achieving universal access to water for drinking and other domestic uses. The section *Addressing the Challenges: Community-led Multiple Use Water Services* explores how the Nepali government institutions, supported by international development partners, innovated responses to these challenges by pilot testing and upscaling community-led MUS. A cost-benefit analysis of this new service model is presented in the section *Costs and Benefits of Community-led Multiple Use Water Services*, before conclusions are drawn.

[3] https://nepalmusnetwork.wordpress.com

Challenges in Conventional Water, Sanitation and Hygiene

Externally Financed WASH Infrastructure is Often Dysfunctional

In Nepal, households with access to basic water services increased from 46% in 1990 to 90% in 2016 (GoN and UNICEF 2018). However, as elsewhere in low-income rural areas across the world, the functionality of water systems designed and financed by external support agencies is low (Moriarty et al. 2013). DWSSM (2019) also noted this high coverage rate of basic water services (88%). However, at any given time, only 28% of the existing rural water supply schemes are fully functional in terms of providing sufficient quantities of water, of an acceptable quality, and with adequate hours of supply (DWSSM 2019). Moreover, 48% of the total schemes require minor and major repairs (DWSSM 2019). In terms of water quality, based on standards, only 19% had access to safe water by 2019 (CBS 2020).

Besides the usual wear and tear and nature's floods and landslides, a contributing factor to dilapidated water infrastructure is the top-down planning and design by external agencies, which may well include engineers with an urban or high-caste background who are not familiar with rural settings (Udas 2006; Udas and Zwarteveen 2010). Future water users are only mobilized after 'hand over' of the infrastructure, and are supposedly in charge of all operation and maintenance (O&M). This includes tariff collection, which is notoriously difficult among closely-knit communities. Moreover, externally designed water systems may be too expensive compared to available alternatives (Whittington et al. 2009).

Formal Water Services User Groups (WSUG) that were established when the infrastructure was planned may dissolve immediately after construction, as identified in two of the seven WSUGs in Ward 8, Dailekh. However, after taking over the infrastructure, households informally came together and took charge of (part of) the water supply systems. Such activities were often initiated by the wealthier households (Rajouria et al. Forthcoming). In Nepal, this widely observed fate of externally supported water infrastructure – also for irrigation schemes for that matter – is compounded by threats of extreme natural events, including floods, landslides, windstorms, hailstorms, fires, earthquakes and, with increasing temperatures due to climate change, the melting of glaciers (Sharma et al. 2021). Each of the following challenges further contributes to the low functionality of externally supported water infrastructure.

Self Supply is Expanding

In the face of low functionality and frequent disruptions of externally financed water systems, or a lack of water in the tail ends, or the hassle, if not unaffordability, of collective O&M, people have little or no choice but to access water from their own sources, either individually or as self-organized subgroups. Aspirations increase as well, and supply chains of small-scale technologies and improved energy sources become more available. Those who can afford these technologies increasingly invest their own money in infrastructure for self supply, e.g., piped gravity infrastructure or manual or motorized groundwater pumps. Remittances received from migrants further enable such investments. In this way, the relatively more powerful and better-off 10 households, out of the 80 households in a Dailekh Dalit village, mobilized their stronger social networks and collectively installed a private pipeline that supplies water only for them (Raut and Rajouria 2020; Raut et al. Forthcoming). Even when the costs are not prohibitive, a key problem for women is their limited technical know-how of installing connections and the lack of a social network for mobilizing the required human resources, as identified by Raut and Rajouria (2020) and IWMI (2021b).

Self supply by individuals or subgroups has existed since time immemorial, not only to provide water to homesteads and residential areas but also to fields. Collective systems for self supply are well recognized in Nepal's irrigation sector. Since the 1980s, studies in both the mid-hills and Terai confirmed the features of widespread investments in infrastructure made by communities or individuals for self supply for irrigation (Ostrom 2005; Pradhan 2010; FMIST n.d.). These water systems are often also used for non-irrigation purposes. For example, small mountain systems not only channelled water to irrigation fields but also to residential areas for domestic uses. Water-powered grain milling has been practiced for thousands of years (Yoder 1983). Farmer-led irrigation by individual households is also expanding in Nepal (Khadka et al. 2021).

Not confined to single-use mindsets of administrative silos of either domestic uses, or irrigation, or livestock, rural communities have always seen water as a resource for their multifaceted agrarian livelihoods. Moreover, households access multiple water sources, even at the same site, to accommodate for fluctuations in water availability. Everyone needs at least some water for domestic uses. Water for human and livestock drinking, and most domestic uses is needed on a daily basis, or sometimes less regularly, for example, for laundry. Productive water uses can be more seasonal or incidental, and only part of the community might engage in a particular productive activity. Self supply infrastructure, whether individual or communal, is mostly multipurpose, especially around homesteads, and steadily improves for those who can afford such infrastructure. Also, In Sarlahi, groundwater discharged from a hand pump was not only used for bathing and washing clothes, but also for cultivation and livestock watering (Raut and Rajouria 2020). Where the costs of transporting water are sufficiently low and the affordability for clients is sufficiently high, water vendors initiate informal water businesses.

In communities' moral economies with social safety nets, water from private manual or motorized pumps is often shared with less fortunate neighbors. However, asking for water can be troublesome. Research highlights how it becomes difficult to fetch water from private hand pumps within the compounds of the neighbor when the gates of the neighbor's premises are locked at night. In such cases, households still resort to community ponds to meet water needs (IWMI 2021a, 2021b). The most marginalized households that have no one to ask, always have to walk to distant natural surface streams or springs, or communal ponds.

In many situations, self supply or informal water purchasing contributes to achieving the constitutional right of access to water for domestic uses, even at no cost to the taxpayer. However, in contrast to the recognition and support to farmer-managed irrigation systems in Nepal, the WASH sector is hesitant about self supply. The quality of water for drinking may be suboptimal. Also, self supply for domestic uses may compete with infrastructure designed and financed by the government or other external support agencies, if the availability of alternatives reduces incentives to maintain expensive externally financed systems. Also, self supply often widens relative inequalities for those without the ability to invest in self supply, or without willing neighbors who can share water or affordable water vendors carrying out informal businesses. Yet, if the government proactively prohibits self supply for domestic uses that contributes to realizing constitutional rights, it would infringe on citizens' rights. This puts the question in even bolder relief: how can external support agencies reach those left behind who lack affordable alternatives?

De Facto Multiple Uses

It Happens Anyhow

Although the focus of the human right to water is on drinking and other domestic uses, the reality is different. Externally financed infrastructure designed for drinking and other domestic uses is used to meet multiple needs, even at the minimum standard level of 45 lpcd. Apparently, people's priority uses differ from those of the designers. GC et al. (2019) identified that over 90% of users of collective water systems designed for domestic uses, in reality, also use them for productive uses. Some productive uses, such as livestock watering or horticulture, are common among the large majority, while a few households may specialize in other productive uses. Productive uses depend on local conditions.

The widespread, notorious redesign (or vandalism) of water systems may aim at such productive uses. In Dailekh, for example, piped water constructed for domestic uses is redesigned to enable irrigated homestead cultivation in the dry season (Raut and Rajouria 2020). In Badakanda, all 65 households wanted to grow vegetables, so they brought the public community taps designed for domestic uses closer to their homesteads for that purpose (Bohara et al. 2013). Significantly, such productive uses can already take place at service levels below 45 lpcd. In the Malewa Basne village, for example, the total volumes of water were still below 45 lpcd, but one-third of all water at homesteads was used for livestock watering and irrigation (Khawas and Mikhail 2008). People prioritized these productive uses over 'luxury' domestic uses' such as daily bathing or weekly laundry, which can be done less regularly and even elsewhere. Community ponds are also typically used for domestic (washing and bathing), productive (fishery, livestock watering) or religious uses.

A study of 200 households in 10 water supply systems, conducted by GC et al. (2019), in Kaski, Syangja and Palpa districts in the western mid-hills region of Nepal showed that most households were using a mean of 34.2 lpcd for domestic use. GC et al. (2019) estimated that the median water use for productive activities in water systems designed for domestic uses was 33 lpcd. For systems designed for multiple uses (as elaborated below), this was 37 lpcd, so not significantly different. In both cases, these productive uses by households did not compromise their domestic uses (mean of 34.2 lpcd). Remarkably, this was less than the designed 45 lpcd.

However, water volumes needed for productive uses can be considerably higher than that needed for domestic uses, depending on the types of productive activities and access to water. Moreover, as only some of the households adopt certain productive uses, there is a risk of inequalities in water uses widening. Within collective water infrastructure, productive uses may in some way deprive some households from accessing water even for basic domestic uses. This real risk for tail end users is illustrated as follows:

> *My house is situated downstream and it is very difficult to access water because people upstream cut pipes to water their crops. Sometimes, they do it at night which makes it difficult to identify the culprit. Even if they are identified, it is difficult to hold them responsible because most people living upstream do this themselves* (pers. comm. tail end user, November 14, 2019).

Responses within Single-use Sectors

Locked within administrative single-use silos, external support agencies can only try to prohibit water uses beyond their respective mandates. The WASH sector would categorically prohibit their systems from being used for any productive uses, hoping this will lead to equal sharing of at least the basic minimum level of water among everyone. The threshold of 45 lpcd (basic level) becomes an upper ceiling instead of a minimum amount. However, such rule setting is often in vain as people pursue their own priorities.

Another argument against using systems designed for domestic uses for productive uses is that it is wasteful, if clean, safely managed or even treated water of drinking water quality is used for productive purposes, especially if water of a lesser quality is sufficient for such activities. However, this overlooks that *more* water at premises is often more effective for health and hygiene than very small quantities of high-quality water (Sutton and Butterworth 2021). Moreover, most other domestic uses excluding drinking and cooking can also do with water of a lesser quality. High-quality water is only required for the 5 lpcd needed for drinking in most situations (Howard et al. 2020). Expensive treatment of all water, for example, for cleaning floors or laundry, would even be a waste of scarce resources. Water from springs and mountainous streams or groundwater may already be safe in some localities. However, in other localities, this may not be the case. When groundwater is locally polluted by arsenic, as in the Terai, alternative surface water sources or water from safe locations elsewhere are indispensable for safe drinking (but not necessarily for most other domestic uses).

Concerns about the quality of water for drinking also play a role in the irrigation sector, but the other way around. These concerns discourage irrigation professionals from even just reporting on the – usually widespread – domestic uses of 'their irrigation' systems, for example, for bathing and laundry (Basnet and van Koppen 2011). Engineers in the public sector are held responsible for complying with certain standards, whether they are realistic or not. As long as they adhere to these accepted standards, they cannot be blamed. Reporting on domestic uses could be seen as accepting the responsibility for people drinking unsafe water. If they report on domestic uses or choose unorthodox solutions, and people are affected by drinking unsafe water or using it for other domestic needs, the engineer and the project will have to take the blame (Yoder 1983). However, this ignores that 'irrigation' water that is used for some other domestic uses except drinking (handwashing; house, yard and livestock shed cleaning; laundry; and bathing) contributes to hygiene and health, and alleviates domestic chores.

Moreover, by staying within sectoral boundaries, the irrigation sector can leave all responsibilities to meeting the constitutional right of access to water for drinking and other domestic uses to the WASH sector. Irrigation professionals can ignore competition between everyone's domestic uses and the productive uses of a smaller or larger proportion of the community. The irrigation sector may even be biased towards those with larger irrigated plots, while considering production at homesteads as just 'kitchen gardens', supposedly for self consumption only, ignoring the sale of produce to gain income. Water used to realize everyone's right to food falls through the sectoral tracks. In this way, multifaceted water-dependent livelihoods and intrinsic inequalities in domestic and even more in productive water uses are ignored. Equality and justice in productive water uses can start at everyone's homestead as the most equitable core minimum. Even the poor and landless have homesteads.

The foregoing inequalities in water uses are valid not only for sharing water within a collective system, but also for sharing the naturally available water resources that flow into infrastructure. For this sharing of water resources, we have to move up from a water system to the community scale with its multiple water sources and many types of infrastructure, depending on highly localized climate, geo-hydrology, and socioeconomic features. Where water resources are shared at higher levels between communities, or watersheds or even transboundary basins, with even more types of infrastructure, water resource allocation among many more uses and users is at stake.

Competition for Finite Water Resources is Increasing

The constitutional right of access to water for domestic uses implies a right to infrastructure for storage and conveyance of water so that it is increasingly available year round near premises, but preferably in yards or even inside dwellings. This constitutional right is not just a right to walk long distances to access and use water from a natural source. However, infrastructure alone is insufficient; natural surface water or groundwater resources must flow into storage and conveyance infrastructure. Water resources passing through or under the territories of a community are typically manifest as multiple scattered sources, which vary according to weather and climate patterns. These resources are mostly limited in the dry season or during dry spells. This implies a fourth major challenge to meet everyone's constitutional right of access to water: to not only have functioning infrastructure but also sufficient water resources flowing into that infrastructure. When demand is higher than natural availability, water resources need to be 'shared in' within communities, and 'shared out' with neighboring communities up to watershed level and, as relevant, even inter-basin transfers.

The need to share limited water resources is increasing. The Rural Water Supply and Sanitation Project in Western Nepal (RWSSP-WN) conducted a study between 2004 and 2014 in Tanahun district of nearly 2,400 water sources. The study showed a 50% reduction in average yield of point sources (springs) over 10 years (Shrestha 2016). This resource scarcity was also identified by Clement et al. (2015): the major factor threatening the resilience and sustainability of the 16 MUS studied is the security of the water resource, with most of the systems already facing decreases in water flows. In almost one-third of the cases, users reported having an insecure source of water throughout the year (Clement et al. 2015).

Competition for water from springs and streams, and groundwater is increasing both within and between rural communities. Within rural communities, populations expand, in spite of out-migration and urbanization; people's aspirations increase; affordable technologies to abstract water become more available; remittances received from migrants are available; and markets evolve. Water resources have to be shared, first in the dry season and gradually during the other seasons as well. This sharing is not equitable. Power relations and notions of first in time, first in right favor wealthier households that are the first to invest in year-round storage or tap water from abundant aquifers for self supply. These options may be too expensive or otherwise unfeasible, or just too late, for the majority of people. Water resources are not only to be 'shared within' communities, but also increasingly 'shared out' with neighboring communities or powerful third parties. Water is increasingly diverted out of rural areas to the latter's large-scale infrastructure to meet urban water needs, hydropower and other national or transboundary uses.

Male Elite Capture in Polycentric Decision-making

The fifth challenge in realizing the constitutional right of access to water for drinking and other domestic uses lies in communities' internal and external social, economic and political decision-making patterns in both infrastructure development and sharing of water resources. Hierarchies are reproduced, with men of advantaged castes often occupying the most powerful positions. Discriminatory norms and patriarchal practices continue. These include women's disproportionate unpaid domestic labor burdens, dowry, child marriage, mobility restriction for girls and women, or 'chaupadi', which forces women and girls in some areas to live in a hut outside the home during menstruation, often without access to taps or toilets (White and Haapala 2019). More powerful, well-informed and outspoken men with influential networks can dominate in leadership positions of water user groups. If they participate in O&M, funds may be embezzled, with communities rarely acting against such action and holding the offenders accountable.

Inequalities in decision-making are also reproduced at the interface between communities, the government and other external agencies from the village level to ward, rural municipality (*gaupalika*) or urban municipality (*nagarapalika*), provincial and national levels. These tiers in government decision-making are being restructured under the constitution's devolution of roles and powers to local governments as the frontline actors to develop and implement policies and programs for water services at the local level (White and Haapala 2019; Khadka et al. 2021). The constitution includes provisions for proportional representation of women in all the state agencies (GoN 2015, Article 38), including their 33% representation in federal (GoN 2015, Article 84[8]) and provincial (GoN 2015, Article 176[9]) assemblies and 40% in the municipal assembly [GoN 2015, Article 222[3]], and at least one-third of women in water users' associations (WUAs) (NLC 2000). Thus, federalism opens up opportunities for bottom-up, inclusive and transformative WASH outcomes (Khadka et al. 2021; White and Haapala 2019; Clement et al. 2019). However, even when women and minority groups participate in decision-making bodies, this participation is still often tokenistic, amidst the contested interests and powers within communities, between communities and the government, and among government officials (Goodrich et al. 2017; White and Haapala 2019).

A limited budget is one of the challenges to implementing inclusive water planning. Despite the fiscal decentralization, only 1% of the total WASH budget currently goes to local levels, compared to 83% and 16% for federal and provincial levels, respectively (WaterAid 2018). Moreover, local chairpersons, elected leaders, private sector members, and administrative and engineering staff tend to be all men, often with strong social networks among themselves, but hardly with women, Dalits or minorities. Many men do not support women members and even silence them. Dalit women representatives in wards in Sarlahi confirmed how they feel ignored: they are not informed, not aware, and let alone included in decision-making, they may even be excluded from meetings as only the Nepali language is spoken instead of local languages (Khadka et al. In prep.). They may also be unaware of the annual WASH budget of their wards, while male ward chairpersons interviewed had this information (Khadka et al. In prep.). Even worse, rural municipalities may exclude any community representative, as found in Gurans, where the rural municipality decided to form and work through their own water and sanitation working group independent of the community WSUGs (Rajouria et al. Forthcoming).

In sum, all the above-mentioned challenges imply a long road to realizing everyone's constitutional right of access to clean water. The following evidence of community-led MUS near or at homesteads in Nepal shows pathways to progress in achieving this constitutional right.

Addressing the Challenges: Community-led Multiple Use Water Services

Features of Inclusive Community-led Multiple Use Water Services

In response to all the above-mentioned challenges, governmental and nongovernmental support agencies in Nepal innovated community-led multiple use water services (MUS) (*Panika Bahu Udesya Upyog in Nepali*) during the past two decades. The WASH sector joined forces with the small-scale irrigation sector for rural water infrastructure development and water resource allocation. Sectoral expertise in other domains was unlocked from their silos. Community-led MUS that emerged as a result can be summarized as follows.

For water infrastructure development and equitable sharing of finite water resources, the WASH, irrigation and other sectors mutually support each other in the following:

- Realize the constitutional right of access to water near or at homesteads, leaving no one behind, by developing infrastructure and prioritizing water resource allocation that provides a core minimum of water *volumes* (e.g., a standard of at least 45 lpcd, near or at homesteads), and by respecting communities' own priorities in the use of this water for multifaceted basic livelihoods – as happens anyhow.

- Conduct inclusive and participatory planning, design and construction processes that are anchored in communities' age-old local, often informal, norms and practices that shape the relations among community members with regard to water – also called community-based or customary water tenure (FAO 2020).

- Follow marginalized women's priorities in planning and designing how to achieve core minimum water service levels for all. Once that is achieved, as feasible in local conditions, promote equitable 'climbing of the water ladder' to gradually meet higher domestic and productive water needs, and requirements for homesteads, fields and other sites of use.

- In this participatory process: leverage and support communities' five types of capital (physical, financial, technical, institutional and human) for self supply that contribute to achieving the constitutional rights and higher-level national goals. In certain contexts, 'supported self supply', which already happens in farmer-managed irrigation systems, can also be expanded to the WASH sector as a cross-sectoral alternative or complementary interim or permanent water services model.

Other expertise excluding the foregoing expertise on infrastructure and water resources is unlocked from their silos. As water is only one input for our well-being, the WASH, irrigation and other sectors widely provide their sectoral expertise to ensure that a particular domestic or productive water use leads to ultimate well-being, especially among the most vulnerable. This includes the following:

- Ensure, in a cost-effective manner, that at least 5 lpcd of water is safe for drinking, and provide capacity building for hygiene (WASH).

- Improve input supply chains, agronomy training, and market development for irrigation at homesteads or fields (irrigation sector).

The innovation process in which community-led MUS gradually evolved is explained below.

Community-led MUS in Nepal

Participatory Planning, Design and Construction: Water Use Master Plan (WUMP)

In 1998, the Water Resources Management Project (WARM-P) of Helvetas developed the Water Use Master Plan (WUMP). This planning tool has 17 activities grouped into five steps (Bhatta and Subedi 2016) and is to be implemented using a bottom-up approach, at the interface between communities and the government with other support agencies. The first step of WUMP involves creating a holistic inventory of the spatial and topographical layout of a community with its diverse water sources, multiple uses and all infrastructure. This step is followed by a participatory design and prioritization of incremental improvements to infrastructure and transparent budgeting, all in Nepali language. In these early phases of the project, (potential) conflicts are anticipated and addressed in a timely manner. Communities mobilize contributions in cash and in kind for the construction of infrastructure, and are also empowered to procure and recruit artisans. Users also operate and maintain the system and carry out small repairs.

In the early 2000s, iDE, coming from the irrigation sector, adopted a similar participatory planning process that starts with creating an inventory of all water sources and existing uses in the area (Mikhail and Yoder 2008; Sharma et al. 2016).

WUMP became well known in Nepal and has increasingly been applied. Through the use of WUMP, de facto multiple uses became visible in the WASH sector. Support agencies not only accepted such multiple uses, but even began to see this as 'an opportunity not to be missed': by providing more water they not only meet domestic uses, but also promote productive uses and reuses through drainage water.

In 2015, the Ministry of Water Supply and Sanitation (MoWSS) included WUMPs in its Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030)[4] (MoWSS 2015). Officials in the Department of Water Supply and Sewerage Management (DWSSM) started to encourage the implementation of WUMP and MUS wherever water resources are sufficiently available, and accept how livestock watering and homestead gardening can be included in rural definitions of 'domestic' uses. In urban areas where livelihoods are less diversified, MUS is less applicable and known.

From WASH to MUS

The Rural Village Water Resources Management Project (RVWRMP) adopted WUMP from the onset in the poor Middle and Far Western Nepal (Sudurpashchim and Karnali provinces), supported by the governments of Nepal and Finland, and the European Union. This included capacity development, especially of women, to shape these processes and public audits. Initially, RVWRMP focused on piped gravity systems for domestic needs of at least 45 lpcd. Realizing the many unmet water needs in this poverty-stricken region, RVWRMP started to proactively identify whether more water resources were available for livestock watering and irrigation at homesteads. Moving from accepting de facto productive uses, RVWRMP started to plan for locally relevant multipurpose infrastructure. They set as an initial target that 10% of its water systems should be MUS. This percentage steadily grew to 38% of a total of 629 water systems, benefitting well over 125,000 people by 2019. The project implemented systems with multiple productive uses, such as field irrigation combined with micro-hydropower or with grain mills.

RWSSP-WN (Gandaki and Lumbini provinces), also supported by the Finnish government, promoted MUS where water resources were sufficiently available. The project found that longer-term planning of water development and ranking communities' priorities over a five-year period appeared to be effective in reducing the ad hoc nature of heavily lobbied and politically motivated project selection (Rautanen et al. 2014). RWSSP-WN observed that there was a declining trend in springs in Nepal and, therefore, recommended to utilize multiple solutions such as storing source overflow and using multiple sources to ensure reliable and sufficient water quantities throughout the year. There is more to be learned about the integrated planning concept of multiple sources for multiple uses, as in many places, one source is just not sufficient or not available all year round.

Both RVWRMP and RWSSP-WN worked through the Municipality WASH Units (sections within the municipal structure, under the leadership of the local governments and their elected bodies). The newly restructured context created new opportunities and gave a new sense of local ownership while reaching out services to everyone within the municipal borders. The Municipality WASH Units were able to support users' committees and cooperatives for extensions, service-level improvements, rehabilitation, continued capacity building and funding, bioengineering and recharge, and for retrofitting multiple use water systems into earlier systems while improving their functionality, especially where the users could not raise sufficient funds from their own sources, or where there was a need for engineering or other technical support and capacity building.

The step-by-step participatory approach led to a variety of localized choices for a community's next incremental improvement in gaining access to water. For example, communities were found to prioritize the construction of a new system, or the rehabilitation or upgrading of existing 'domestic' water supply systems. Another option was where a former system designed for domestic uses was rehabilitated to provide water to fields for irrigation, while a new system provided water to homesteads.

A survey conducted by RVWRMP among 22 district officials in the WASH sector in West Nepal confirmed that more than four-fifth of the officials were well aware of de facto multiple uses: 'productive uses happen anyhow'. The same percentage agreed that, therefore, multiple use water systems are the 'natural option' (Rautanen 2016). However, half of the staff highlighted obstacles to implementing MUS because of the conventional administrative silos of support agencies: budget headings or earmarks mentioned 'domestic uses' only, ignoring multiple uses. Also, there appeared to be a lack of knowledge about MUS and skilled staff to implement designs and guide communities (Rautanen 2016).

International WASH NGOs such as WaterAid and national NGOs (e.g., Nepal Water for Health [NEWAH]) moved to the concept of MUS at higher service levels. Practical Action, RAIN Foundation, and other national and international NGOs developed and applied appropriate small-scale technologies for MUS, especially for storage, such as Thai jars or soil ferro cement water retention ponds for individual households (Bhatta and Shrestha 2016). On the other hand, in some areas, water resources were found to be too limited and water supplies could only be provided for 2 hours per day. In such cases, the community and

[4] "Water Use Master Plan (WUMP): In recent years, an effective planning tool to assist communities and planners in better understanding the water situation and multiple uses of water (e.g., domestic uses and livelihoods) in a locality, be it a village or a watershed across several local administrative units, for the equitable and sustainable use of water sources is being practiced in the western and far western Nepal. The approach is being used to make an inventory of water sources and together agree on their use at local level. The approach is seen effective in promoting local solutions with flexibility by acknowledging the local situation. The key lesson learned from the practice of the approach is that local institutions with adequate authority in planning and implementation of water resources at local levels are keys to sustainable conservation of small water sources. Also that, the more local the institution, the more effective is local water governance. The WUMP serves as the 'Mini Integrated Water Resources Management (IWRM) or Basin Plan' and is expected to be an effective planning tool for raising water security for human use, livelihood and economic development and watershed management. A guideline document will be developed based on good practice and experiences gathered in water use planning at local levels over the years. The approach will be gradually applied in all local level water resources planning" (MoWSS 2015, 80–81).

NEWAH prioritize domestic uses, prohibiting productive uses.

From Small-scale Irrigation to MUS

In the small-scale irrigation sector, irrigation professionals typically look for and find water sources that are well beyond 45 lpcd. Technically, the standard communal piped gravity system implemented in the WASH sector in the mid-hills appeared to be a highly water-efficient technology to cultivate vegetables and other high-value off-season crops year round, or for livestock watering and small-scale enterprises. Compared to irrigation canals, piped water supplies open up new land, in particular unleveled upland often around homesteads (*bari*). Unlike irrigation canals, pipes overcome undulations and do not require the arduous land leveling that the distant irrigated lowland (*khet*) plots for irrigated rice and other cereals require. Piped water supplies are also more reliable in the dry season. Water distribution between head and tail enders can be better managed. Soil erosion and risks of flooding at sensitive sites are also less. Proper drainage enables wastewater reuse for irrigation (Lohani 2016).

In the early 2000s, iDE in the Smallholder Irrigation Market Initiative (SIMI) project championed two innovations (technical and income generation) in collaboration with the Nepali NGO Support Activities for Poor Producers of Nepal (SAPPROS Nepal) and Winrock International, supported by the United States Agency for International Development (USAID). The first technical MUS 'innovation' started by respecting the de facto productive uses in the WASH sector's prototype and, as much as possible, increase the discharge at low incremental costs, while maintaining the priority for domestic uses. After all, each farmer is also a domestic water user. Taking 45 lpcd for domestic uses, design criteria added another 40-120 lpcd. Initially, these systems were called 'hybrid' systems (Polak et al. 2004). Joining the global move in the mid-2000s to call these systems 'MUS' (van Koppen et al. 2006; Renwick 2007), iDE also changed the name of these piped designs to MUS, both for its gravity systems and water-lifting systems. Labor- and water-saving technologies such as drip irrigation are also promoted. Depending on communities' local spatial layout, the priority for domestic uses at everyone's homesteads can be hardwired by using two tanks, each with its own distribution lines, or a 'two-line system'. The first tank is used to supply all homesteads, and only the overflow of the first tank to the second tank is piped to provide water to fields. In one-line systems, institutional sharing arrangements ensure the prioritization of core minimum water volumes for all before the few larger-scale users can take more water.

Whereas everyone's domestic uses are the general priority, there are local exceptions. Pant et al. (2006) found a case in which domestic uses were curtailed to enable irrigation. During lean seasons, farmers enforced a time allocation (2-3 hours daily) for accessing drinking water to save water for irrigation. Domestic uses requiring more water, including bathing, had to be carried out in the nearby streams.

By 2019, iDE had implemented 502 MUS (including 31 solar MUS) for 82,609 people in 32 of Nepal's 77 districts. iDE mobilized external support from – in this order – UKAid, USAID, Canada, European Union, Bill & Melinda Gates Foundation, World Food Programme, Lottery, Asian Development Bank, and 11 other development partners, and the Government of Nepal.

The second innovation by iDE was to target irrigation at homesteads or small fields for income generation, through agronomic training in crop calendars for the cultivation of vegetables or other high-value crops; development of supply chains for seeds, fertilizers, integrated pest management and other inputs; and greenhouses. Nutrition education, as implemented by iDE under the Anukulan/ Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) project, amplifies the benefits of food production for own consumption. Moreover, in Nepal, where only 13% of agricultural produce is marketed, iDE started facilitating collection centers for marketing to improve food security, nutrition and incomes all at the same time (Polak et al. 2004). Accompanying training in marketing skills and forging market linkages help to increase incomes, and become incentives to increase productivity. Members of the WUA of the MUS become the 'last-mile' collectors or 'community business facilitators' to collect and store produce to achieve the bulk required to better attract external traders. Challenge funds and insurances are set up to encourage businesses to enter these underserved markets. Collection centers can also evolve into cooperatives that provide the wider range of services to their members: marketing, detailed crop calendars, technical support, inputs, credit, linkage to government services, and advocacy. This support to the irrigation of homesteads and small plots is equally relevant elsewhere in Nepal (GC et al. 2021a) and increasingly adopted.

RVWRMP took up similar livelihood components in its third phase. These and other projects also develop saving groups such as Village Savings and Loan Associations. The interest gained from keeping money in a box with three locks can be loaned to members or used to pay the operator and finance system repairs, as done by the NGO *Samjhauta* ('Agreement') (Jha 2016). The various group activities mutually reinforce cohesion, performance and, hence, system sustainability.

Other government and nongovernmental support agencies with productive water uses as an entry point also expanded their MUS systems. SAPPROS estimates that it has implemented a total of 1,600 MUS in collaboration with iDE and through other consortiums. Other partners of iDE and MUS implementers include Agro Enterprise Centre (AEC), Center for Environmental and Agricultural Policy Research, Extension and Development (CEAPRED), Concern Worldwide Nepal (CWN), Centre for Integrated

Urban Development (CIUD), and Renewable World for solar MUS (as explained in the section *Solar MUS in the Water-Energy-Food Nexus*).

Winrock International continued as a partner in the USAID-funded Knowledge-based Integrated Sustainable Agriculture in Nepal (KISAN) project. In the first phase from 2013 to 2017 (KISAN-I), the project constructed 16 multiple use water systems. The second phase (KISAN II) focuses on promoting technologies of micro-irrigation and shallow tube wells, and on canal rehabilitation of 150 existing irrigation systems. It also experiments with fertigation through drip irrigation with fertilizer.

Last but not least, from the earliest phases of the project, and as the first government agency supporting MUS, the then Department of Irrigation, through its Non-Conventional Irrigation Technology Project (NITP) unit, supported iDE's piped gravity systems for multiple uses. This unit promotes small-scale irrigation technologies such as sprinkler, drip, treadle pumps, rainwater harvesting, and piped systems. In line with the integration of MUS in the general irrigation policy of 2014, the current Department of Water Resources and Irrigation is mandated to develop water infrastructure to provide irrigation water to farmlands. Farmers are not restricted from using the water for other purposes such as drinking, washing and cattle raising.

Solar MUS in the Water-Energy-Food Nexus

Solar energy, which plays an increasingly important role in off-grid electrification of rural Nepal, further boosts MUS in a water-energy-food (WEF) nexus. In the decade since 2009, the price of solar photovoltaic (PV) modules has dropped by 80%, which has made the life cycle cost of solar power cheaper than diesel. This enables MUS and even combinations of water and energy sources. SAPPROS develops such integrated systems that generate electricity to provide water for domestic uses and irrigation, and other energy uses.

In 2012, Renewable World and iDE, supported by the Alternative Energy Promotion Centre (AEPC) and co-financers, introduced solar panels to pump water from surface water sources in deep valleys up to high elevation reservoirs for reticulation by gravity. A community-centered model ensured participation and contributions from the community, which were complemented in each project site with co-funding from locally available grants and subsidies.[5]

AEPC, a government agency in the renewable energy sector under the Ministry of Energy, Water Resources and Irrigation, also provides subsidies to other organizations installing MUS. An example is the Renewable Energy for Rural Livelihood (RERL) project, supported by the Government of Nepal, Global Environment Facility (GEF) and United Nations Development Programme (UNDP) (RERL 2016). At wider integrated scales, mini-grids provide energy for both domestic and micro-industrial energy needs, also enabling water pumping for domestic uses and improved irrigation.

National Learning and Exchange

Since the early 2000s, there has been systematic learning, exchange and study around WUMP and MUS innovation at national levels through 'learning alliances'. Initially supported by the International Water Management Institute (IWMI) and iDE, MUS also became one of the themes of the biannual international seminars of the Farmer Managed Irrigation Systems Promotion Trust (FMIST), organized in 2015, 2017 and 2019. State-of-the-art studies were regularly compiled by iDE and IWMI (Mikhail and Yoder 2008); Rockefeller Foundation, IWMI and IRC (Basnet and van Koppen 2011); and the International Centre for Integrated Mountain Development (ICIMOD), Helvetas and the European Union in the World Overview of Conservation Approaches and Technologies (WOCAT) tool (Egloff et al. 2015). The challenges and opportunities for further national institutionalization of MUS were analyzed by IWMI, FMIST and iDE for the BRACED project (Clement et al. 2019). The most rigorous research on MUS in Nepal was conducted as part of a postdoctoral degree (PhD) program for Virginia Polytechnic Institute and State University (Virginia Tech), USA, on the common prevalence of de facto multiple uses (GC et al. 2019); commercialization of smallholder farming linked to MUS (GC and Hall 2020); productive uses as a contributing factor to the sustainability of rural water systems (GC et al. 2021a); and approaches to advance MUS in Nepal (GC et al. 2021b).

This learning involved many sectors: irrigation, water supply, local government, climate change adaptation, disaster risk reduction, energy, and national planning. Affordable water technologies were broad including, for example, hydrams (which use the gravity energy of flowing streams to lift a smaller amount of water to a greater height) and biogas (which also requires water as one of the inputs; it combats indoor air pollution and prevents deforestation for the creation of woodstoves for cooking).[6]

MUS was formalized in the block grant guidelines of the Department of Local Infrastructure Development and Agricultural Roads, under the Ministry of Federal Affairs and Local Government. In 2010, the then Ministry of Population and Environment issued a National Adaptation Programme of Action (NAPA). MUS is recognized as one of the climate-smart technologies in the local-level Local Adaptation Plans of Action (LAPAs), which are being planned in consultation with local stakeholders. This Ministry of Population and Environment also hosted the International MUS Workshop in 2016, in collaboration

[5] https://renewable-world.org
[6] https://renewable-world.org

with iDE, FMIST, IWMI and the global MUS Group. The workshop was attended by 250 stakeholders engaged in MUS research and implementation in Nepal and elsewhere. At this workshop, a Nepal MUS Network[7] was created, coordinated by iDE. The goals of the network are to share best practices in MUS development and knowledge, and to develop the capacity of stakeholders to advocate enabling policies for the MUS approach. The Nepal MUS Network consists of representatives from the government, development partners (from USAID, UKAid, Finland, Switzerland), NGOs, and research organizations such as IWMI. Facilitated by iDE, the network convened meetings in April 2017, three meetings in 2019, and a global webinar at World Water Day in 2021.

The foregoing innovation focuses on the infrastructure required to improve everyone's access to water, primarily at homesteads. However, this assumes that water resources at community-scale and, as needed, beyond a community are available to flow into the infrastructure. Participatory WUMP and MUS processes also innovate in addressing the growing challenges of the sharing of finite naturally available water resources, as elaborated in the next section.

Community-led Sharing of Water Resources

As mentioned above, in the mid-hills region of Nepal, many springs and streams are gradually drying up, especially in the lean season from March to June. The sharing of water resources in and under the community's territories and beyond affects existing water users, but also those who consider and plan new infrastructure. The participatory WUMP and MUS processes are increasingly shown to provide a basis to address this all-important challenge (Neupane et al. 2016). These processes start by identifying the multiple water sources in a community. For example, in the Gurans Ward in Dailekh district, there are 14 rivulets and streams and 653 natural springs, of which 24 are fit to use for accessing low volumes of water and 14 for larger volumes and for irrigation. The remaining sources are unfit for use (Gurans Rural Municipality 2019a; 2019b).

Assessments like these may seem complex to outsiders. Yet, in participatory resource mapping, communities swiftly draw not only their multiple sources, but also their uses and infrastructure, whether self supply or externally supported infrastructure. During the planning and design of new systems or upgrades, current and potential limitations in water sources can be identified in a timely manner. When they appear too limited, an obvious solution is water supply augmentation. Such options are increasingly important components of community-led infrastructure development. The Department of Forests and Soil Conservation of the Ministry of Forests and Environment and others apply such community-, area- or watershed-level soil and water conservation and groundwater recharge practices through conservation ponds and underground barriers in streams that would otherwise dry up in the lean season. Reuse of water is encouraged through proper drainage, also avoiding mosquito breeding. Water buffering interventions in the WUMP + 3R (recharge, retention and reduce) approach stores water within the landscape so that it can be used later. This helps to prevent droughts, and is also beneficial to downstream users because flood risks are reduced (Aidenvironment 2015).

However, at some stage, first during the dry season and then more permanently, trade-offs may become unavoidable and water sharing arrangements need to be negotiated. For example, it was identified that landowners claimed that a stream or sprout located on their private land is their property, so they can refuse rights of way to others to tap into the same resource. Also, households with private pipelines for self supply forbid others from using a water source they already own (Rajouria et al. Forthcoming).

Formal boundaries of administrative units also play a role. Such boundaries complicated access to water resources for around 10 households of Gairi Gaun, a largely Dalit village. They had been sharing a water source from a nearby community in the same pre-federal structure of the so-called Village Development Committees. Under federalism, boundaries of rural municipalities were newly demarcated. The new administrative boundaries are now used to claim rights to the water resource.

> *Before the formation of Gaupalikas (rural municipalities), we had access to an adequate amount of water through a sharing arrangement with the adjacent Village Development Committee. Now, due to diminishing water sources, and increasing population, the demand for water has increased. Users of the Gaupalika, where our source of water is now located, are laying exclusive claim over the source. We are at a loss as to how we will fulfill our water needs.* (Rajouria et al. Forthcoming)

Participatory WUMP and MUS processes provide a sound basis to better understand and mediate in conflict resolution at the interface between formal and customary water sharing arrangements. Little is known as yet about the ways in which communities have managed the water resources flowing over or under their socially defined territories since time immemorial, as informal or customary water tenure. Norms and practices govern the 'sharing in' of water resources within communities, but also the 'sharing out' of water resources with neighboring customary communities. In any case, water sharing negotiations are often about

[7] https://nepalmusnetwork.wordpress.com

preferred sources among the combinations of sources available, depending on natural availability and location. Having alternatives is important. For example, Clement et al. (2015) found that downstream users in a multiple use water system received so little water that they decided to go to another system. Without that option, they might well have insisted on better flows to the tail end of the multiple use system.

Within communities, social hierarchies and power relations play strong roles in negotiations about water resources, but moral economies with social safety nets may still ensure that less fortunate kin, neighbors or disadvantaged castes are not completely deprived of access to water resources for basic water and food needs.

At the interface between customary and formal water law, such value- and livelihood-based customary moral economies may well align with the core minimum prescribed in the Water Resources Act, 1992 (GoN 1992). The Act vests ownership of the country's water resources (surface water, groundwater or other forms of water) in Nepal (GoN 1992, Article 3). The Act prioritizes a core minimum of water resources for everyone to flow into infrastructure, whether this is externally supported infrastructure or self supply, for domestic uses and irrigation (GoN 1992, Article 7). This priority also aligns with the constitutional prohibition of gender-, caste- and ethnicity-based discrimination or other longstanding marginalization at the community level, including in access to water resources, that would prohibit such groups from using communal water sources (Rajouria et al. Forthcoming).

In other cases, customary arrangements that align with the constitution are a useful starting point for conflict mitigation. This warrants a better understanding and recognition of customary tenure. Yet, these arrangements are largely invisible. The Act emphasizes formalization of water tenure through the formal registration of a 'water users' association' that manages particular collective infrastructure and the sources from which they tap water. Registration provides useful information to the government, but it only covers the tip of the iceberg. The millions of informal users, including the most vulnerable, and their self supply and verbal, community-based water sharing arrangements, risk remaining invisible. Prior and new uptake of water for self supply for domestic uses and irrigation of own land is exempt from the obligation of applying for a license (GoN 1992, Article 4[2]). Even though these uses are formally priority uses, the question is how this can be enforced if these uses remain invisible.

Administrative invisibility renders the majority of rural people even more vulnerable in the 'sharing out' of water resources with powerful third parties, from local to catchment, inter-basin and international scales. Such powerful national or international players, and their consultants and lawyers have to follow the administrative process to apply for a licence. This provides them with the country's strongest water resource entitlements. However, if the majority of users remain invisible, their prior and future uses can be infringed upon. This underlines the importance of a first step towards equitable water resource sharing: protecting core minimum volumes of 45 lpcd to meet, at least, everyone's basic water needs, whether domestic only or both domestic and productive water needs, as people prioritize. This will gradually raise awareness about inequalities in water distribution: a few high impact users within or outside a community may infringe on even the basic domestic and productive water uses of the majority.

This section provided a largely qualitative description of the story of community-led MUS in Nepal, and the likely further importance of community-led infrastructure development under growing competition for water resources. In the next section, we look at quantitative comparisons of costs of hardware and process, with accompanying financing modalities, and benefits of MUS for well-being.

Costs and Benefits of Community-led Multiple Use Water Services

Financial Benefit-Cost Ratio

Investments in multiple use gravity systems have a high return. Shrestha (2010) studied five early gravity flow piped MUS implemented by iDE (four new systems and one upgrade). The (hardware and software) costs of installing MUS per household were between USD 137 and USD 512, with an average cost per household of USD 184. Four-fifth of the households undertook year-round vegetable cultivation. Income from vegetable production and sale varied from USD 11 to USD 2,000 per family annually, depending on the household's area of cultivation, market access and proportion sold. Taking everyone's potential income from vegetable cultivation into consideration, this would allow repayment of the investment in a period between 9 and 21 months (Shrestha 2010). iDE found similar payback periods of one year for gravity MUS (GC 2010) and three to five years for solar MUS. Egloff et al. (2015) also referred to a one year payback period for installation costs of gravity MUS with the income gained from the cultivation of high-value crops.

Costs are even lower, and the benefit-cost ratio much higher, if only the incremental costs are considered to augment a system with the design taking into account the basic water needs for domestic uses only (45 lpcd), and adding another 40 to 100 lpcd in order to enable more productive uses. Incremental costs are consistently reported to be at most 30% higher than the system designed for domestic uses only. WaterAid through NEWAH reported that approximately 10% of costs are added. With the income generated, they report a payback period of 13-14 months and a Financial Internal Rate of Return of 58%. This renders the incremental amount 'nominal when considering the benefits it offers' (Rajbhandari 2011). This echoes the global study conducted by Renwick (2007) of the high benefit-cost ratio of MUS: relatively low incremental costs generate high incremental benefits. Repayment of these costs from the income gained takes between 6 months and 3 years. Renwick (2007) estimated that each additional liter of water per person per day that is provided beyond 20 liters per person per day generates USD 0.50–1.00/person/year of income. In all these calculations, domestic uses of the system are cross-subsidized.

Financing Modalities

MUS enables the convergence of financing streams of various external agencies because MUS contributes to achieving a range of sectoral outcomes that earmark these financing streams: health, food security, nutrition, climate resilience, alleviation of domestic chores, disaster risk reduction, and resource conservation, among others. Accordingly, a wide range of locally available financing streams can flexibly complement each other. For example, in the co-funding of iDE's 502 MUS, projects/development partners contributed 30% of the costs, various agricultural departments of the government (District Agriculture Development Offices, Department of Irrigation, District Soil Conservation Offices, Annapurna Conservation Area Project, Micro Irrigation Pilot Project) contributed 21%, and other NGOs/community-based organizations (CBOs) contributed another 8%. Local communities contributed the most (in cash and in kind): 41%.

Similar co-funding has been arranged by RVWRMP. In this case, the government contributed 35% of investment costs, whereas RVWRMP contributed 33%. Communities provided 32% in cash and in kind. For the MUS implemented by KISAN, 75% of the costs were leveraged.

However, the convergence of financing streams, each with their own conditions and planning cycles, is complex. Yet, harmonization also saves confusion and local transaction costs for the same few community members who sit in the range of committees. iDE pioneered such a harmonization of planning processes in two locations for two financing streams at the lowest levels: the LAPA and the Disaster Risk Reduction Program (as part of the UKAid-supported BRACED program). In 86 areas, covering a total of almost 1.5 million people, iDE facilitated the compilation of areas' harmonized plans with priorities. For this, the list of activities and technological solutions to adapt to climate change in the LAPA (coordinated with the then responsible Ministry of Science, Technology and Environment; now the Ministry of Forests and Environment) were combined with the largely overlapping list for disaster risk reduction activities (coordinated by the Ministry of Home Affairs, responsible for disaster management). This led to one combined list with a budget for climate-induced immediate and longer-term disaster risk reduction. Only non-climate induced disasters or emergencies, such as earthquakes, had their own financing and financing cycle. In one of the two locations, MUS came up as the local priority (iDE and UKAid 2014; Rajouria et al. 2019).

Community-led Investment Processes and Support to Self Supply

Participatory processes that accept intrinsically diverse local realities as a starting point may be seen as too costly. It is true that these processes require time and facilitation skills of external support agencies, especially in the planning, design and construction phases (Goodrich et al. 2017). Reaching the most marginalized households and women remains a key challenge (Clement et al. 2015). However, although no quantitative data could be found, it is likely that the time and costs of participatory processes in which future beneficiaries can voice their knowledge and priorities and contribute their five types of capital compare relatively well with the time and costs of external pre-feasibility and feasibility studies and designs, especially when these are outsourced to powerful profit-oriented consultants and contractors, and require time-consuming transparent tendering processes.

Importantly, time and interaction during the design phase are key to including the most marginalized and women, in order to elicit their priorities and anticipate problems and agree on solutions in a timely manner. Working with written guidelines, in particular, reduced the risks of political interference and corruption at local levels (Haapala and White 2018). Such inclusive community-led participatory planning and design aligns with the aims of the new local government to render it more accessible to citizens through genuine representatives in the ward committees. Instead of top-down, untransparent design by outside engineers, technical planning and design can include the most vulnerable in a timely and effective manner (GC et al. 2019), as the following anecdotes further illustrate.

Inclusive decision-making about the layout of a system is key: where do pipes and taps go? For instance, one of the locations for installing a community tap initially picked by men was later shifted when women were involved in the decision-making (Rajouria et al. Forthcoming).

Technical choices in the design phase also determine costs and, hence, implicitly tariff setting. Affordability of fees is critical, and even more so when a fee is standardized and enforced irrespective of the ability to pay, as a local technician asserted: "*We cut off the water supply using the special lock if any household does not pay their tariff*" (Rajouria et al. Forthcoming). Although representatives of the Dalit communities flagged their problems from the onset, they were ignored. Stepped tariffs with a low cost or free core minimum for all as a social safety net can be a solution, especially when only a few households use disproportionately high volumes of water for production. However, such households may be powerful and difficult to challenge. Costs also depend on context. In general, gravity systems are more affordable than groundwater abstraction, as in the Terai. Moreover, arsenic contamination of groundwater requires expensive treatment, or replacement with surface water sources to provide for drinking purposes (Raut and Rajouria 2020).

Further, ample experience about 'vandalism' has highlighted how pipes to communal taps are invariably cut for extensions to yards. Also, individual households or small groups of households reorganize and redesign the system. If designs are drawn up in a participatory process, these future actions can be anticipated and addressed upfront. For example, if households require connections to yards or dwellings and can afford these, they can pay for such extensions, whereas support agencies finance the bulk water supply.

As mentioned above, recognition and support of users' own contributions can be extended to supporting, instead of rejecting, all self supply. Leveraging users' capital is cost-effective and sustainable. The main challenge is to provide market-led supply chains of affordable water and energy technologies, or farmer-led irrigation development in general (Khadka et al. 2021), accessible to the most vulnerable, especially women.

Other obstacles to self supply can also be addressed when support is anchored in a sound understanding of local realities and problems. For example, a landless family was living in a relative's house. They had no option but to lay their water supply pipe on private land that belonged to landowners who were not living in the village. The family fears that the landowner may return and remove the pipeline (Rajouria et al. Forthcoming). In this case, too, community-level discussions on the required servitude rights can be a cost-effective pathway to realize access to water for all parties involved.

Once technical designs and other support have been planned and materials procured, construction can begin. Community participation in the construction has important gender implications. As found across the globe, contributions to the construction, and later maintenance, tend to generate claims to water conveyed in 'hydraulic property rights creation' (Boelens and Vos 2014). Traditional taboos prohibited women in Nepal from participating in construction or maintenance work, as identified by Clement et al. (2015). The households whose male heads were away during the MUS construction process could not contribute to construction of the tank and, as a result, did not get access to the MUS (Clement et al. 2015).

However, these norms are gradually changing, also as a result of male out-migration, as found in the extensive study of 336 irrigation systems by Meinzen-Dick et al. (2021). In 90% or more of all systems studied, women were found to be involved in O&M, and water allocation and distribution. However, women's participation in irrigation systems increased with male out-migration. In such systems, WUAs adapted rules to better allow for women's participation. Women voiced their opinion more often in meetings and their participation in supervising water distribution was significantly better. However, maintenance obligations were more often monetized, or even contracted out. At field level, male out-migration was found to be associated with mechanization of harvesting and threshing, which are time-critical tasks usually associated with male labor. Overall, shortages of male labor did not cause a deterioration of the systems, although the chairpersons of the WUAs interviewed expressed their concerns about women's labor burden. The study also flagged the importance of other trends: government quotas for women's participation in WUAs and the development of roads and bicycles, which increased women's mobility to implement irrigation system management. Mobile phones enabled the hiring of laborers on the farm and for irrigation system maintenance, and allowed migrant men to continue to participate in decision-making (Meinzen-Dick et al. 2021).

The high benefit-cost ratio, of MUS and flexibility in shaping complementary external financing modalities, while ensuring that the design and construction processes are, gender and socially inclusive, contribute to the following ultimate benefits.

Benefits

Less Domestic Chores and More Convenience, Hygiene and Health

Alleviation of domestic chores is unanimously reported as a major benefit of MUS. This mainly benefits women and girls who used to carry out these chores. Shrestha (2010) reported how households that spent one to eight hours to fulfil their water needs before the new system, reduced that to a maximum of 5 minutes. For solar MUS, 80% of women and girls saved an average of 2.4 hours per day that was spent collecting water. Improved access also stimulates men to collect water for domestic uses (Clement et al. 2015). Water-dependent grain milling further alleviates women's labor, as RVWRMP often found.

RWSSP-WN, in turn, surveyed 1,252 households in three districts in Western Nepal (Rautanen and White 2019).

Since the aim was to interview the person fetching water (or used to fetch), 99% of the respondents were female and 99% were those in charge of fetching water. Of these, 67% spend more time in home gardening and this has improved their livelihoods by earning income (selling vegetables) and saving on purchases. When asked about several options and which of these changed the most in their life as a result of the time saved in fetching water, 42% stated 'home gardening/farming'. MUS occur naturally when water systems are improved. In another survey covering 100 lift schemes serving a total 54,554 people, it was found that a total 16,200 hours were saved *every day* due to the lift scheme. This is time spent by women (Rautanen and White 2019).

MUS also greatly enhances convenience when activities that used to be done from a distance can be done at home. In five MUS implemented by iDE, Pant et al. (2006) found that only 14% of the sampled households were washing clothes at home before the project. After the project, this proportion reached 83%, besides using water for other domestic activities (dish washing, bathing of adults and children, and vegetable cleaning). However, Pant et al. (2006) also found that 19% of households reported an increase in waterborne diseases, mainly due to wastewater logging close to the households where the number of mosquitoes had increased.

More water nearer to homesteads enables improved hygiene for food processing, dish washing, handwashing, and cleaning the house and livestock sheds (Sutton and Butterworth 2021). Water at home is vital for menstrual hygiene. Improved hygiene may well be as, if not more, important for overall health than water quality for drinking per se. The quality of water from springs or high streams that is conveyed through pipes is generally seen as being safe for drinking or, in any case, of a better quality than alternative nearby sources. Protection of springs and intakes can further improve water quality. In any case, only 5 lpcd of water needs to be safe for drinking. Water of a lesser quality is sufficient for many domestic uses. Many urban middle-class households filter the small quantities of water for drinking and cooking from their piped water supplies. In low-income areas, treatment of 45 lpcd to achieve drinking water quality is even less affordable. The use of specific sources, such as clean rainwater harvesting or point-of-use treatment technologies, may be more effective in many rural settings. In MUS, the responsibility for clean drinking water is unlocked from the WASH sector. Irrigation engineers who observe that people drink water from canals, springs and ponds can advise and assist in better covering and protecting these sources, or provide other options. This was done in the Local Infrastructure for Livelihood Improvement project (Basnet and van Koppen 2011).

However, in other settings, water quality for drinking can be a major issue. For example, in Sarlahi in the Terai, shallow hand pumps produce water contaminated with iron and arsenic; safer water is only available through deep wells that reach 50 m or below. Because the installations of deep wells is expensive, only a few households can afford them. These households may share that water with a few less fortunate neighbors. However, in the absence of community-owned deep boreholes, a large number of households still rely on hand pumps drawing arsenic-infused water from shallow sources. At present, with support from development partners, seven overhead water tanks are being constructed to supply safe, piped water, but this solution risks being too expensive for the most vulnerable households (Raut and Rajouria 2020; Raut et al. Forthcoming).

More Food Security, Better Nutrition and Higher Incomes

Even at the core minimum volumes of water, many users not only realize their constitutional rights to water for domestic uses but also for some productive uses. MUS providing water to homesteads render productive water use accessible to all. Where water availability is the limiting factor, as is often the case for the most vulnerable, more water would meet even more productive water uses. Homestead-based production overcomes the wide inequalities that are intrinsic to productive water uses.

Own consumption of diverse mineral- and vitamin-rich vegetables, and rearing of livestock for protein-rich eggs, meat and milk improves nutrition of children under five years of age, mothers and other adults. MUS users may not compromise the consumption of vegetables for additional income through sale. In Senapuk village, vegetable consumption was shown to increase from a very limited 2-3 kg per week to almost 1 kg per day with MUS (Mikhail and Yoder 2008). Nutrition education enhances the benefits of consumption. At the same time, higher incomes from the sale of produce enable the purchase of nutritious foods.

Incomes particularly increase with more support on the productivity and profitability of production, as provided by iDE through the above-mentioned capacity building, collection centers and other external support. In their study of the 200 households in 10 gravity systems, GC et al. (2019) found that around 90% of the households were engaged in productive activities that contributed to over 10% of their mean annual household income. The level of productive uses and related income further depended on household-level characteristics and agricultural support: households that farm as a primary occupation use productive technologies (drip irrigation, greenhouses, cattle troughs), and are motivated to pursue productive activities. Importantly, being relatively poor was significantly associated with lesser water uptake for productive uses, possibly also because of their smaller homestead and land sizes and lesser access to external agricultural support. The water infrastructure appeared neutral: there was no difference between systems designed for domestic uses only and those designed for multiple uses (GC et al. 2019).

Importantly, homestead-based irrigation or other enterprises empower women, who tend to have more control over land and water and power for joint decision-making at homesteads than at distant fields. Clement et al. (2015) found that MUS enables more consultation and joint decision-making between men and women for farm activities. Also, women controlled the income gained from vegetable sales (58%), compared to men (33%) and both (9%).

The cross-sectoral focus on the provision of core minimum volumes of water for all also avoids gender stereotyping in which WASH would focus on women as 'housewives' and irrigation on men. Instead, MUS implies that both domestic chores and productive activities are shared within households. Men's contribution to the provision of water for domestic uses has to increase, and women need more access to water for production, in both male- and female-headed households (Goodrich et al. 2017). Thus, MUS also aligns with the Irrigation Rules 2000 that stipulate representation by marginalized communities and women (NLC 2000).

Sustainable and Functional Infrastructure

Last but not least, evidence suggests that gravity piped MUS are more sustainable than systems designed for domestic uses only. Clement et al. (2015) studied 16 MUS implemented by iDE and found that 88% of the systems were still fully functional or needed minor repairs after 7-10 years. Also, 75% of the user groups were still regularly collecting a service fee for O&M. Users with a higher economic interest to use the system were particularly active to keep the system running.

WARM-P conducted a functionality study of 92 drinking water systems built from 2001 to 2004 (Pant 2013). Out of the range of social or institutional and technical parameters studied, one of the factors supporting functionality was the productive use of water (Pant 2013). GC et al. (2021b) also confirmed statistically that water-based productive income is significantly and negatively related to the duration of system breakdowns. Similarly, RVWRMP found a high functionality rate of 98% across all its systems (White et al. 2017).

Two likely pathways mutually reinforce each other and lead to higher sustainability and functionality of MUS: a higher willingness and a higher ability to pay for O&M. A higher willingness to take care of the MUS derives from the participatory planning and design process according to communities' priorities. They may prefer support to self supply or maintenance of existing systems instead of constructing new infrastructure. Potential conflicts can be anticipated and addressed in a timely manner. Participation in construction strengthens ownership. The ability of water users to ensure sustainability of the MUS is further enhanced by the capacity building and organization created during these participatory processes. Strong and well-facilitated participation of women in decision-making and their capacity development, in particular, contributed to the 98% functionality rate of systems of the RVWRMP (White et al. 2017). Further, the multiple benefits increase the value of the system to the users, including the ability to pay. Part of the income gained can be reinvested, even though the income gained is not necessarily used for fee payment, as found by Clement et al. (2015). Moreover, collection centers, as iDE proactively pursues, not only organize water users around the water system but also its economic opportunities. This reduces transaction costs and builds longer-term contacts and representation in local government institutions for future co-funding arrangements.

However, the functionality of MUS is not 100% either. For example, it was observed that some areas planned for irrigation in MUS were not fully used or even abandoned (Egloff et al. 2015). The diversity in productive uses requires localized solutions through participatory processes, but risks remain. As in any externally financed system, some post-construction support to organize users and to mobilize funding and implementation of O&M may well be needed.

Conclusions

This paper explored proven and plausible ways in which community-led MUS, as evolved in Nepal over the past two decades, tackles five persistent challenges in the WASH sector for further realization of the constitutional right of access to water for drinking and domestic uses, and in addition, the right to food.

The problem of low functionality of conventional WASH systems (or irrigation systems for that matter) as a result of top-down planning and design of infrastructure is addressed by inclusive well-facilitated participatory planning, design and construction processes. Well embedded in local conditions, designs consider the priorities of women and those left behind. This creates ownership and enhances both the ability and willingness to contribute to O&M of the system.

Participatory planning processes identify local self supply by subgroups or individual households near and at homesteads, where support agencies may ignore self supply or even see as a problem. Yet, recognition of and support to self supply to fields is not new in Nepal: farmer-managed irrigation has been recognized as communities' vital capital and supported for decades. Community-led MUS expands such recognition and welcomes self supply for people's priority uses, also at homesteads, as a complementary alternative or in some localities, a permanent water services model. Infrastructure for self supply is often multipurpose.

As in self supply, externally financed water systems designed for domestic uses are, in reality, also used for productive uses, already below 45 lpcd. Instead of sticking to single-use mandates of administrative water sectors and trying to prohibit such productive uses (WASH sector) or ignore de facto domestic uses (irrigation sector), community-led MUS respects people's priorities. It welcomes cost-effective, multipurpose infrastructure and proactively promotes the broader productivity of the activity in which water is an input. This not only includes women and landless households as potential producers, but also realizes the constitutional right to food in a cost-effective manner, leaving no one behind. By overcoming silo mindsets, external support agencies collaborate in accelerating the development of (neutral) water infrastructure near or at homesteads, tapping the same water resources. However, specific sectoral expertise to increase the benefits of water use is unlocked from silos. For example, the WASH sector's solutions to improve the quality of at least 5 lpcd of water for drinking for all or its education for regular handwashing are also disseminated by irrigation and other professionals. Also, agricultural expertise, for example, in inputs, agronomy and markets is applied to boost production at homesteads for better nutrition and incomes.

Community-led MUS, and WUMP that underpins MUS in Nepal, is the starting point for solving the fourth challenge: increasing temporary, if not permanent, competition for finite naturally available water resources at community scale. Cross-sectoral participatory planning recognizes all water resources in or under communities' territories to meet multiple needs through multipurpose infrastructure as the rule, and single-purpose infrastructure as the exception. Existing and potential conflicts can be addressed in a timely manner, building on age-old informal water sharing arrangements. Nepal's Water Resource Act, 1992, prioritizes a core minimum volume of water for everyone to flow into infrastructure for basic domestic uses *and* basic water-dependent food production and income. Core minimum flows are applicable for the 'sharing in' of water resources within communities, and also for the 'sharing out' of water resources with neighboring communities. Most importantly, the inequalities in the distribution of water resources between the rural poor and the few national and international third parties of high impact users are made visible.

This leaves the fifth challenge – male elite capture across all levels – as probably the major remaining challenge as elsewhere in the world. The constitution and the new local government structures have opened up new opportunities for inclusion. Capacity building and well-facilitated bottom-up participatory processes in providing external engineering and other support have proven to have impact. Core minimum rights to water and food may align with communities' social safety nets.

In sum, from the perspective of external support agencies and researchers, this paper showed how constitutional rights to water and food were operationalized cost-effectively and sustainably by targeting support to water infrastructure near or at homesteads, and prioritizing water resources to flow into that infrastructure. The benefits mutually reinforce each other: better access to water for domestic uses saves time and improves health and hygiene. Consumption of nutritious food and income to buy food help to overcome malnutrition, also in infants. Time, health and being well nourished, at their turn, enhance productivity for more health, food and income in virtuous intergenerational circles out of gendered poverty. However, further research and action are needed to better hear the voices of poor women in households that are left behind.

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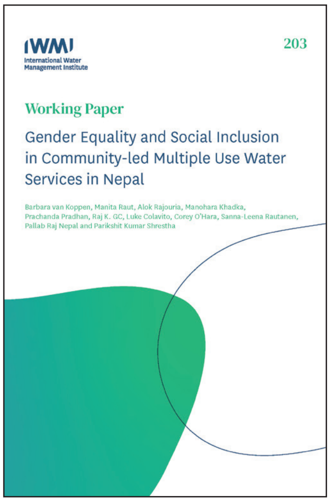

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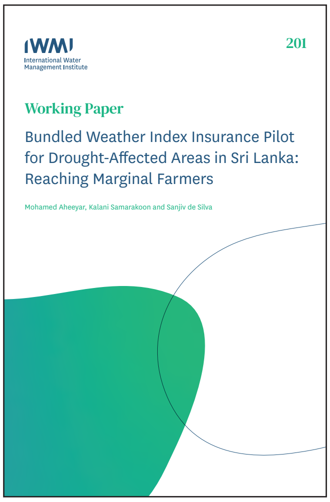

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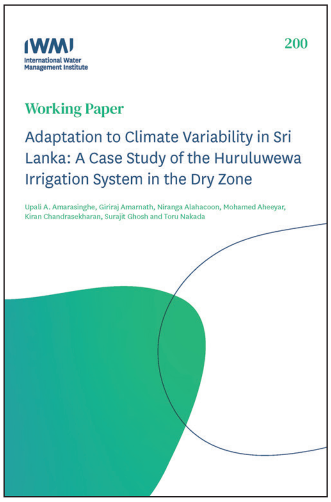

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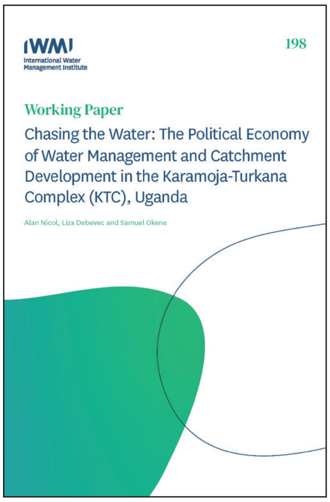

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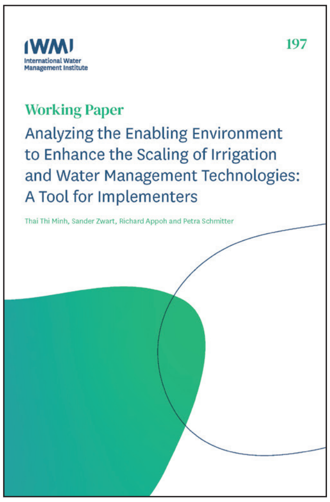

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