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Multiple-Use Services as an Alternative to Rural Water Supply Services: A Characterisation of the Approach

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ABSTRACT: Multiple-use services (MUS) have recently gained increased attention as an alternative form of providing rural water services in an integrated manner. This stems from the growing recognition that users anyway tend to use water systems for multiple purposes. This paper aims to characterise this practice on the basis of case evidence collected in eight countries in Africa, Asia and Latin America. The cases show that people almost universally use water for both domestic and productive activities at and around the homestead. Although seldom the main source of people's income or food production, these activities are of considerable importance for people's livelihoods. The extent to which people use water for multiple purposes is closely related to the level of access to water expressed in the form of a water ladder in this paper. The case studies presented demonstrate how access is created by different types and combinations of well-known technologies. Additional financial and management measures are required to ensure sustainability of services. Despite the practical feasibility of the MUS approach, it is not yet widely applied by service providers and sector agencies due to observed barriers in institutional uptake. A better characterisation of MUS, alongside a learning-driven stakeholder process was able to overcome some of these barriers and improve the consideration of multiple uses of water in policy and practice.

KEYWORDS: Multiple-use services, livelihoods, technology, institutional change

INTRODUCTION AND OBJECTIVES

There is a growing body of case material describing practices of multiple use of water services (see compilations by Moriarty et al., 2004, Butterworth et al., 2008 and MUS Group, 2009). This body includes cases where domestic water supply systems are used for small-scale productive activities such as backyard gardening, livestock, processing of agricultural products, and other home-based enterprises (e.g. Lovell, 2000; Pérez de Mendiguren Castresana, 2004). Already in the 1980s cases were reported on how irrigation systems were used for purposes other than growing field crops (e.g. Yoder, 1983). But since the mid-1990s the use of irrigation systems for domestic purposes, such as drinking and washing and for other productive purposes, has been an active area of study (see for example, Meinzen-Dick, 1997; Boelee et al., 1999; Renwick, 2001). These cases have shown that these practices are not only a reality, but also bring additional health and hygiene benefits through using irrigation systems for domestic uses (Meinzen-Dick, 1997; Van der Hoek et al., 2001; Boelee et al., 2007) and additional benefits to livelihoods from the productive use of domestic water supply systems (e.g. Pérez de Mendiguren Castresana, 2004; Renwick et al., 2007).

Although such de facto multiple use of water services is fairly widespread and obvious, this practice is at best ignored, and more often discouraged or prohibited by policy-makers and operational staff of water agencies (Moriarty et al., 2004). For example, the national water supply agency staff in Honduras prohibited communities from using water from rural water supply systems for productive purposes, even when sufficient water was available (Smits et al., 2010). Arguably, among irrigation agencies there is a broader recognition of the need to cater to other uses beyond the main mandate of field-scale irrigation. Renault (2008) looked into the extent to which water for different uses was provided in the management of 21 large canal irrigation systems in Asia, Europe and the Middle East. A positive correlation was found between the number of uses present and the degree of formality in catering to these in system management. Still, in many cases agency staff have ignored multiple uses of water or turned a blind eye on them.

The lack of recognition of multiple use of water in water system planning, design and management has two main drawbacks. First, it limits the livelihood options of users, as they may not have access to water for all their needs (Moriarty et al., 2004); particularly, the homestead as a potential site of production has been largely ignored (Van Koppen et al., 2009b). Second, there may be negative impacts on the performance and sustainability of services. Not having formal access to sufficient water for production often forces users of rural water supply schemes to access it in other ways, e.g. through unauthorised connections, or overusing system capacity, which in turn may contribute to physical breakdowns or conflicts among water users (Schouten and Moriarty, 2003). Where members of agency staff do not recognise multiple use as a de facto practice, they cannot support communities in solving conflicts that may arise from competition for water, as found, for example, in Honduras (Smits et al., 2010).

The failure to provide water for multiple uses stems from a policy context in which there is a sharp division into distinct water subsectors, particularly the irrigation and water supply and sanitation subsectors. Van Koppen et al. (2009b) highlight a contradiction in, on the one hand, a trend in water policy to recognise multiple uses of water at higher levels of scale under the heading of Integrated Water Resources Management (IWRM), and, on the other, a continued division between subsectors at operational levels where water programmes are conceived and implemented. Sector professionals and line agencies are all guided by their own subsectoral mandates, even informed by distinct paradigms (Moriarty, 2008), centred on increasing food production through irrigation, and reducing morbidity and mortality from water-borne diseases through water supply and sanitation services. These mandates limit the scope of water interventions beyond their direct focus. This can be illustrated by the water supply sector's main paradigm reflected in the Millennium Development Goal (MDG) of reducing by half the percentage of the world's population without access to drinking water supply. This effort translates often into the provision of access to water at basic service levels (in many countries around 25 l/p/d of safe water within a certain distance). These allow for hardly any productive use of water to take place, and thereby reduce potential to contribute to other MDGs. In addition, each subsector has its own set of institutions, objectives, methodologies, and financing frameworks that reproduce the subsectoral focus. As a result, agencies from both subsectors fail to see, let alone address, people's water needs beyond the type of use they are mandated to provide.

Towards multiple-use services

In view of the above, the multiple-use services (MUS) approach has been proposed as an alternative to water services provision (Moriarty et al., 2004; Van Koppen et al., 2006). It is an approach, which starts from the recognition of multiple-use of water as a de facto practice, and seeks to plan, design and manage water services with the aim of meeting people's water needs for multiple purposes (Van

Koppen et al., 2006). In this way, it is expected to have more impact on livelihoods and improve the sustainability of services. Because MUS is focused on reducing rural poverty through access to water rather than on conventional sectoral objectives, Moriarty (2008) argues that MUS can be considered not only as an alternative approach but even as an alternative paradigm to water service delivery in rural areas. By focusing on integration, the MUS concept borrows from the principles underlying Integrated Water Resources Management (IWRM). However, it differs in the sense that MUS are focused on service delivery at the local level, whereas IWRM focuses on the management and development of the water resource base (Moriarty, 2008).

Accepting MUS as a broad approach or paradigm implies there are no blueprint technologies, systems or fixed steps to follow. Yet, as Moriarty (2008) argues, this new paradigm needs to be elaborated, by focusing on the question of "how to" provide these services. Planners, policy-makers and other sector stakeholders need practical tools and instruments that support them in better understanding current multiple-use practices and designing and managing services that fit this reality. By identifying practical implications of adopting a MUS approach, barriers and limitations to overcoming subsectoral divisions can also be better understood and addressed. These two issues constitute the focus of this paper.

The MUS Project

The MUS Project (Multiple Use Systems Project), a project under the Challenge Program on Water and Food (CPWF), aimed to respond to this need, by studying and developing operational models for MUS and identifying the institutional implications for scaling-up the approach. It operated in eight countries: Bolivia, Colombia, Ethiopia, India, Nepal, South Africa, Thailand and Zimbabwe. Action-research was carried out in over 30 (groups of) villages across these countries, synthesised in a series of case studies (Van Koppen et al., 2009a; MUS Project, 2008). In addition, the project worked through so-called learning alliances (Smits et al., 2007), or platforms established at national and subnational levels, bringing together relevant sector stakeholders, such as policy-makers, staff of water agencies, NGOs and user groups. Altogether, over 150 sector stakeholders were involved in the learning alliances (Van Koppen et al., 2009a). These acted as fora to guide the action-research, discuss the implications of findings for service provision and scaling-up, and address the limitations of subsectoral divisions.

Objective

This paper presents findings on operational models studied and tested within the MUS Project. Specifically, it aims to provide a characterisation of the key elements that constitute MUS. It does so by describing and analysing the way water services are provided in the case study areas and the resulting impact on water use. Based on a cross-case analysis, key elements of MUS and implications for service delivery are then identified.

METHODOLOGY

The study was guided by a framework developed by Van Koppen et al. (2006), and subsequently adapted by Van Koppen et al. (2009a) (see figure 1). This framework was used to structure the research across all study sites, though with different levels of emphasis on different parts of the framework in each country.

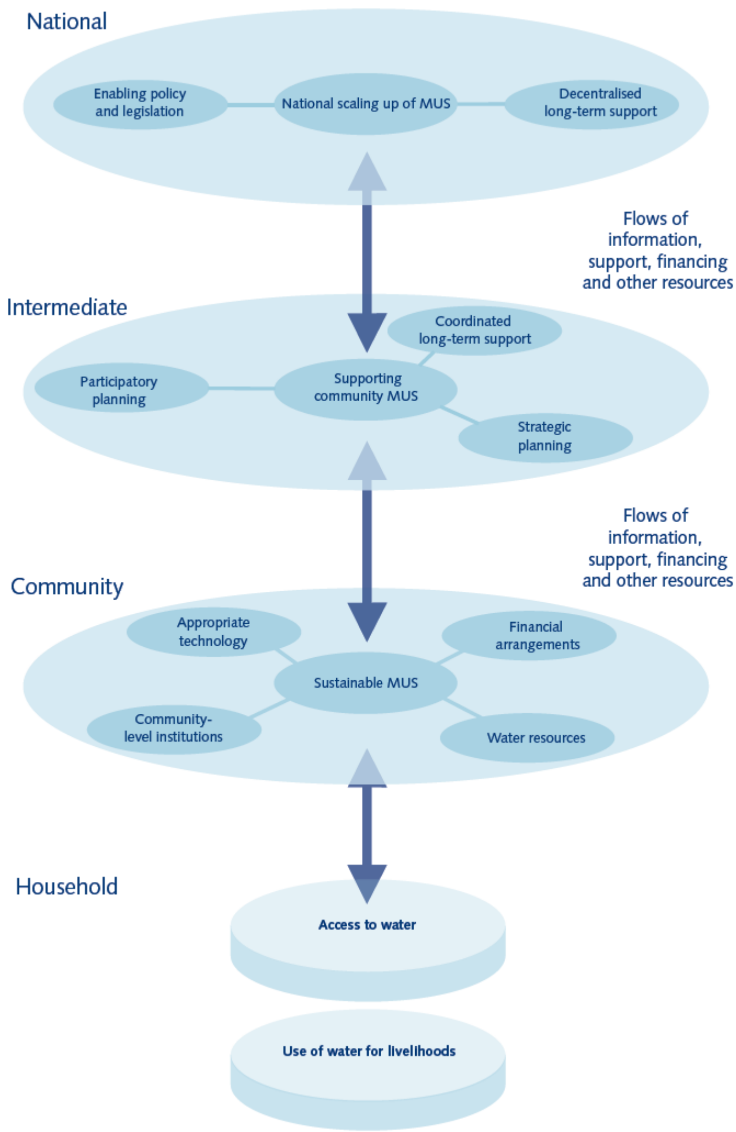
Central to this multi-layered framework is the individual user, who is understood to be using water in a range of livelihoods activities. The research characterised these water-related livelihoods, and assessed their (relative) benefits, using both quantitative and qualitative methods, including surveys and household interviews.

The extent to which water is used for livelihood activities is determined by the user's degree of access to water expressed by factors such as quantity, quality and distance between source and point-of-use. An analysis of the relation between the use of water in people's livelihood activities and access levels led to the development of a 'water ladder'.

Access in turn was assumed to be determined at the level of the community by four interrelated factors: technology (or infrastructure), community-level institutions, financial arrangements and water resources. We looked into the ways each of these factors would need to be given shape, when adopting a MUS approach. This was done on the basis of case studies at water system level. Methods used in each case differed, depending on the specific emphasis given, but included a range of techniques, such as community mapping, infrastructural assessments, measurements of water consumption, interviews and focus group discussions. Details can be found in each individual case of the MUS Project (2008).

Finally, the research looked into the factors at intermediate (i.e. the level from which service delivery is normally organised, such as a district or municipality) and national levels required to support and enable the scaling-up of MUS. Van Koppen et al. (2009a) give a presentation of the full methodology and findings at these levels. This paper focuses mainly on the findings at household and community levels, but will discuss the implications for the other levels.

Figure 1. Conceptual framework for MUS (Van Koppen et al., 2009a).



Study areas

The countries (eight) and sites (30 villages) were selected on the basis of the interest of sector stakeholders in innovation in the MUS area, rather than on the basis of a sampling method. For example, in Colombia, learning alliance members identified case study sites based on their prior knowledge of multiple-use practices in these villages and where they saw problems and opportunities (Cinara, 2006); in Nepal, MUS were developed in three villages, which expressed interest in having such systems (Mikhail and Yoder, 2008). The case studies therefore do not aim to provide an average representation of all communities. Yet, by working in countries and communities representing a wide range of contexts, the length and breadth of MUS in diverse geographic, socio-economic and institutional settings could be explored.

The cases provide a mix of de facto and planned MUS, i.e. both systems that were developed and studied during the course of the project as well as pre-existing water systems that had already been adapted or used for multiple purposes. Nearly all the cases discussed here can be classified as 'domestic-plus' systems (Van Koppen et al., 2006). Water was provided for productive uses, on top of domestic uses, mainly at the household point-of-use and also at the community level in some cases. Table 1 provides an overview of the study areas, and the main focus of the action research and related learning alliances.

Table 1. Study areas.

Country	Study area	Main focus in study area
Bolivia	Five communities around the city of Cochabamba	Community initiatives for planned MUS in peri-urban areas
Colombia	Six communities in different municipalities in the Quindío and Valle del Cauca departments	De-facto multiple use of domestic gravity-fed piped systems, and inclusion of lessons learnt into the government water programme
Ethiopia	One Peasant Association of 11 villages in Dire Dawa *woreda* (district)	MUS pilot projects by NGOs in extremely poor areas, with very low levels of access to services
India	Two villages in Nasik district in the state of Maharashtra	Piloting MUS within the government domestic water supply programme
Nepal	Three communities in different districts in the southern Himalayan foothills	Piloting gravity-fed piped systems for multiple use
South Africa	One ward, consisting of 11 villages, in Bushbuckridge local municipality	Introducing MUS into the integrated development planning of the local municipality
Thailand	Four groups of farmers in the provinces Buriram, Chayaphum, Khorat and Yasothon in Northeast Thailand	Farmer Wisdom Network focusing on self-sufficiency and integrated farming, through rainwater harvesting
Zimbabwe	The Rural District Councils of Marondera, Murehwa and Uzumba Maramba Pfungwe	Domestic-plus through technological innovations of NGO programmes

FINDINGS

Water, livelihoods and access to services

Benefits of access to improved domestic water supplies have been well documented in global studies (e.g. Hutton et al., 2007), mainly focusing on direct and indirect health benefits and the benefits of reduced drudgery. The potential benefits from productive uses are excluded from these studies because of lack of data and because these are expected to be small compared to health benefits (Hutton et al., 2007). In this study, we have looked only at the *additional* benefits of productive uses, without detailing the health and time benefits for each of the cases. The assumption is that under a MUS approach the health and time benefits would be similar to those under improved access to water supply, potentially with not only gains through nutrition impacts and better sustainability of systems but also losses due to conflicts or quality issues that were not properly managed. However, analysing these changes in health and time impacts would require costly epidemiological studies, beyond the scope of this research.

In all of the cases studied, water was used nearly universally for a broad range of small-scale productive uses mainly at and around the homestead, alongside domestic use and field-scale irrigation. These activities were seldom the main source of a family's income or food, but played an important role in people's livelihoods. For example, in the case of villages in Nepal, farmers were able to increase their annual income by around 10% through MUS, representing between US$40 and 199 per family per year (Mikhail and Yoder, 2008). In both the Bolivian (Durán, 2005) and South African (Cousins et al., 2007a) case studies, it was found that small-scale productive uses provided the main source of income for less than 10% of the population. However, in the Bolivian case it provided a complementary source of cash for 60% of the population (Durán, 2005), acting as a form of income diversification and reduction of vulnerability. Furthermore, in some cases there was an observed increase in household food security, especially in terms of high-quality non-bulk foods, such as vegetables and animal products. In the Thailand case, food from gardens provided, on average, 30-50% of the food consumed in a household (Penning de Vries and Ruaysoongnern, forthcoming). In South Africa, this fraction was much smaller (Cousins et al., 2007a) but provided a kind of food (green vegetables, etc.) that otherwise would not be purchased by the studied households.

The relative extent and significance of these productive activities are highly variable across countries, communities and even households, as these are mainly related to the level of access to water provided. Access to water was specified in terms of four characteristics: a) quantity of water, b) distance between the water point and the point-of-use, c) quality of water, and d) reliability of supply.

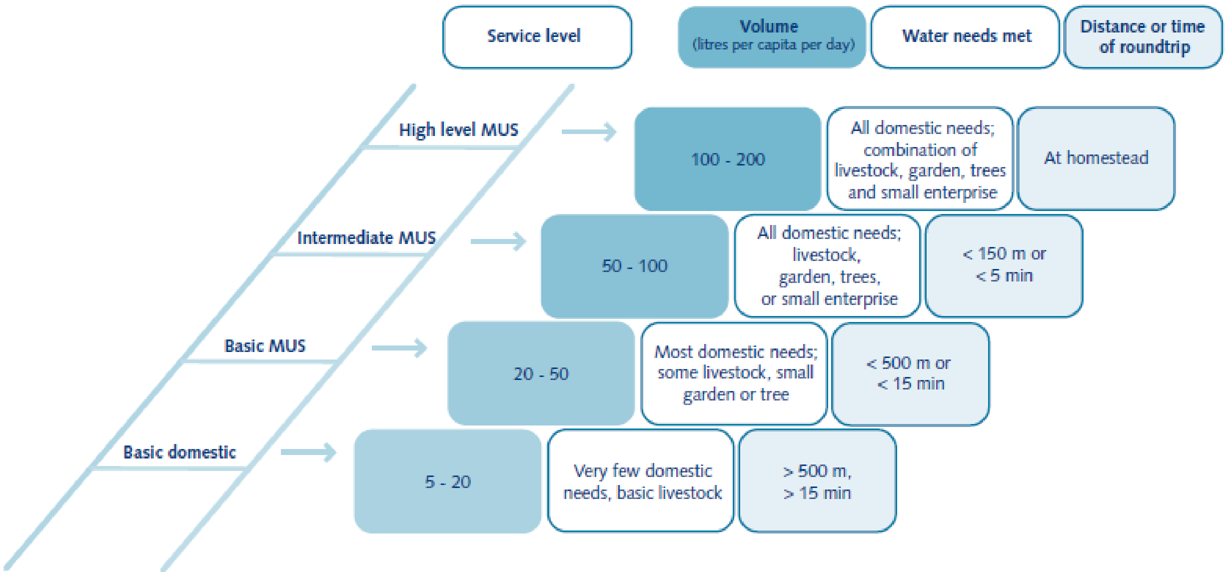
Table 2 provides an overview of the ranges of actual water use and distance used as a proxy for the actual access found across the study areas and relates these to the observed livelihood activities. Actual use of water across the cases ranged from less than 17 litres per person per day (l/p/d) in the villages in Ethiopia at a long round-trip's walk (Scheelbeek, 2005) to over 200 l/p/d in communal systems in Colombia where water flowed through gravity-fed systems (Cinara, 2007). Despite these differences, in all cases people used the water for multiple purposes. Even in Ethiopia, people used a few litres a day for a cow or some fruit trees. But, with higher access to water, the extent to which water is used for multiple purposes increases disproportionally. Similarly, as the distance between water points and point-of-use increases, quantities used decrease rapidly and limit livelihoods activities, as for example found in one of the cases in Ethiopia (Scheelbeek, 2005).

These empirical data, in combination with those from other studies, and expert estimates were used to describe the relation between access characteristics and the water needs that can be met, in the form of a water ladder, building upon the work by Van Koppen and Hussain (2007) and Renwick et al. (2007) (see figure 2).

Table 2. Actual use of water and livelihood activities.

Study area	Predominant type of technology	Distance or round-trip	Range of average daily water use (l/p/d)	Use of water
Ethiopia	Communal piped systems with scattered standpipes	Round-trip up to several hours	8-17	Domestic uses with few litres of grey water reused for fruit trees
South Africa	Communal piped systems with scattered standpipes	Round-trip can take up to an hour	30	Domestic use, a few families have gardens and home-based industries
India	Communal piped systems with frequent standpipes	At homestead or short round-trip	40 (design supply)	Domestic, small backyard gardens and communal cattle troughs
Zimbabwe	a. Communal boreholes with hand pumps b. Individual shallow wells with windlass and buckets c. Individual shallow wells with rope-and-washer pumps	a. 0-500 m b. At homestead c. At homestead	a. 10-15 b. 60-70 c. 80-90	a. Domestic, a few cattle and community gardens b. Domestic and household gardens c. Domestic and extensive household gardens
Bolivia	Piped distribution systems	At homestead	60-80, with exceptions up to 140	Domestic use of 50-60 lpcd and remainder for dairy cattle (6-8 heads per family), or household garden (up to 50 m^2)
Nepal	Communal piped systems with frequent standpipes	Water point shared between 2 or 3 houses, short round-trip	137-225 (design supplies)	Around 45 l/p/d for domestic uses, and the remainder for extensive household gardens of 125-250 m^2
Colombia	a. Communal piped systems with household connections (rural communities) b. Communal piped systems with household connections (peri-urban communities)	a and b. At homestead	a.190-250, with some cases much higher b.76-118	a. Around 75 l/p/d for domestic uses, and the remainder for irrigation of extensive gardens (up to 350 m^2) and over 10 heads of cattle and small animals, and processing of agricultural products b. Domestic and small businesses
Thailand	a. Farms with ponds and other sources b. Farms without ponds, with other sources	a and b. At homestead	a. 80-1000 b. 80-500	a and b. 20-60 l/p/d for domestic uses and the remainder for gardens b. > 500 l/p/d/ for rice irrigation

Figure 2. Multiple-use ladder (based on Van Koppen and Hussain, 2007; Renwick et al., 2007).



The ladder illustrates that, based on a range of case studies, a quantity of between 50-100 l/p/d within a distance less than 150 metres from the point-of-use is the estimated access level needed for significant multiple uses of water at and around the homestead. In addition, water needs to be available with some reliability. Domestic uses require daily availability, either through daily supply from the system, or through storage at the homestead. The same goes for livestock. For other productive uses, such as garden irrigation, reliability can be slightly less, e.g. a couple of days or even much less frequently, depending on the type of crop and growth stage.

Water quality is not shown in the above ladder. Obviously, for drinking purposes, water needs to meet inter(national) quality norms. The same water-quality criterion thus applies to all steps on the ladder. However in theory, only a minimum of 3-5 l/p/d need to be of such good quality, and for other uses quality needs are less stringent. So, not all water necessarily needs to have the same quality, and this is an important factor to consider in technology options and their respective costs as will be discussed further below.

Technologies for MUS

Based on the case studies, this section summarises the potential of different technologies to provide access levels as defined in the water ladder. This follows the same technology descriptions used earlier (table 2). Additionally, based on the case study experience the authors have identified various incremental changes that can be made with the specific aim of facilitating multiple use. Table 3 summarises the technologies and incremental steps from the case studies. This table can be linked to the water ladder (figure 2) to allow planners to identify the technology options that can provide for the required levels of access or types of livelihoods to be supported.

Table 3. Potential of different technologies for MUS.

Group	Technology	Potential for multiple use	Incremental changes in technology
Household-based options	Wells	Individual (shallow) wells at the homestead provide a reasonable quantity, although reliability may be reduced due to fluctuations of groundwater levels. Water quality may be compromised, if wells are not properly located.	Installing additional lifting capacity to facilitate multiple use. Including point-of-use treatment technologies
	Rooftop rainwater harvesting	As a stand-alone source, may not have sufficient storage capacity, particularly in semiarid areas, for all uses year-round. It can be used as complementary source to other year-round supply systems.	Increasing household storage capacity as far as possible
	Household ponds and other in-field rainwater-harvesting measures	Potential for increasing availability for productive uses. Water quality is usually not suitable for domestic consumption, and needs to be complemented by another good-quality source.	Including point-of-use treatment technologies
Communal single access point systems	Communal wells or boreholes with handpumps	Limited potential for multiple uses at the homestead, as quantities are often limited and average distance is long.	Including communal productive uses by add-ons such as a communal cattle trough, or developing a communal garden next to the water point. Increasing household storage capacity.
	Village ponds	Multiple productive purposes around the pond. Sometimes also domestic uses, though water quality and distance between pond and point-of-use may be limited.	Including point-of-use treatment technologies
Communal distribution networks	Piped systems	Potential for multiple use depends on system capacity and average distance between point-of-use and water points. Household connections provide plenty of scope for multiple use at the homestead. If standpipes are few and far between, multiple use is limited by distance and quantity. Water quality may be a concern in case of sources of surface water.	Reducing average distance between point-of-use and water points. Increasing household storage capacity. Increasing overall capacity (in l/s) of different. infrastructural components Various treatment options at different levels in the system
	Gravity-fed open canal systems	High potential, as quantity is often not a limiting factor. Continuity and quality may limit domestic uses.	Various treatment options, especially point-of-use treatment ; increasing household storage capacity

As can be observed from the case studies, MUS does not require any 'new' technologies. Many currently used common technologies all hold some potential in providing the required access, though to different degrees. Technologies that bring water close to the homestead such as household wells and ponds or piped systems with household connections can enable the highest service levels. This is expected given the shorter distance to the point-of-use and typically higher design capacities. The current technological standard of communal boreholes with handpumps, or piped systems with scattered standpipes in much of rural sub-Saharan Africa and South Asia has least potential to meet homestead-based productive uses since distances to the point-of-use are long, and design supply quantities are low. At best, communal-level multiple uses, such as community gardens, can be facilitated through such technologies.

The MUS approach does not require that all water should be supplied by one single technology or one piece of infrastructure. In fact, certain access levels are often achieved by combinations of technologies, particularly where each single technology does not give continuous reliability. Examples of this include the combination of rooftop harvesting tanks to complement a communal borehole in Zimbabwe, or three overlapping distribution systems from different sources for different sections in the village of Chaupisuyo in Bolivia (Valenzuela and Heredia, 2007). Combining technologies also allows for achieving economies of scale in investments. For example, in the case of Vinto in Bolivia, an irrigation distribution system and a domestic piped supply system shared an intake, conveyance pipe and storage tank, thereby avoiding the need to invest in these separately (Quiroz et al., 2007). This way of combining of water infrastructure for use beyond the homestead level is what Van Koppen et al. (2009b) call community MUS.

Combining technologies is of particular relevance when considering water quality. There may be a perceived trade-off between supplying water of high quality and increased quantities of water for productive purposes that do not necessarily have to be treated or disinfected. The following options were identified:

- Spring protection. Proper protection of additional springs used for multiple use may reduce (though not eliminate) the need to treat relatively clean surface water sources.
- Central treatment and disinfection were applied in most of the gravity-fed systems in Colombia. In some of the cases, this led to conflicts or abandonment of the treatment plants, as users preferred accessing more water to high-quality water. In others, the plants were operated inadequately anyway, showing that more general problems exist with water treatment and disinfection and the priority given to this by users. This was echoed in the study in Honduras where it was found that, although all study communities did have chlorination devices, these were actually being used only in a third of the cases (Smits et al., 2010).
- Partial central treatment with separate distribution systems for domestic and irrigation purposes. This option was only applied in two case villages, with the idea of only investing in the treatment of that part of the water that requires it. The main disadvantage lies in the additional costs of having parallel distribution systems.
- Household level treatment. The main advantage of household treatment is that it can improve water quality for drinking, cooking and hygiene at the point-of-use (Clasen and Cairncross, 2004) without the need to treat all water used. This was successfully applied in one of the Ethiopian cases (Guchi, 2007). Although this option holds potential for combined use in MUS, there is a much wider debate on the disadvantages and scalability of this technology option, which goes beyond MUS considerations only (see Schmidt and Cairncross, 2009).

To conclude, there are different (combinations of) technology options for dealing with the potential trade-off between increasing water quantity and quality. In this case, not only costs but user priorities should be considered.

Community-level institutions for managing MUS

Multiple-use services also pose different requirements in terms of management. This section examines the issue of community institutions for managing MUS. We understand the term 'institutions' here to include both the community-level organisations and the formal and informal regulations around water use, or what North (1990) defines as the rules of the game.

Out of 27 cases studied, 22 were community-managed where some form of community body such as a water committee was responsible for service provision. This is the most common management model in rural water supply. Of the other cases, three were managed by an entity external to the community, either a utility or municipality, and the remaining two were household-managed. The next section is limited to a discussion of the community-managed services only.

The management issues in MUS were found to be largely similar to the issues in conventional community-managed water supply services. These included challenges such as lack of leadership or poor accountability between the water committee and the community. Such problems may lead to reduced performance of MUS systems, and hence in actual access to services. However, MUS pose additional management challenges, the main one being the need to cater to a wider diversity in demands within a community where not everyone has similar livelihood needs and ensuring a basic supply to everyone without overuse of the services.

Only a few of the communities, mainly the ones with planned MUS, developed institutions to deal explicitly with this additional challenge. Examples include:

- Establishing rules which seek to ensure that everybody gets some water before larger users take more. For example, in one of the South African villages, the community established a rule that everybody should first be able to fetch two buckets of water before additional productive use would be allowed (Cousins et al., 2007a).
- Establishing rules to limit the maximum amount of water to be used for productive purposes. In one of the Bolivian villages, the community established that water could only be used for livestock and backyard gardens, but not for irrigating larger field plots (Heredia, 2005). Some of these measures were hard-wired into the technology through metering in Bolivia and Colombia through the use of small diameter pipes for household connections in India (Mikhail and Yoder, 2008); or by only allowing water overflowing from the storage tank to be used for irrigation as in a case in Nepal (Mikhail and Yoder, 2008).

Since some of these systems have only just gone into operation, it is rather early to assess the durability and enforcement of the rules, and their implications for actual access. Yet, these examples show that such local rules can be developed rather easily to accommodate differential water demands.

The water committees responsible for de facto multiple-use systems struggled more in addressing this in management, reflected for example in intermittent supplies due to overuse in South Africa (Cousins et al., 2007a), or conflicts with other users in the sub-catchment over water quantity, such as in the El Chocho sub-catchment in Colombia (Cinara, 2007).

In nearly all the cases, where communities developed local rules around multiple use of water, they were assisted by an external agency. The ones in de facto multiple-use systems did not get such support. As the practice of multiple use is often not recognised by external agencies, clearly, they cannot adequately support water committees in developing locally relevant rules around water use, as exemplified in the case in Colombia (Cinara, 2007). This finding is echoed by other studies, such as in a global review of community-management of rural water supply by Schouten and Moriarty (2003).

It has now been more widely recognised that community-managed water supply does not imply that communities can do all management on their own. In order to have sustainable service, water committees require external post-construction support (Schouten and Moriarty, 2003), which can be supplied through different institutional support mechanisms (see for example Lockwood, 2002), or solicited by water committees (Bakalian and Wakeman, 2009). The cases above show that community-managed MUS would require similar support, but one that includes and explicitly recognises multiple use and supports communities in developing local rules around them. This was also found in a similar study in Honduras, where staff members of the national water supply agency that supplies water to committees were able to reduce some of the management challenges around de facto multiple use of water (Smits et al., 2010).

Financing MUS

Going from the lower steps of the ladder to the highest-level MUS will require doubling or tripling the quantities of water provided. Providing such higher levels of service comes at an additional cost, in terms of both capital investments and the operation and maintenance (O&M) costs. However, it could also be expected that through the provision of water for multiple uses there might be a higher willingness and ability of users to contribute to the financing of services because of the additional benefits. This section looks at the additional costs and benefits of providing MUS and links these findings to recommendations on the way the services can be financed.

Comprehensive cost-benefit analyses of MUS do not exist yet. But, Renwick et al. (2007) made a first approximate review using the available data on benefits from some of the MUS Project cases, as well as from other studies, and global datasets on costs of rural water supply. This analysis quantified first the additional income (or expenditure reduction) that can be obtained from small-scale productive uses at the homestead. Costs were analysed in an incremental way by assessing the additional costs of upgrading existing systems from one step to another on the water ladder, or by developing new systems at higher levels of service. The review showed that higher capital investment costs in increasing service levels can be justified by high benefit-cost ratios of between 4 and 8, as shown in table 4. In fact, the benefits from productive uses are not as small as compared to health benefits as expected by Hutton et al. (2007). It would therefore be recommended to build upon the work by Renwick et al. (2007) and include benefits from productive uses in a structured way in global studies on cost-benefits of water supply.

Table 4. Incremental costs and benefits of MUS for upgrading existing systems (Renwick et al., 2007).

	Capital investment costs (US$/capita)	Annual income, net of recurrent costs (US$/capita)	Benefit-cost ratio (10% discount rate)
From basic domestic to basic MUS	25	22	5.4
From basic domestic to intermediate level MUS	32-84	46-58	4.7-8.7
From basic MUS to intermediate MUS	56	26	3.9

Multiple-use services appear to make good economic sense but how can they be financed and what can we learn from the way the systems studied in these cases were financed? In nearly all the MUS Project case studies capital investments came from an agency external to the community, either government, a donor or an NGO, with only small contributions by the community (for a full list, see Van Koppen et al., 2009a). Users only took up the bulk of the investments for household technologies, such as rainwater-harvesting systems in the Thai cases, or complementary on-farm technologies such as drip kits in Nepal (Mikhail and Yoder, 2008). It is only in some of the Bolivian cases, that communities made the bulk of the investments in communal systems (Heredia, 2005).

The O&M costs, however, were assumed fully by the community in nearly all cases. But different tariff systems were found. Particularly in systems where water was lifted, volumetric tariff systems were applied, in which payment was done per unit of water used. In some cases, the unit cost is differentiated between users by some criteria. For example in Chaupisuyo, the unit rate of water applied to farmers is lower than the one applied to domestic users, even though they share the same borehole. Gravity-fed systems were found mostly to charge flat tariffs, as there is a less direct relation between the consumption of additional units of water and the operational costs of the system. In most cases, the tariff charged was more or less in line with the operational costs. However, a few communities were found to be making savings for major repairs, expansion or future replacement costs. High default rates may in some cases put the financial sustainability of services at risk as well.

Table 5. Tariff systems and sustainability in selected case studies.

Site	Tariff system	Financial sustainability of service
Challacaba (Bolivia)	Volumetric system	Tariffs cover operational costs, as well as savings for expansion
Chaupisuyo (Bolivia)	Volumetric system, with different rates for domestic and irrigation users	Tariff is much higher than what is needed for operational costs
Cajamarca/San Isidro (Colombia)	Volumetric system, with different rates for large and small farmers	Tariffs cover operational costs
Various communities of El Chocho (Colombia)	Flat rate, with one case of cross-subsidy between poor and better-off	Tariffs cover operational costs, but actual income is too low, due to high default rate
La Palma – Tres Puertas (Colombia)	Flat rate for basic consumption, and volumetric above that	Due to high default rate, actual income is too little to cover all required costs
Legedini (Ethiopia)	Volumetric system (per jerry can)	Actual income insufficient for major repairs
Samundi (India)	Flat rate	Tariff covers operational costs
Chhatiwan (Nepal)	No tariff system. A revolving loan is set up, and the interest is used to cover O&M costs	Too early to determine, as the system has just gone into operation
Senapuk (Nepal)	Flat rate and additional contribution of labour	Too early to determine, as the system has just gone into operation
Ward 16 of Bushbuckridge (South Africa)	Water is provided free to users as part of the Free Basic Water policy. Municipality covers the operational costs.	No data on implications of financial sustainability for the municipality

Analysis of the case studies showed that while investments in MUS are cost-effective this does not mean that services will be fully auto-financed by users. Since most of these systems would have been developed with financing arrangements based on the Demand-Responsive Approach (DRA) to community-managed water supply, this is not surprising. In the DRA model, user communities contribute a small percentage to capital investments but take responsibility for all O&M costs (Schouten and Moriarty, 2003; Bakalian and Wakeman, 2009). Financing MUS at a larger scale would require giving further consideration to a mixed financing model, in which both communities and external agencies contribute to the costs. Because of the larger benefits, there is potential for increased user contribution to the incremental costs in communal multiple-use systems, especially for additional household-based hardware. However, these systems still have a large cost component related to the basic infrastructure which, in line with current models for financing water supply, can be expected to remain largely in the domain of public service delivery. Such experiences do not yet exist, but examples, such as those from Nepal (Mikhail and Yoder, 2008) and Bolivia (Heredia, 2005) could serve as a basis for developing such financing approaches. Existing types of tariff systems would still be applicable to MUS. However, further effort needs to go into strengthening appropriate financial management skills among water committees to ensure that tariffs are equitable and are used to keep services sustainable. External support agencies, as discussed in the previous section, could play an important role in this.

Multiple-use services and access to water resources

Climbing the water ladder obviously implies the use of more water as compared to basic domestic supplies. Since planned MUS development has so far mainly taken place at a pilot scale, no empirical evidence is available on implications at a (sub)catchment scale. Yet, it can be estimated that the amounts required remain relatively small when considered at a catchment scale. Domestic water supply represents only a small percentage (10-20%) of total water abstraction in most countries (AQUASTAT, 2009). Rural water supply is likely to be less than half of that, as a larger part of the population lives in urban areas, where water consumption also tends to be higher. If all villages in a country would upgrade from a basic domestic supply to higher levels of access, similar to the ones found in urban areas, consumption would double or triple, and consumption for rural water supply would possibly end up representing 10% of total water abstractions. Though this is a significant increase compared to current levels, this remains small compared to other sectors.

The case studies come from locations with different water resources statuses and illustrate the implications that increase in water demand for multiple use have on water resources management:

- Closed or closing basins. In closing basins, there may be some unallocated water for multiple use. For example, even in the water-stressed Sand river catchment in South Africa, where the Bushbuckridge study area is located, a modelling study indicated that sufficient water resources would be available in the area to increase supply up to 60 lpcd to the entire population of the Bushbuckridge municipality without negatively affecting other users (Smits et al., 2004). It is only in fully closed basins, such as in the case studies in India (Mikhail and Yoder, 2008), that there may be a need for reallocation between other users (such as field-scale irrigation) and MUS. The potential benefits of MUS would have to be an important consideration in reallocation discussions.

- Open basins, but with local or temporal competition between neighbouring communities that use water for multiple uses. Such cases were reported in Bolivia, Colombia and Nepal. For example, in the El Chocho mountain stream in Colombia, the de facto use of water for multiple purposes contributes to the competition among rural communities, but alongside other factors such as rapid population growth, and poorly designed and inefficient water systems (Cinara, 2007). In nearly all these cases, local mechanisms for dealing with competition with neighbouring water users were developed, ranging from negotiations around customary water rights to springs in Nepal (Mikhail et al., 2008) and Bolivia (Quiroz et al., 2007) to the establishment of a catchment forum in El Chocho (Cinara, 2007).

- Open basins, with no competition for water resources reported. These are the typical cases of economic water scarcity, such as in Ethiopia and Zimbabwe, where water resources are available, but where infrastructure is lacking to extract and convey water. Here MUS can constitute an important way to help develop the necessary infrastructure to abstract, store and use water.

DISCUSSION

The findings presented above show that MUS present a new approach to water services provision for sector agencies as compared to the current ones based on restricted subsectoral mandates. However, the case studies show that operational application can largely build upon commonly used technologies and approaches, but with adjustments and additional considerations. For example, common technologies can be used, but with more emphasis on achieving higher levels of service, through household-based options or homestead connections; community management approaches would still apply, but with more emphasis on the need to support water committees in aspects related to MUS, such as the development of local rules on water use, as seen in the Nepal case; the DRA approach to financing would still be valid, but with more need and potential to get more mixed financing between public and user investments, building upon the examples seen in Nepal and Bolivia. None of these additional considerations seems infeasible or posing radically different requirements.

Therefore, this begs the question why MUS are not provided more widely, if relatively little change is needed and if benefits outweigh the costs. This is exactly the question that was central in the discussion with service providers, and other stakeholders in the learning alliances. Workshops, meetings and field visits helped stakeholders to not only identify concerns and questions but also opportunities, in a multiple-use approach. Most of the barriers to adopting MUS could be broadly grouped into three categories:

- *'Blind spot'*. Many staff of water agencies had never realised that MUS were being actually practised at community level. Or, if they had an anecdotal knowledge on such practices, they had never undertaken an effort to look into these in a more structured way to analyse the implications for service delivery.
- *Practical and operational concerns*. A second group of questions arose around the practical implications of MUS. Typical issues included the potential trade-off between water quantity and quality, implications for design supply norms, concerns over equity in access between larger and smaller users, questions on water scarcity, methodologies to include MUS in planning procedures, technology options, etc.
- *Concerns related to policies and institutional mandates*. Even when stakeholders could visualise practical ways of applying a MUS approach, some still had concerns related to their institutional mandate. Would a water supply agency be able to invest in higher levels of service to provide water for small-scale production? Would an irrigation agency be able to claim to be providing drinking water? How could efforts between agencies be coordinated? An illustrative case is the one from South Africa, where three different agencies were involved in promoting small-scale productive activities, but with confusion over who was responsible for what aspect of service provision (Cousins et al., 2007b).

It is realised that addressing these barriers would require engaging in what has been called the "politics of policy processes" (Mollinga, 2008), as some would imply fundamental changes in policy, institutional mandates or even subsectoral paradigms, which are not achieved overnight. Rather, a pragmatic approach was chosen to use the characterisation of MUS as input to the learning alliances. A full description of these experiences goes beyond the scope of this paper (see Van Koppen et al., 2009a for a full description). Here we will limit ourselves to discussing how a characterisation of MUS has helped to deal with the three groups of barriers in these learning alliance processes.

First of all, by providing the characterisation, stakeholders were able to see water use practices beyond their own direct area of interest. It also helped to show orders of magnitude, e.g. of water consumption for different uses, or costs and benefits, and thereby often taking away myths and preconceptions. For example, it helped stakeholders to realise that the demands for water for production in the gravity-fed piped water systems in the Colombian cases are significant but well within the orders of magnitude that can be typically supplied (Cinara, 2007).

The main use of the characterisation of MUS was around the second group of questions. In most study countries, this was done through action research to look at these valid concerns in practice. This helped to link what Mikhail and Yoder (2008) have dubbed in the Nepal case as "conceptual advocacy to practical advocacy", i.e. bridging the gap between discussing MUS as a broad approach and looking at the practical implications for service delivery. There, for example, different prototypes of MUS systems were developed in different conditions of water resources availability, as a way of finding ways to deal with such concerns. In other countries, a similar approach was taken to look into and discuss other practical concerns such as methods for planning in South Africa (Cousins et al., 2007b), cost implications in Bolivia (Heredia et al., 2008) and technologies in Zimbabwe (Guzha et al., 2007).

The third group of questions could only be discussed after the first two. For example, the characterisation of MUS in Honduras made water supply technicians realise that multiple use of water, even though apparently outside their direct mandate, has implications for the sustainability of services which is their core mandate (Smits et al., 2010). It was also realised that the institutional barriers to adopting a MUS approach differed a lot between different sector organisations, such as government agencies, NGOs, water user groups, knowledge centres or local authorities. For example, the studied NGOs tended to have more flexibility to include MUS in their programmes, whereas for government agencies changes might be required in their formal mandate. Hence, entry points for different institutional barriers to adopting MUS would differ between these different sector organisations, as elaborated in more detail by Van Koppen et al. (2009a).

Following up on the case studies, learning alliances have taken different pathways of addressing institutional barriers, ranging from focusing on gaining recognition for the approach in the formal policy framework in South Africa, to the promotion of altered design parameters for rural water supply programmes in Colombia (Cinara, 2006) or the development of joint planning approaches between domestic and irrigation sector agencies in Nepal (Mikhail and Yoder, 2008). But at the Bolivia site a full learning alliance approach did not materialise, and findings were only taken forward by a local resource centre (Heredia, 2007).

These pathways may not yet reflect a full paradigm shift. Such a shift would need to take place at different levels, ranging from national water policies, to the politics of water agencies or even to the formation of associations of new water professionals. Yet, the pathways started in the mentioned countries offer pragmatic steps in getting recognition for multiple uses and opening up sector agencies' ways of operating towards one that takes multiple uses better into account. The authors believe that a focus on characterising MUS and their implications for service delivery have contributed to this, as it helped to make the practice more visible and allowed focusing on valid practical concerns. These, in turn, may eventually help to achieve more fundamental changes in mandates and paradigms of water sector agencies, although it is recognised that these may take a long time, and may still be full of hurdles.

CONCLUSIONS

Over the last few years, the MUS approach has been recognised as an alternative approach to water services provision. It is claimed that this approach presents a new way of thinking about water services, with a service delivery objective that goes beyond subsectoral mandates to one of reducing rural poverty through improved access to water. This paper aimed to contribute to this change in thinking, specifically through a characterisation of the key elements to operationalise MUS as the basis for identifying implementations for service delivery. It did so by analysing case studies from over 30 communities in eight countries, covering a range of physical, socio-economic and institutional contexts, and including both de facto and planned multiple-use services.

In these cases, people almost universally used water for both domestic and productive activities at and around the homestead. These activities are seldom the main source of people's income or food production, yet are of importance in diversifying their livelihood options, reducing vulnerability or providing access to cash. These benefits are in addition to the health and time-saving benefits already obtained from access to improved water supply.

The extent to which households can undertake these activities depends, to a large extent, on their level of access to water. The better the access to larger quantities of water delivered closer to the homestead the more the additional water is put to productive uses, once basic domestic needs have been met. The empirical relation between access to water and its use in, and impact on, livelihoods has been summarised in the form of a water ladder. This illustrates how typically 40-100 l/p/d are needed within a short round-trip from the homestead for small-scale productive uses to take place at a significant level. All steps on the ladder require a minimum amount of water meeting quality standards in drinking water.

Even though MUS present a new approach to water services provision, their operational application can largely build upon technologies and approaches commonly used in the sector. However, important adjustments and additional considerations are needed. Currently, all common technologies hold some potential in providing the required access. It is important to stress that particularly the options for providing this access at homestead level have the highest potential. An important finding was that sometimes combinations of technologies are needed which taken together provide such access levels, particularly when considering potential quantity and quality trade-offs. The case studies revealed management requirements to be largely similar to conventional community-managed water supply. This includes the finding that water committees need ongoing external support with, amongst others, specific attention to the development of local rules to deal with differential demand for, and use of, water. MUS bring incremental costs, but these are apparently justified by the additional benefits. Financing mechanisms, as currently applied under the demand-responsive approach, have so far been used for MUS. These are likely to remain relevant for future investments as well. However, MUS open up the need and opportunity to mobilising more self-investment in water services by users, alongside public financing of investments in basic water infrastructure. Finally, it is noted that MUS need to be developed within frameworks for water resources management, particularly at the local scale, where competition with other users is mostly felt. None of the additional considerations is considered infeasible.

This then begs the question why the approach is not more widely applied in the sector. In learning alliances of sector stakeholders, different barriers for adopting the approach were identified, including a lack of awareness of the issue, practical concerns and policy and institutional limitations. Addressing some of these may require fundamental changes in policy, institutions or even subsectoral paradigms. This is not achieved easily. Therefore, in the learning alliance a focus was taken of using the characterisation of MUS to help clarify the topic and address some of the valid practical concerns. As a result, some of the countries have started processes of pragmatically including issues of multiple use of water into programmes and activities of sector agencies.

The authors conclude that MUS represent not only a common practice for many communities but also a new and alternative way of thinking about water services provision for sector agencies, in the sense that MUS fundamentally change the objectives of water services provision, and the expected impacts they can generate. Putting the new thinking into practice can be done through adjustments and additional considerations to existing technologies and approaches. Instilling the new way of thinking requires working within existing institutional arrangements so that operational adjustments and additional considerations for MUS can be identified, and possible barriers to adoption can be potentially addressed. The findings presented in this paper show that such an approach is both feasible, and can be justified by the potential benefits that the MUS approach holds.

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