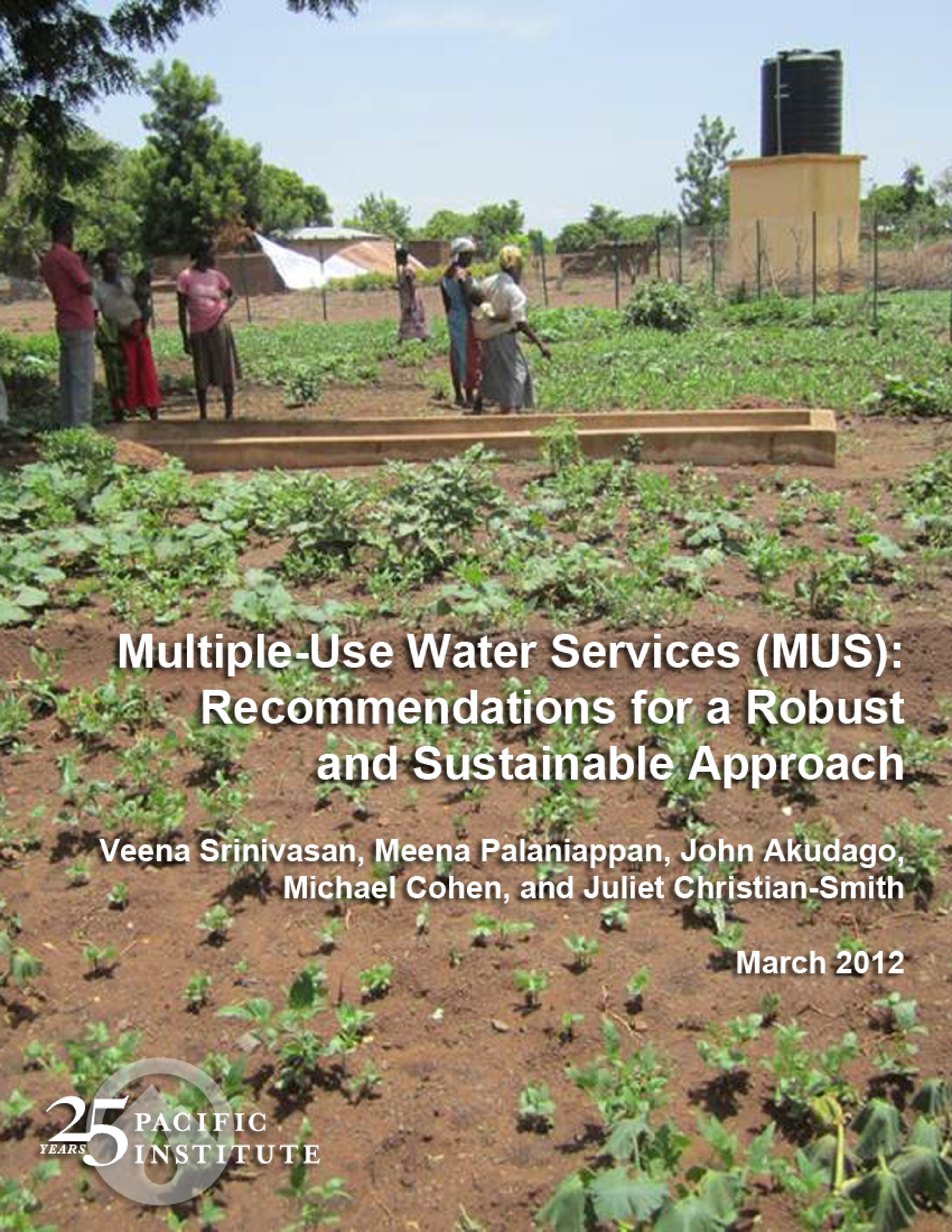

Multiple-Use Water Services (MUS): Recommendations for a Robust and Sustainable Approach

Veena Srinivasan, Meena Palaniappan, John Akudago, Michael Cohen, and Juliet Christian-Smith

March 2012

25 YEARS PACIFIC INSTITUTE

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ISBN: 1-893790-35-5
ISBN 13: 978-1-893790-35-3

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Acknowledgements

We would like to thank the Rockefeller Foundation for their generous support and guidance throughout this project. In addition we want to thank the participants of the October 13-14, 2011 Multiple-Use Water Services Workshop we hosted in Oakland, California. These experts, funding organizations, and local implementers provided their diverse experiences and rich insights that are captured in this report. Many thanks to Braimah Apambire (who could not attend but provided comments), Bekele Abaire Male, Avril Alexander, Marc Andreini, Jim Collins, Ben Crow, Jennifer Davis, Martin Dery, Peter Gleick, Amanda Gimble, K.J. Joy, Narayan Khawas, Sylvia Lee, Sara Marks, Robert Marten, Sharon Murray, Willie Mwaruvanda, Emmanuel Opong, Mark Redwood, Ines Restrepo-Tarquino, Cristina Rumbaitis del Rio, Katherine Spooner, Sudarshan Suryawanshi, John Thomas, Barbara van Koppen, Divyang Waghela. We thank Mark Redwood, Stef Smits, Emily Kovich, Mary Renwick, and John Thomas for insightful comments that helped substantively improve this report. The initial guidance of Cristina Rumbaitis del Rio and Robert Marten helped shape this report. We thank Susan Lamberth and Jessica Adams for their assistance throughout this project. We are also deeply grateful to Nancy Ross and Paula Luu who edited and designed the final report. All errors in this document are our own.

Contents

Executive Summary

Water is fundamental for human societies and ecosystems. We need water to grow food, run industries, satiate thirst, and ensure health. Yet, the development of water resources to date has left a large number of people without enough water to meet their basic needs and impoverished the ecosystems upon which we depend. Population growth, urbanization, and climate change add new stress to water availability and demand. International institutions have over the last few decades attempted numerous solutions to meet these basic needs, from identifying water and sanitation as targets in the Millennium Development Goals, to developing international frameworks and funding streams for water development. Despite many decades of effort, water projects implemented with the best intentions still fall into disrepair or have drained existing water sources, and the poorest still face water and food insecurity.

Defining MUS

In the last decade, a new paradigm called "Multiple Use Water Services" (MUS) has emerged from the recognition by water sector professionals that the rural and peri-urban poor need water for a variety of purposes, ranging from drinking and sanitation to growing food and other productive activities. As the name suggests, MUS aims to develop multiple community sources to meet multiple needs. The MUS Group (www.musgroup.net), a collaborative partnership between international organizations interested in the approach, offers the following definition:

> *Multiple-use Water Services (MUS) are water services by the public sector or private sector, that take rural and peri-urban people's multiple water needs, which are met from multiple sources, as the starting point of planning and design. This participatory, integrated planning approach fully recognizes and strengthens the often informal ways in which communities have been developing and managing their water resources.*

The definition reflects the notion that the concept of Multiple-Use Water Services (MUS) is in many senses, pre-historic: since time-immemorial, communities have settled near water bodies and used them to meet their multiple needs, from growing food and making goods, to drinking, bathing and sanitation. However, the public sectors of most countries have bureaucracies that have mandates for "single use" service delivery - irrigation or drinking water or fishing. Water projects to meet these needs are often developed independently or even in conflict with one another. The MUS approach aims to overcome this problem by reflecting how rural and peri-urban communities actually use their water sources to render a range of services: drinking water, hygiene, and productive needs.

The MUS approach has generated significant interest among organizations working on agriculture and water issues, particularly those working at a community scale, as it offers an opportunity to meet the many needs of poor communities. Yet, the approach also has some limitations which may hinder the long-term sustainability of MUS projects, including consideration of water resource sustainability, climate resilience, equity, sanitation, public health, and the environment. In this paper, we present challenges that need to be addressed in a successful MUS strategy, consider key lessons learned from previous efforts to improve water management, and present a set of principles and recommendations for a more comprehensive approach to accelerating water and sanitation development through MUS.

Benefits of the Multiple-Use Water Services Approach

The Multiple-Use Water Services framework offers several potential benefits, some of which include:

- MUS projects reflect the way communities actually use water. When projects which were designed for single-use (drinking water or irrigation only) are used for multiple purposes, this can lead to conflicts over water quantity or quality.
- Financial sustainability of water projects can be enhanced with MUS. Allowing for small-scale productive uses of water can boost household income and at the same time provide users with both an incentive and the financial capacity to sustain and maintain the water service system.
- The MUS approach takes a more holistic approach to public health going beyond avoidance of water-borne diseases. Lack of access to a diversified diet contributes to poor nutrition, which in turn results in higher rates of childhood mortality and morbidity from a host of different diseases. MUS projects improve access to vegetables, fruit, or protein (via livestock and fish) for the poor, which can boost immunity and reduce susceptibility to many diseases.
- The MUS approach could improve food-security among the urban/peri-urban poor, who tend to be net food consumers (consuming more than they produce), by allowing them to grow their own food.
- The MUS approach could improve coordination and provide economies of scale. MUS projects often cost less; when compared to the costs of providing drinking water and irrigation services independently.
- The MUS approach could empower women by focusing on kitchen gardens, livestock, and cottage industries, which are often the mainstay of women in the household. This is in contrast to the irrigation sector which focuses on field crops - traditionally viewed as a male activity.

Because the MUS paradigm is less than a decade old, most MUS implementations are relatively new. While these claims are plausible, it is too early to judge the long-term impacts. Additionally, there are few independent evaluations to test whether these claimed benefits have materialized.

Limitations in Multiple-Use Water Services Approach

If MUS becomes the focus of funding in the global water community, it could impact the structure of the entire water sector. Yet, the MUS approach has some limitations which may hinder the long-term sustainability of projects. In analyzing the limitations of the MUS approach, we distinguish between "risks" – unintended consequences resulting from MUS projects as currently implemented, and "gaps" – elements that are missing or weak in the MUS approach.

Risks

MUS may exacerbate existing inequities in water supply: Improved access to water for livelihoods could benefit elite sections of society more than poorer or less powerful members. Those with the land or the capacity to store large quantities of water may be able to capture a larger share of the resource for productive use. In addition, the cost of infrastructure to bring piped supply to homes may exclude poorer residents from benefiting from MUS projects. The poor may be limited by the amount they can carry to their homes and the land they have. Carrying water increases poverty, especially for women.

MUS may result in unsustainable use of the resource base: In many regions of the world, increasing use of water resources to expand agricultural production or domestic use has led to the failure of water supply. With increased populations and climate impacts, water availability is projected to be more constrained in the future. While significant attention has been paid to the sustainability of infrastructure, the sustainability of the resource is also fundamental to the ongoing success of MUS projects. Scaling up MUS projects in particular regions could lead to water conflicts or over-extraction, potentially leading to insecurity or the failure of livelihood systems supported by these projects.

The MUS approach may exacerbate public health issues: MUS projects need to address the water quality issues emerging from the coupling of domestic, irrigation, and productive water supply. Drinking water requires potable water of high standards, while irrigation and productive use water can be treated to different standards; combining both into a single project may result in compromising drinking water quality. At the same time, MUS projects will introduce new waste streams from livestock, nitrates and pesticides from farming, or chemicals from small-scale industry. These waste streams may reduce the quality of the source water used for drinking. MUS projects also increase the quantity of water supplied to the household. Without adequate management of the wastewater generated, there is a real risk of contaminating water bodies.

However, the MUS approach offers unique opportunities to mitigate some of these problems. There is a potential create a win-win situation by locally "closing the water loop." Because irrigation uses can tolerate lower water quality, there may be opportunities to reuse domestic sewage in agriculture with inexpensive treatment – particularly where the treated wastewater is used for cash crops.

Gaps

MUS may not provide sufficient climate resilience: Climate change affects how, when, where, and how much water is available. Climate resilience in MUS projects, including addressing longer or more intense droughts, will be critical to ensure the long-term success of these efforts. MUS projects are small community-based projects that often lack the storage to withstand multi-year droughts. However, to improve livelihood resilience in the poorest communities, MUS projects must explicitly include strategies for climate variability and change.

MUS may overlook environmental concerns: By some estimates, humans already use over half of the available freshwater supplies globally, and this fraction is likely to rise. The MUS approach as currently conceived focuses primarily on meeting only *anthropogenic* water needs. The concern is that as water for drinking, agricultural, and industrial uses expands, it is likely to further reduce the amount available for freshwater ecosystems, which are already disappearing at an alarming rate.

MUS may set back the sanitation sector: For many decades, sanitation has been largely ignored or under-funded, despite the fact that in almost every country in the world, more people live without adequate sanitation than live without safe drinking water. Sanitation has been shown to play a critical role in preventing the spread of waterborne diseases. The MUS approach proposes a new set of linkages in the water sector, in effect decoupling sanitation from water, while adding livelihoods. There is a concern that focusing donor attention to water services could set back recent gains in sanitation funding.

Lessons from Previous Water Sector Integration Efforts

There have been many attempts at integration in the water sector, for example Integrated Water Resources Management (IWRM); Water, Sanitation, and Hygiene (WASH); Payments for Ecosystem Services (PES); and Participatory Watershed Management (PWM). Each of these approaches (Figure ES-1) targets water problems at a slightly different scale with different objectives.

Multiple-use water services fits into the landscape of other approaches as a user-focused approach situated at the community scale which works to meet the domestic and productive water needs of households. The MUS approach can benefit from lessons learned from successes and failures in other water sector approaches. Integrated Water Resources Management (IWRM), one of the dominant paradigms in the water sector, was developed in the 1970s as an approach to integrate and coordinate water supply at the basin scale. Recently, IWRM has been severely critiqued for being a meaningless buzzword that offers no roadmap to guide actions. IWRM also does not focus on the priorities and needs of local stakeholders. A global analysis of 184 IWRM projects demonstrates that there have been a variety of projects undertaken under the IWRM framework, many of which have resulted in little new infrastructure on the ground to meet local needs, improve water or food security, or address inequity.

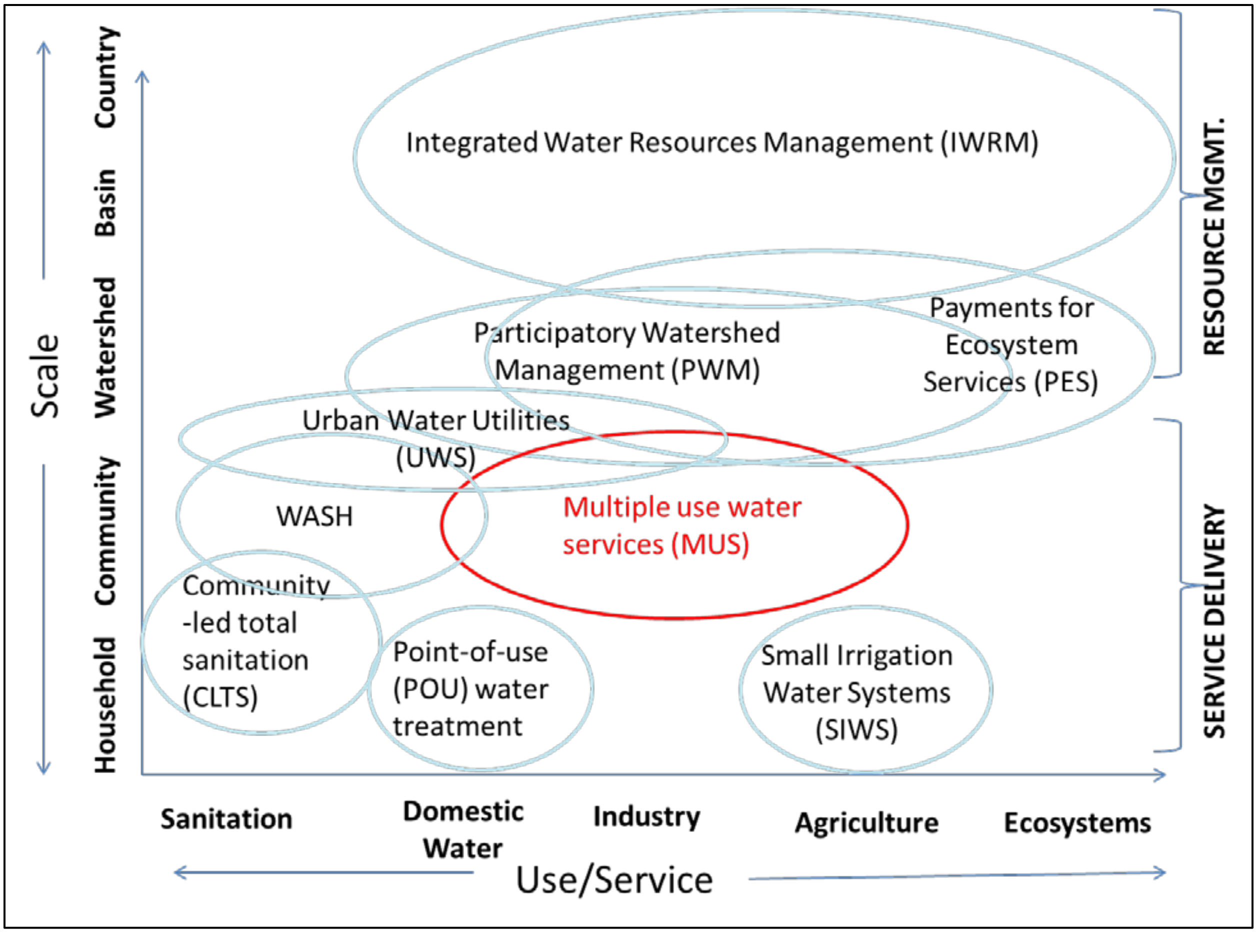

Figure ES- 1. Landscape of different water sector approaches

In contrast, one of the strengths of the MUS concept is that it focuses on the needs of the poorest and aims to deliver a basic quantity of water for drinking and livelihood needs. However, MUS funders and practitioners should work to clearly define and develop a MUS roadmap. They should clarify what *is* and, importantly, what *is not* MUS, how to implement it, and how to recognize and measure success. Attention should be given to how MUS projects can be more accountable to user communities. Additionally, bottom-up coordination to address upstream/downstream issues will be important to ensure sustainability and address potential conflicts.

Recommendations

Based on our review of Multiple-Use Water Services (MUS) and other water sector projects, we provide a set of recommendations to make the MUS framework more robust and sustainable, so that MUS implementation efforts can avoid the pitfalls described and be successful over the long term.

In this report, we offer recommendations at two levels. Project-level recommendations are geared toward communities and implementers of individual MUS projects to assist them in operationalizing sustainability, equity, environment, and water quality. Program-level recommendations are directed to donors, governments, and international and national NGOs as they work to create support structures to make all MUS implementations more successful.

Project-Level Recommendations

Technical design: The choice of technologies in project design provides opportunities to embed equity, sustainability, climate resilience, and other priorities into MUS projects. Projects can be designed in numerous ways to provide incentives for particular uses or enhance sustainability and climate resilience. Pipe sizes, check dam heights, conjunctive use of surface and groundwater, and location of the access points with respect to communal gardens are examples of technical design choices that can influence project outcomes.

Institutional design: Designing effective management institutions within MUS projects can "hardwire" equity, sustainability, and climate resilience into MUS projects. Institutions include both operational rules (e.g., water rotation scheduling, tariff structure, staff hiring practices), as well as constitutional rules (e.g., fair voting rules, representation of all major stakeholders including the environment). Institutions can address water conflicts, improve water use efficiency, ensure equity, and include environmental priorities through formal rules, pricing, and informal social norms.

Program-Level Recommendations

Knowledge sharing and tools: Improving the transfer of knowledge through staff training and tools will assist practitioners in understanding the MUS implementation approach, addressing environmental sustainability issues, and ensuring public health and water quality. A guidebook on MUS and how to implement it in a variety of topographic, socio-economic, and hydrologic settings is needed. Opportunities to reuse wastewater and incorporate sanitation will require more information on the public health and water quality implications of this effort, and water quality testing tools are needed. A drinking water treatment and sanitation decision tool could help practitioners include these technologies in MUS implementation in ways that support project outcomes to improve health and food security.

Data and research: Better data and research are fundamental to ensuring MUS implementations are sustainable and achieve stated goals, and will be even more crucial as MUS scales up. However, in many regions, the basic hydrologic data such as topography, precipitation, recharge rates, and stream flow rates needed for project design do not exist. There is an opportunity to achieve economies of scale by investing in data repositories that make such data available to all water sector practitioners. Additionally, there are opportunities to expand data collection efforts beyond centralized, governmental data collection by using participatory hydrologic monitoring; e.g., via mobile phones. There is also a need for independent, carefully structured, third-party studies beyond existing research from MUS proponents and practitioners. Careful evaluation of the costs and benefits of projects including equity, long-term sustainability, and public health would allow a comparison of MUS relative to other water sector approaches.

Success and accountability measures: One of the lessons from IWRM was that more effort needs to be made to clearly define success and hold funders and implementers accountable to communities so that projects reflect the interests and priorities of stakeholders. A blend of subjective and objective metrics would be most appropriate. Objective metrics could include quantity and reliability of supply, Gini coefficients of water allocation, increase in household income before and after the project, and percentage of household contribution to project capital costs and maintenance. Subjective metrics could include community score-card approaches that measure beneficiaries' self-assessment of how the project has benefitted them. To be accountable to communities, funders and implementers need to go beyond the project mind-set to revisit their projects after ten years, and provide incentives for ongoing sustainability.

Bottom-up coordination and enabling legislation: MUS projects operate at the community-scale. To avoid conflicts and over-abstraction of water resources, there will need to be coordination across communities as MUS scales in particular regions. This can be accomplished through other non-MUS funding approaches, although some MUS projects have already demonstrated that "bottom-up coordination" is possible by constituting a watershed committee made up of representatives from each MUS water committee to coordinate sharing and address conflicts. If MUS is to scale beyond pilot projects, regulatory roadblocks at the national and state scale will need to be addressed, including modifying laws that deem MUS projects illegal and adjusting unnecessary and impossibly high standards where they prevent efficient use and reuse of the resource.

Looking Forward

Multiple-Use Water Services is a promising framework for funding and implementation in the water sector that can address basic needs for water to meet health as well as livelihood needs of the poorest. While the MUS paradigm is historically rooted in the multiple ways in which people have always interacted with their local water sources, it seeks to overcome the fragmented way in which water is currently managed. However, the MUS approach has some limitations that can become significant if increasing international effort expands the funding and implementation of MUS projects globally.

From our analysis of lessons from previous efforts, we arrived at a set of recommendations for making MUS implementations more robust and sustainable. At the project level, MUS implementers can address sustainability, equity, and climate resilience through specific technological and institutional systems. At the programmatic level, water sector professionals, funding organizations, and governments can help create a supportive environment for more successful projects by better knowledge sharing, improved data and research, defining and measuring success, and coordinating and enabling legislation. In addressing these key limitations, Multiple-Use Water Services can avoid the failures of past approaches and ensure sustainable progress toward addressing the needs of the global poor.

Multiple-Use Water Services (MUS): Recommendations for a Robust and Sustainable Approach

Introduction

One of the biggest challenges of the 21st century will be to create water systems that can sustain human well-being while protecting natural ecosystems. Nearly one billion people lack access to potable water; more than two billion people lack access to adequate sanitation. An even larger fraction of the world's poorest people is unable to lift itself out of poverty because of the lack access to water to meet basic livelihood and nutritional needs. Population growth, urbanization, and changing lifestyles add new stress to water demand. Even as humanity tries to meet the food, drinking water, and hygiene water demand of an expanding global population, the world's critical ecosystems are being destroyed at an unprecedented rate. Climate change threatens to further place water resources at risk. A balance will be essential between water for basic human needs and water to preserve natural ecosystems in the presence of rapid environmental and socio-economic change.

Over the last few decades, international institutions have attempted numerous solutions to meet these basic needs, from identifying water and sanitation as targets in the Millennium Development Goals, to developing international funding streams for water development. Several different approaches have been attempted in the water sector, including "Integrated Water Resources Management," "Participatory Watershed Management," and "Water, Sanitation and Hygiene." Each of these approaches has had a slightly different objective and met with varying levels of success. But despite best intentions and a large amount of international funding, a surprisingly large fraction of water systems have either fallen into disrepair or have been abandoned as water sources are drained. The poorest bear the burden of this failure as they continue to face water and food insecurity.

Multiple-Use Water Services: A New Approach

In the last decade, a new approach called Multiple-Use Water Services (MUS) has emerged from the recognition by some water sector professionals of the role that water supply plays in improving livelihoods and food security among the rural and peri-urban poor. The term Multiple-Use Water Services stresses the multiple purposes for which the rural and peri-urban poor need water, ranging from drinking and sanitation to growing food and productive activities. Despite the multiple needs of communities, the public sectors of most countries have bureaucracies that have mandates for "single use" service delivery, such as irrigation or drinking water or fishing. As a result, water development projects are often structured independently or even occasionally in conflict with one another. The MUS approach aims to move beyond a single-use mindset to find strategies to serve a whole range of user community needs. As the name suggests, MUS refers to using a community's water sources to render different services to people – drinking water, hygiene, and productive needs – for the betterment of their lives.

Purpose of this Report

The goal of this report is to critically evaluate the potential of Multiple-Use Water Services (MUS) as a framework for funding and project implementation in the water sector and offer a set of principles and recommendations to make the MUS framework more robust and sustainable. We hope this report can guide donors, practitioners, and water sector professionals on the challenges and opportunities of a MUS approach.

Critical evaluation of an emerging approach is important for several reasons:

First, it takes a lot of effort to "socialize" an approach – getting donors, researchers, and practitioners familiar with the approach (Redwood 2011, Pers. Comm.). Before making such an investment in time and resources, a careful, critical evaluation of the robustness of the concept is warranted. There have been many previous integrative approaches in the water sector (e.g., Integrated Water Resources Management (IWRM), Water Sanitation and Hygiene (WASH), and Participatory Watershed Management (PWM)) with varying objectives and degrees of success. Some of these previous approaches have faced challenges because of the lack of early attention to potential pitfalls. Other approaches have suffered from being too ambitious in attempting water sector reform. In the process they have failed to meet the immediate needs of the poorest, most vulnerable communities. Often the problem occurs *after* the completion of the project, when donors and implementers are no longer involved. If a water project fails, communities may end up being worse off than they were before. Poorer households, who might have taken loans or invested their scarce resources in the expectation of an assured, reliable water supply, are often the hardest hit.

Second, any approach promoted by major international funders greatly influences the entire structuring of the sector in some countries, including job descriptions, performance indicators, and upward reporting requirements. Top-down financing streams within countries from national and state governments are also influenced by the structures set by donor funded programs (Moriarty 2008). In a world with limited resources, funding directed toward a particular mandate could imply funding taken away from other areas, so it is important to place MUS in the context of other water sector approaches. Does MUS complement or replace these efforts?

This report will critically evaluate the potential of Multiple-Use Water Services (MUS) by providing:

1) A description of the MUS approach: how it is implemented, its strengths and weaknesses, and review of case studies.
2) A critical analysis of the limitations in the current MUS approach.
3) Lessons from previous integrative attempts in the water sector.
4) Recommendations and principles to make MUS more robust.

Report Organization

This report is divided into five sections:

Section I provides a history, background, and motivations for MUS.

Section II provides a review of MUS as it is currently being practiced. We offer a typology for MUS projects in terms of objectives, technical and institutional design, and environmental constraints.

Section III identifies missing elements in current MUS efforts. We discuss problems associated with up-scaling MUS in terms of external impacts on other basin water users as well as the environment. We also discuss missing links to sanitation and public health.

Section IV places MUS in the context of previous and existing approaches in the water sector. We discuss how MUS efforts might be integrated either into these or alongside these other approaches and what MUS practitioners can learn from them.

Section V concludes with a set of recommendations to make the MUS approach more robust and sustainable.

Section I. The Multiple-Use Water Services Approach

History and Background

The idea that communities need to develop water sources to meet their domestic and livelihood needs is not new. In some senses, the concept of Multiple-Use Water Services (MUS) is pre-historic: since time-immemorial, communities have settled near water bodies and used or developed them to meet their multiple needs, from growing food and making goods, to drinking, bathing, and sanitation.

The current concept of Multiple-Use Water Services was formalized in 2003 as a project on "productive uses of water at the household level (PRODWAT)" within IRC, the International Water and Sanitation Centre in Netherlands, funded by a grant from the Consultative Group on International Agricultural Research's Challenge Program on Water and Food (CPWF). "Productive Use of Water" is defined as water used for small scale, often informal activities whose primary purpose is improved nutrition or income generation. In contrast, domestic water is defined to include the water needs of families for drinking, cooking, washing, and sanitation/hygiene (Bustanmante et al 2004:144). The PRODWAT project emerged from the recognition that food security and poverty alleviation are major goals that need to be addressed, and to achieve them poor households need to expand access to water beyond the minimum quantity of water used for drinking and hygiene (Moriarty et al. 2004).

The attention to productive uses represented a departure from the exclusive focus on improved access to safe drinking water, sanitation, and hygiene (WASH) formulated in the Millennium Development Goals which is now the dominant paradigm in the water sector. This has resulted in systems designed to provide access to the minimum quantity of water needed for drinking and hygiene (25-50 lpcd – liters per capita per day). Instead, the PRODWAT group argued that at the most basic level, poverty is the lack of opportunity. Without access to sufficient and reliable water for productive uses in and around the household, people are excluded from a range of options that would allow them to diversify and secure their sources of food and income (PRODWAT Group statement 2003). Focusing exclusively on drinking water and sanitation offers few opportunities for the poor to escape from poverty toward self-reliance. Self-reliance in livelihoods and food security is ultimately the stated goal of development efforts.

The PRODWAT group changed its name to "MUS Group" in 2006. The MUS Group (www.musgroup.net) is a "collaborative partnership between international organisations interested in the Multiple-Use Water Services," approach. MUS Group members include The International Water and Sanitation Centre (IRC) based in The Hague; the Overseas Development Institute (ODI) in Britain; the International Water Management Institute (IWMI); the Consultative Group on International Agricultural Research's Challenge Program on Water and Food (CPWF); CINARA in Colombia; the Water, Engineering and Development Centre

(WEDC) at Loughborough University in Britain; PLAN International; Pump Aid; Winrock International; Stockholm Environment Institute (SEI); Rain Foundation; World Fish Center; the United Nation's International Fund for Agricultural Development and Food and Agriculture Organization (FAO); and the Water Supply and Sanitation Collaborative Council (WSSCC).

According to its webpage, the MUS Group's main objectives are as follows:

- Bringing together a group of sector professionals from the water, rural development, and poverty alleviation sectors to operate as a "think tank" with the aim of advancing our common understanding of the issues related to developing and scaling up community managed, multiple-use water supply systems and improving the productivity of water used at the household level;
- Initiating specific "projects" (e.g., action research, workshops, e-conferences, etc.) involving a wider group of stakeholders to improve our understanding of how to implement effective systems on the ground, support improved water productivity (market linkages, crop choice, inputs, etc.), and scale-up community and household-managed multiple-use systems; and
- Engaging in advocacy activities to support and promote self-managed multiple-use systems. Advocacy is principally aimed at: a) policy makers and donor agencies and b) the wider community of sector professionals.

It must be noted that although the concept of MUS has been recently *formalized* within the international community, the practice and design concepts are not new. Designing water projects to serve multiple needs has been practiced throughout the developing world. Indeed, NGOs focused on "community development" have long taken a holistic approach in implementing health, education, livelihood, and water and sanitation projects simultaneously. For example, the photo on the right (Figure 1) shows a World Vision Project installed by Pacific Institute staffer Dr. John Akudago in 2000 in Kadia, Ghana. The project design involved a livestock trough, washing area, and a domestic water point.

Figure 1. A multiple-use system in Tamale constructed in 2000
Photo credit: Dr. John Akudago

What are Multiple-Use Water Services?

The official definition of MUS is still being refined. Several different definitions emerged from the workshop on Multiple-Use Water Services in Oakland, California, U.S.A. on October 13-14, 2011 hosted by the Pacific Institute and the Rockefeller Foundation.

Representatives of the MUS Group offered the following definition:

Multiple-Use Water Services (MUS) are ***water services*** *by the public sector or private sector that take* ***rural and peri-urban*** *people's* ***multiple water needs****, which are met from* ***multiple sources****, as the starting point of planning and design. This participatory, integrated planning approach fully recognizes and strengthens the often informal ways in which* ***communities*** *have been developing and managing their water resources.*

Rural communities have managed water in this integrated manner since time immemorial, and they continue to do so. In communities in transition in low- and middle-income countries, livelihoods are often both agriculture-based and diversified, and may also depend on other domestic uses, sanitation, livestock, cropping, fisheries, small-scale enterprise, etc. MUS further recognizes that people strengthen their livelihood resilience vis-à-vis seasonal weather fluctuations, droughts, and floods by improved water harnessing, storage, and conveyance and by combining multiple conjunctive water sources at homestead- and community-level or higher scales. These coping strategies will become more important under climate change.

Another more succinct definition offered by Mr. Martin Dery, the founder of Pronet North, Ghana (an NGO), was:

Multiple-Use Water Services (MUS) entails a systemic approach to water provision that recognizes the alternative and competing uses of water in a changing environment. The approach is comprehensive, participatory, and informed by indigenous knowledge and practice systems and aims to increase the efficiency, reliability, and livelihood resilience under climate change. Dignity, inclusion, sustainability, and multi-stakeholder involvement are essential to the MUS approach.

Interestingly, the MUS Group webpage does not include an official definition of MUS on the main website. An important step will be for the MUS Group to develop and post a consensus definition. This will greatly reduce uncertainty about what MUS actually means and entails. However, despite the lack of a single definition, it is clear that MUS represents a departure from previous integrative attempts in the water sector and there is sufficient convergence on the idea. Most accepted definitions above have four common elements:

1. Rural/peri-urban focus: Because of the focus on livelihood resilience, MUS projects primarily target rural and peri-urban poor. Large urban water utilities are not a primary area of focus.

2. Small-scale infrastructure: MUS projects typically involve small-scale storage and distribution infrastructure. Most projects are at the community scale, although a few larger multi-purpose dams have also been called MUS.
3. Services delivery: The MUS approach puts “people” before “resources.” MUS projects are focused on delivering water to the poorest communities rather than managing water resources. The MUS approach includes both the “hardware” or infrastructure and “software” or institutions of water systems.
4. Both domestic and productive uses: In designing MUS systems, practitioners take both the domestic and productive needs of communities into account. Thus, MUS projects aim to provide both health and livelihood benefits.

van Koppen et al. (2009) use a “water ladder” metaphor to conceptualize MUS (Figure 2), arguing that, as users’ progress beyond the basic 50 liters per capita per day (lpcd) used for domestic needs, extra water would be increasingly used for food security, and then for productive uses. Thus, climbing the water ladder would help the rural and peri-urban poor escape from poverty.

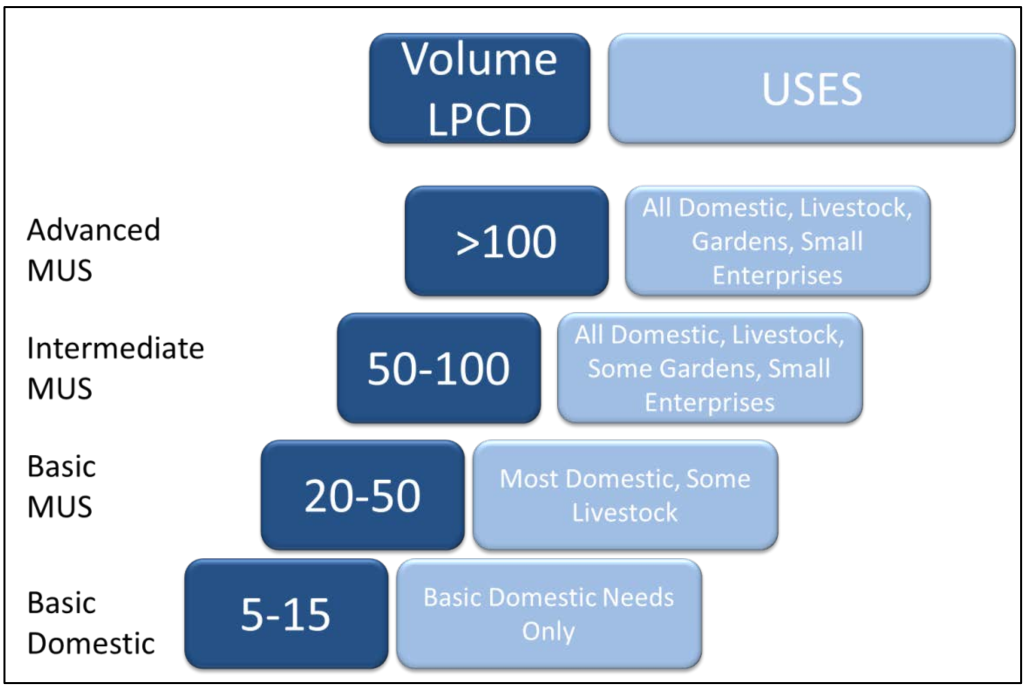

Figure 2. The “Water Ladder”
Source: van Koppen et al. (2009)

Conceptual Framework for MUS

In developing the MUS framework, the MUS Group adopted a two-pronged approach: first, implementing and evaluating MUS projects at the community scale; second, scaling-up successful MUS models by creating a supportive environment at higher institutional scales.

Van Koppen et al. (2006) suggest a number of necessary pre-conditions for successful MUS projects for each scale. We briefly list these below:

Community-scale*:*
1. Livelihoods must be the starting point for design: water use is necessary to achieving livelihood benefits and poverty alleviation;
2. Appropriate technology and financing models and institutions are necessary to ensure long-term sustainability and equitable access.

Intermediate or national scale*:*
1. Making intermediate-level water providers accountable downwards to water users;
2. Providing coordinated long-term support to finance and support continuous, incremental growth in line with communities' own plans and preferences;
3. Including MUS in strategic planning to ensure that individual projects are not isolated but replicated across communities;
4. Enabling policies at the national level to remove bottlenecks to MUS implementation; and
5. Fostering decentralized support structures so that decision-making can be devolved to the "lowest appropriate level."

Claimed Benefits of the MUS Approach

MUS proponents and practitioners make several claims to promote the construction of MUS systems instead of single-use systems. The claims advanced by various practitioners and scholars are detailed below.

Planned MUS systems reflect communities' actual use of water, reducing risks associated with "de facto" multiple use.
The idea of communities using a water source to meet all of their needs is not new. Historically, communities had water sources that were used for everything; the separation into distinct drinking water and irrigation uses arose later as countries developed government departments and bureaucracies.

Today, in most countries, the institutional framework of water supply is organized by sector. Drinking water systems, which systems aim to deliver potable water to meet drinking-water demands and improved hygiene via washing, cleaning, and sanitation, are developed independent of irrigation systems. The problem is that in practice, many so-called "drinking water systems" are used for kitchen gardens or livestock anyway – uses for which they were not designed. This inconsistency between system design and how communities actually use water causes many problems after the project is commissioned (van Koppen et al. 2006). Experience shows that this inconsistency promotes illegal connections, causes water shortages and conflicts between users, and results in unsustainable use of water resources.

Financial sustainability of water systems can be enhanced/improved with MUS.
Many rural drinking water systems have been unsuccessful in raising sufficient funds for operation and maintenance. Getting poor communities to pay for safe, secure access to drinking water on their meager incomes is challenging. But without some ability to recover costs, the systems do not get built or become non-operational once they break down and replacement parts are needed. Long-term sustainability of water projects is one of the biggest challenges of the water sector.

The MUS Group argues that rather than focusing on drinking water alone, allowing for small-scale productive uses of water can contribute significantly to increases in household income. This could alleviate poverty and at the same time provide users with the incentive and the financial ability to sustain and maintain the system. Equally important for sustainability is a sense of ownership (Narayan, 1995). Proponents claim that MUS inherently promotes a sense of ownership because participation and consultation of communities' actual water needs is central to the MUS approach (van Koppen et al., 2006).

MUS promotes a holistic view of public health by focusing on nutrition.
The Water, Sanitation, and Hygiene or WASH approach to improved water supply is motivated by the need to reduce the burden of waterborne diseases. MUS proponents argue that waterborne diseases contribute to only part of the health problems of under-developed, rural communities. Lack of access to a diversified diet also contributes to poor nutrition, which in turn results in higher rates of childhood mortality and morbidity from a host of different diseases. Improving access to vegetables and fruit in the poorest communities would boost immunity and reduce susceptibility to many diseases. For example, in the MUS projects in Nepal implemented by International Development Enterprises (IDE), villagers reported that their health improved after the MUS project implementation mainly because of consumption of fresh vegetables. MUS projects also expand opportunities to own livestock and fish ponds, important sources of protein for the poor.

Additionally, there are the ancillary health benefits from improved access to water for domestic needs (reduced labor burden for women can result in increased time devoted to child care) and productive needs (increased income results in increased ability to pay for health care).

The MUS approach improves food-security among the peri-urban poor.
Peri-urban poor households (unlike rural households) tend to be net food consumers. They often work in urban jobs and spend up to two-thirds of their income purchasing food, and as a result, are particularly vulnerable to rising food prices. The peri-urban poor often do have access to small patches of land, making kitchen gardens feasible. Enabling the peri-urban poor to grow vegetables or maintain livestock provides them both a source of income as well as security against food price spikes. One study (van Averbeke 2007) suggests that the livelihood benefits derived from peri-urban farming extended far beyond income generation, reducing “social alienation and the disintegration of families” associated with urban poverty.

The MUS approach improves co-ordination, potentially lowering costs.
The segmented nature of water ministries and bureaucracies has resulted in rural water supply being uncoordinated. The structuring of the public sector along “single-use mandates” leads to projects that operate in parallel with each other even when they serve the same user community. There is no comprehensive database of how users are currently being served, and often there is a duplication of effort (van Koppen et al. 2009). MUS proponents argue that MUS systems entail lower costs. In rural and peri-urban areas it is common for communities to need water for productive uses like kitchen gardens and livestock watering, etc. However, many small-scale irrigation systems lack sufficient revenue to justify investments in stand-alone systems. At the same time, domestic water systems are prioritized because of the need to meet Millennium Development Goals targets and national policies.

MUS proponents argue that relatively modest investments in extending domestic systems to include productive uses, such as small-scale irrigation, could yield significant benefits to the community as a whole and would cost less than if domestic and irrigation systems were developed separately. Adank et al. (2008) provide cost estimates comparing MUS systems with domestic water supply systems across two communities in Ethiopia. Their data suggest that MUS projects involve a relatively modest increase of about 10-20% of total annualized costs, assuming a 20-year project life. However, it should be noted that this result depends on the sophistication of the system. The two projects analyzed involved a small investment in capping a spring source and improvements to make the tap more accessible. The overall projects costs are quite low and not representative of other MUS projects involving piped distribution systems discussed later in this report.

Renwick et al. (2007) provide extensive cost comparisons of different levels of MUS systems. Their estimates suggest capital costs ranging from $25 to $140 for MUS systems ranging from basic to advanced systems. Their study suggest that when the income benefits of MUS systems are accounted for, payback periods can be as low as 3-24 months when single-use systems are upgraded to Multiple-Use Water Systems.

The MUS approach empowers women.
The MUS approach focuses on livelihood opportunities close to the homestead. Livelihood opportunities such as kitchen gardens, livestock, and shea butter production are often the mainstay of women in the household, versus field crops or construction which are traditionally viewed as male activities. Vegetable growing is often viewed as a labor-intensive activity and it occurs close to the home. Khawas and Mikhail (2009) report that IDE-MUS projects in Nepal gave women income and decision-making power they previously lacked. Interestingly, IDE staff report an evolution of gender roles within the household as males began to take on more “feminine” tasks in vegetable production once they became lucrative. In contrast, single-use irrigation systems tend to be used on field crops, traditionally a male domain.

In summary, MUS practitioners claim a range of benefits from long-term sustainability, poverty alleviation, food security, and improved gender equity from MUS projects. Because most MUS projects have just been completed, many of these claims are anecdotal to individual projects. Additionally they have not been systematically or independently tested by researchers. It is too early to judge if these assessments will stand the test of time.

Section II. Multiple-Use Water Services in Practice

In this section, we review key elements of existing MUS projects from three perspectives: a) the nature of domestic and productive needs targeted; b) technical design; and c) institutional design. Then we present a summary statistical analysis of global MUS projects along the above dimensions.

An excellent review of MUS has been written by van Koppen et al. (2009). Another very detailed review of MUS implementations by the International Development Enterprises (IDE) Nepal (Mikhail and Yoder 2010) covers technical design, financing mechanisms, capital costs, and related topics. In the interest of brevity, we summarize the broad lessons from various MUS reviews to stress the following points:

1. MUS projects encompass a wide diversity in objectives.
2. The success of MUS projects is dependent upon a series of interrelated factors, including: technical design, topography, water availability, settlement patterns, and institutional design.
3. These factors are interlinked: certain types of system design are better suited for some types of management options and preclude certain other types of management (Yoder et al, 2008, Mikhial and Yoder 2010). "Appropriateness" of the technical and institutional design to the user needs and resource endowment is critical to success.

MUS systems develop via different "modalities." First, existing domestic or irrigation systems may be modified slightly to accommodate multiple uses (van Koppen et al 2009), or projects may be designed and implemented to meet both domestic and productive uses from inception (designed MUS systems). Modifying existing drinking water or irrigation systems constrains design choices far more than designing for a MUS system from inception, but this may be the only feasible option if funding is limited and an existing delivery system is already in use. Second, community MUS systems may be designed for multiple uses from conception.

Modified systems

Modified systems involve minor modifications to traditional drinking water schemes or irrigation schemes to accommodate additional uses. These modifications may occur either by deliberate action of local agencies or unintentionally as local communities adapt a single-use water service system into a de facto MUS system. Thus, modified MUS systems could be categorized as "Irrigation Plus" or "Domestic Plus" schemes depending on whether they involve modification of an irrigation system or a domestic system.

Irrigation Plus

Irrigation Plus systems enhance the design of planned irrigation systems to include "add-ons" to allow for multiple-uses. Two types of changes are usually made to standard irrigation systems to convert them to "Irrigation Plus" systems:

A. *Minor modifications to irrigation system design may be made*, such as by constructing washing steps or cattle entry points in irrigation canals or building an outlet to a domestic storage tank connected to a treatment and distribution network.

Figure 3. Irrigation tanks being used to wash clothes and cattle
Photo credit: KJ Joy

"Irrigation plus" projects are most common when there is a canal going by a village where no drinking water infrastructure exists. In such cases, determining a way to divert a small portion of the canal water toward a drinking water project is logical, but using water from irrigation canals as direct access drinking water points would be discouraged because of public health concerns (although this has been observed in a handful of de facto MUS systems where individuals use canal water for drinking because they lack other options). Usually, where a drinking water component is added on to an existing irrigation system, a diversion is created to a chlorinated storage tank from which drinking water is distributed (van Koppen et al 2009).

A more common modification is to use irrigation canals for washing clothes or vessels or even multiple productive uses. Often, the simple the addition of steps allows people to access the water safely, instead of risking broken limbs or accidental drowning. Provisions may also be made to divert wastewater away from the irrigation canal, reducing health risks. Irrigation canals may also be expanded for other types of productive uses: cattle troughs, washing, and small-scale industry are common.

B) *Dead storage use may be expanded* for aquaculture or effecting field-level changes in in-field storage to accommodate crop-fish systems. For instance, one Irrigation Plus system by NGO Plan Ghana, involved building eight small multi-purpose dams. By design, the dams were intended for irrigated farming, provision of water for livestock watering, and fish cultivation. Each dam therefore had a fenced irrigable area between 5 and 20 hectares, two animal drinking troughs, and all the reservoirs were stocked with fish upon completion of construction works. These were expected to improve the nutrition of community members and provide additional income for them through the consumption of produce and sale of surplus produce respectively.

Domestic Plus

Domestic Plus systems involve enhancing domestic systems to allow for productive uses, including kitchen gardens, communal gardens, and small-scale enterprises such as saltpans, shea butter extraction, rice parboiling and milling, block molding, brewing and distillation, and the like. Several types of modifications are typically made to conventional domestic systems to convert them into “Domestic Plus” MUS systems: c*hanging design capacity* to accommodate a much larger quantity of water use; *changing management philosophy* by treating productive uses as beneficial and desirable instead of punishing productive uses as “wasting water”; and *changing institutional design* by allowing productive uses to be prioritized or charged differently.

Community-based MUS systems

Systems which were intentionally designed to be MUS have a lot more flexibility in design, both in technical and institutional terms. When projects are designed as multiple-use they do not have to adhere to the more stringent requirements or design specifications that domestic or irrigation departments may mandate.

Van Koppen et al. (2006) classify MUS designs into three broad categories. In increasing order of cost and sophistication, they are:

1) Single access point systems.
2) Systems with distribution networks to common standpipes.
3) Systems with distribution networks to individual homesteads.

Each of these categories can be further classified into sub-categories, depending on the extent to which storage and distribution infrastructure for domestic and productive water uses are separated. These different design sub-categories may arise from differences in the water source, quality of the water source, homestead settlement patterns, type of productive uses intended, system cost, and user ability to pay.

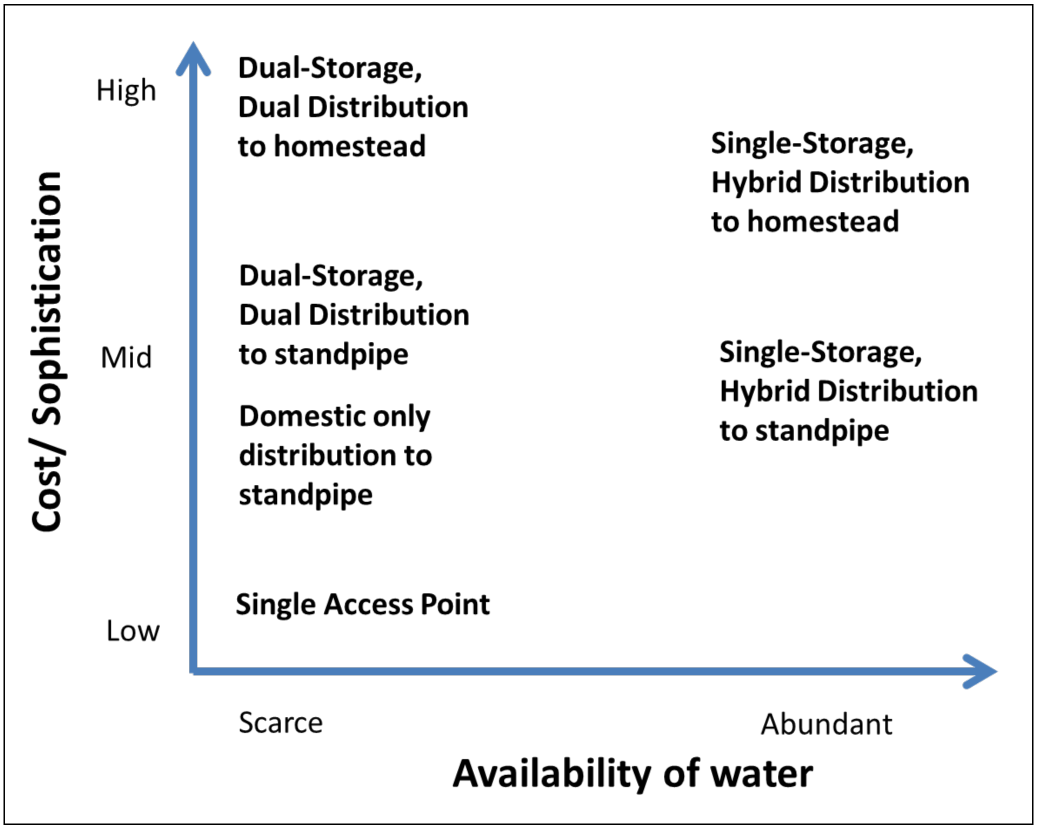

Figure 4. Cost of systems versus availability of water

Single Access Point Systems

Single access point systems are systems where water for all uses must be collected from a single access point to which the user must walk. The single access point is usually a community borehole, hand-pump, or a motorized borewell pumping water to an overhead storage tank. Single access point systems may also include communal ponds, small reservoirs, or tanks. These have traditionally served as single access "MUS" point for over a century in much of South India (Ranganathan and Palanisami, 2004) and Brazil, Ghana, Ethiopia, Kenya, Sri Lanka, and other countries, and can also be considered to be MUS systems.

Figure 5. Communal Garden in MUS project in Meguo, northern Ghana
Photo credit: Dr. John Akudago

These types of systems are the most common types of MUS system in rural parts of Africa (eg. Ghana (World Vision, CARE), Mozambique (CARE), and Senegal). Among all of the technical designs described in this section, Single access point is the lowest in terms of cost and sophistication and institutional demands.

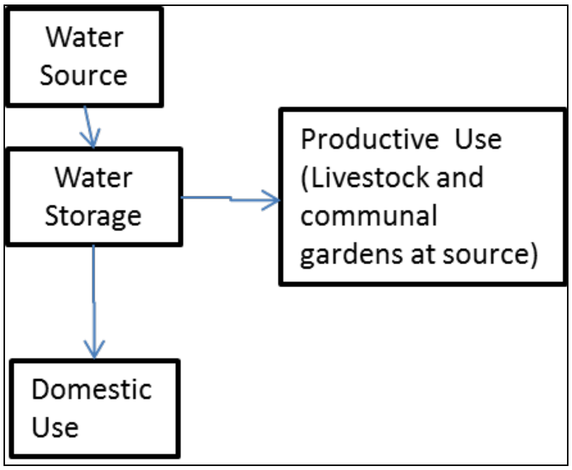

Figure 6. Single Access Point Systems

Technical Design

The key to ensuring livelihood benefits in single access point systems appears to be to ensure that the productive uses are close enough to the water source. If the distance between the homestead and the water point is large, productive uses are precluded (van Koppen et al. 2006), simply because the quantity of water people can haul per day drops off quickly beyond a distance of 500 m (Renwick 2001, Scheelbeek 2005).

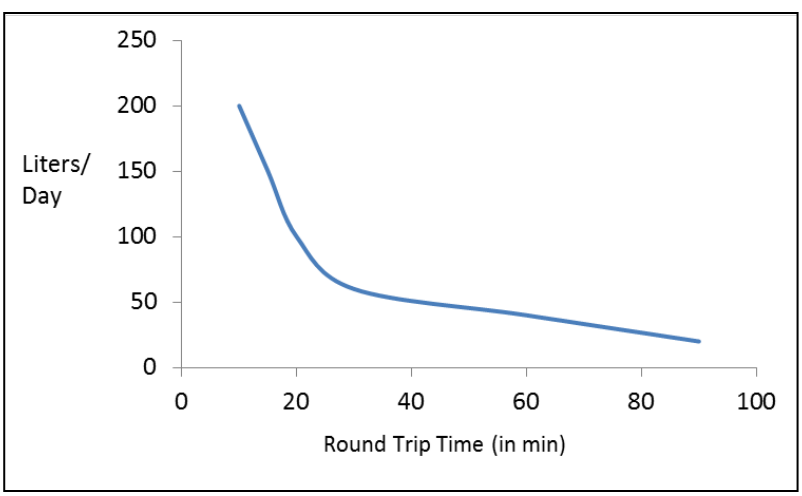

Figure 7. Relationship between trip time and liters/day collected

Source: Renwick, 2001

There are two ways this problem has been resolved in MUS projects. In denser settlements, the single access point water source can be located close to the homesteads to allow people to carry water home to use in their kitchen gardens or cottage industries. However, if the settlement is scattered, the productive uses must be co-located close to the access point so that the water can be carried or delivered via a flexible hose pipe.

Institutional Design

Single access points rarely need sophisticated institutional arrangements. In the case of boreholes, the only requirement is to ensure that the access point works and can be fixed if it breaks down. In such cases, it is enough to appoint a standpipe or borehole manager who could charge users per bucket or animal (Davis 2011) or collect a small monthly fee from community members. However, despite their seeming simplicity, MUS practitioners need to be particularly sensitive to potential failure of single access point systems. Frequently, even this minimal institutional arrangement is not put in place and no attempt at maintenance or recouping costs is made. In the absence of formal mechanisms to collect money or assign responsibility to buy spare parts, if the pump or borehole fails, often the community must wait for the next NGO intervention.

Distribution to Standpipes

In standpipe systems, water is distributed from the source to a standpipe close to the homesteads.

Technical Design

This category can be further sub-divided into two categories depending on the degree to which domestic and productive uses are separated.

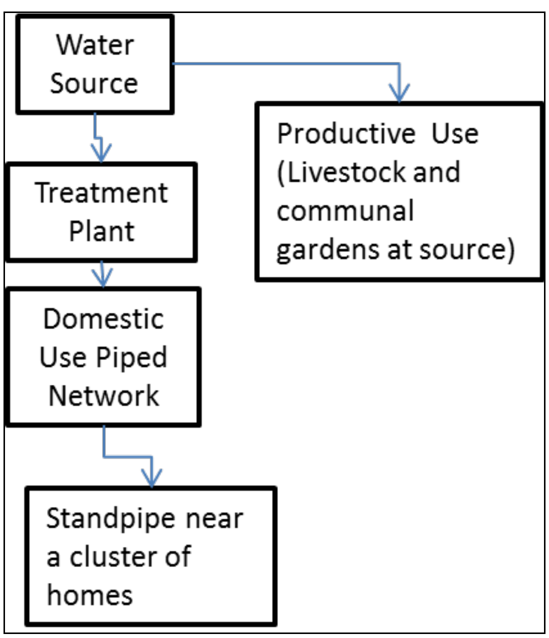

Figure 8. Domestic Only Standpipes

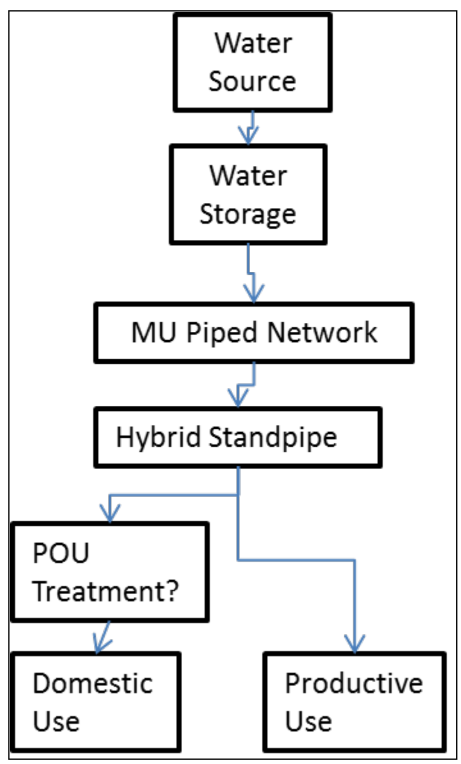

Figure 9. Hybrid Standpipes

Figure 10. Hybrid Standpipe in Nepal
Photo credit: Monique Mikhail

In the domestic only standpipes, domestic water is treated at the source (if needed) and then distributed to a standpipe located close to the homestead. However, productive uses continue to be co-located near the water source. In contrast, in hybrid standpipe systems, the water is piped to a hybrid standpipe for both domestic and productive uses. This technology has been implemented by International Development Enterprises (IDE) in Nepal's Palpa and Syangja districts. Here, the relatively dense nature of the settlements makes it possible for households to run one flexible pipe from the hybrid standpipe to a storage tank inside the house and a second flexible hose pipe from the hybrid standpipe to vegetable plots near the houses. In some parts of the world, such as Nepal and the mountains of Colombia where the water source is a relatively pristine spring, the water supplied to the hybrid taps may be completely untreated.

Institutional Design

Standpipe MUS systems call for more sophisticated institutional arrangements than single access point systems. There are several different *points* of water collection separated from the water source. This means the different clusters must agree on a system of equitable distribution of the source water between the different standpipes and must develop a system to ensure that the money collected at each standpipe makes its way back to maintain the entire network of borewells, treatment plants, distribution pipes, and standpipes.

In other words, there are two levels of co-ordination, one between households served by a single standpipe and one between the different standpipes within the MUS system. Additionally, the universal problem with hybrid systems is to decide whether and how to distinguish between domestic and productive uses. There is a range of different institutional arrangements that could work (e.g. allowing household tanks to fill first before allowing any water to be used for productive uses), but all of these require the users to agree on a set of rules and follow them, further requiring a framework for decision-making within the community.

Distribution to Homestead

Homestead systems involve a sophisticated distribution system that extends all the way to the homestead. They can be further categorized based on the degree of separation between domestic and productive water.

Technical Design

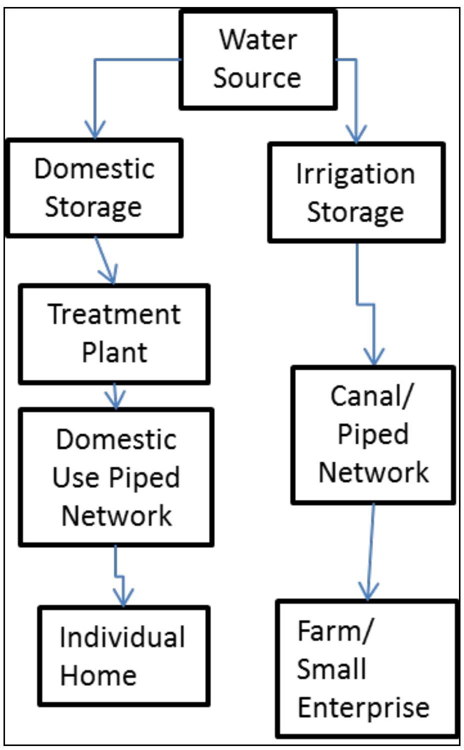

Figure 11. Dual Delivery Systems

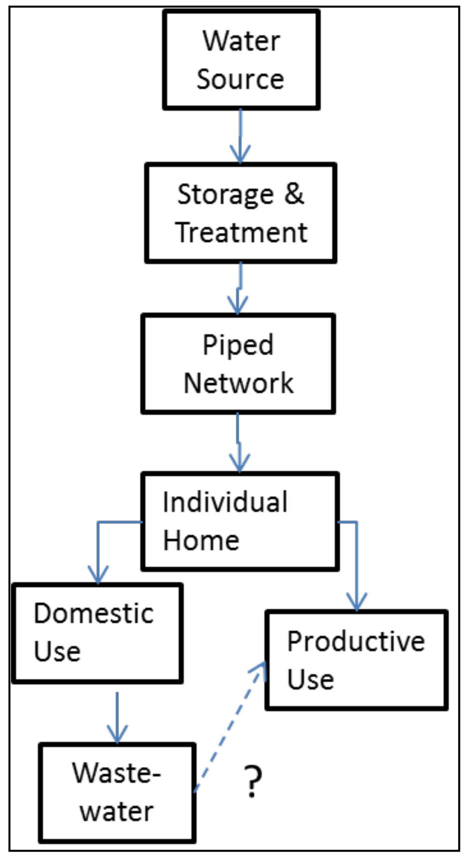

Figure 12. Hybrid Piped Systems

Dual Delivery Systems

Dual delivery MUS systems are the most expensive and sophisticated of the various systems. In many ways these are similar to a conventional multi-purpose projects, where one water source feeds both domestic and irrigation schemes. Once the initial allocation between the drinking water and irrigation components is agreed upon, the management of the irrigation and domestic components can be quite separate.

Hybrid Piped Systems
A hybrid piped system is similar to a conventional domestic piped network except that it has been scaled and designed to accommodate productive uses such as small-scale industry or kitchen gardens. The challenge is in recouping costs. The high cost of construction of a piped supply project, particularly in rural areas where houses are far apart, may require a high upfront connection fee.

Mixed Delivery Systems
In many communities, only the wealthiest can afford piped connections to their homes while the poorest continue to rely on public standpipes. In this case, there is a significant disparity in the price paid by the wealthy and the poor households, when labor costs are accounted for. The cost of hauling the water causes the poor to effectively pay more and use less water for productive purposes. As discussed earlier, the wealthy households can use significantly more water than poor households and may end up capturing the lion's share of the benefits (Davis 2011, Pers. Comm.). This was observed in Kikware village in India, where the wealthy village elite allocated much of the new water from the public project to further improve their own position.

In the section below we summarize the various technologies, their benefits, where they might be most effective and what the drawbacks maybe.

Type	Description	Benefits	Costs	Cases
Domestic Plus systems	Essentially, domestic supply systems that permit some productive uses.	Can be accommodated within current drinking water “single-use” mandate drinking water systems.	Depending on the size of the system, length of distribution network, and amount of productive use accommodated, they can be quite expensive. However, in most cases, domestic plus systems involve relatively modest increases in water for small kitchen plots and livestock.	Aple Pani, Maharashtra
Irrigation Plus	Irrigation systems that permit some domestic uses such as washing steps.	Can be accommodated within current drinking water “single-use” mandate irrigation systems.	Very little cost with these minor modifications.	Plan Zimbabwe
Single Access Point	Single point source such as a borehole or a spring.	Low cost. Does not require sophisticated institutional arrangements.	Limited benefits in terms of time or labor cost of water collection. Productive uses must be co-located with access point. Recouping costs or setting up a contingency fund is difficult as it is hard to exclude people from collecting water.	World Vision, Ghana

Type	Description	Benefits	Costs	Cases
Domestic Only Standpipe	Single point source involving some treatment and storage. Water is distributed to multiple domestic only standpipes located close to the homestead. The fields are not located close to the homestead.	Relatively low cost. Involves some distribution and treatment.	Productive uses such as communal gardens, cattle troughs, or small-scale industries need to be co-located with source. Four types of institutional arrangements are needed: • A method to recoup costs at each standpipe and aggregate to a single Water Committee. • A method to recoup costs from productive users. • Rotational rules to distribute water across the multiple standpipes. • Decision on how to allocate water between the on-site productive uses and the domestic piped system.	Mozambique (CARE)
Hybrid Standpipe	Supply both productive and domestic uses at a single point. They work best when in dense settlements with kitchen gardens.	Simple, low-cost extension of a standpipe design.	Hybrid standpipes work best when water resources are relatively plentiful and not reliable. Types of institutional arrangements needed: • A method to recoup costs at each hybrid standpipe and aggregate to a single Water Committee. • Rotational rules to distribute water across the multiple standpipes. • Mechanisms for prioritization of domestic uses (e.g., strict rotation rules, so that each household gets the same quantity of water). • Whether to treat all the water or leave households to do POU for domestic uses	IDE Nepal – Syangja and Palpa Districts

Type	Description	Benefits	Costs	Cases
Dual Delivery MUS System	Community-level systems that share one or more sources. However, the distribution for domestic and irrigation systems is completely separated. Dual delivery MUS systems may be necessary where the households are located in a dense village settlement but the fields are dispersed.	In many ways dual delivery MUS systems are bureaucratically simpler. Once the initial co-ordination between the drinking water and irrigation components is agreed upon, the management of the project is quite straightforward and along the lines of traditional "single-use" systems.	Dual delivery systems are expensive because they resemble a typical small-size multipurpose project. Both the drinking water piped network and irrigation pipes/canals must be built separately. A dual delivery MUS project differs from traditional single-use projects mainly in the extent of co-ordination between the domestic and irrigation components.	IDE, Senapuk District Nepal

Type	Description	Benefits	Costs	Cases
Hybrid Piped System	Single piped rural water supply system sized to serve both domestic and productive uses at the home. These may be necessary in wealthier communities where the households have large plots but have a strong preference and willingness to pay for piped supply.	This is the most expensive/sophisticated of all the MUS systems. However, although piped systems in general are expensive, a hybrid piped system is only a slightly more expensive than a piped drinking water system.	Hybrid piped systems work best when water resources are relatively plentiful, reliable, and high quality. Types of institutional arrangements needed include: • Prioritization of domestic uses (challenging as both domestic and productive uses are accessed by a single system). • Because water is piped to the homestead, volumetric pricing may be necessary because of the large volume of water involved. • Whether to treat the water centrally or leave it to POU at each household.	Colombia

Type	Description	Benefits	Costs	Cases
Mixed System	Combination of hybrid pipes and hybrid standpipes. Wealthier households may have private connections, but poorer households may rely on standpipes.	These allow some level of flexibility, where different households may participate in the system to different extents depending on their ability to pay.	The main concern with mixed systems is inequity and exacerbating income inequality. Large wealthy households can capture the lion's share of the benefits because they receive water piped to the house/kitchen garden. Poorer households who have to haul the water may gain very little in terms of productive uses. Some of these concerns may be mitigated by making an allowance for a single common connection to a communal garden with plots shared my many poorer households. Types of institutional arrangements needed include: • Prioritization of domestic uses (challenging as both domestic and productive uses are accessed by a single system). • Because water is piped to the homestead for some households and accessed at standpipes by others, dual pricing may be necessary. • Shortage sharing agreements to ensure standpipe-dependent households are able to access a minimum quantity of water during droughts. • Decisions on whether to treat the water centrally or leave it to each household.	Kenya

Section III: Limitations of the MUS Approach

In this section we review some potential problems with the MUS approach as it is currently practiced. If MUS becomes the focus of funding in the global water community, it could impact the structure of the entire water sector in terms of financing, staff training, and performance indicators. The MUS approach has generated significant interest among organizations working on water issues, as MUS offers an opportunity to improve both the health and livelihood needs of the rural and peri-urban poor. Yet, the MUS approach has some limitations which may hinder the long-term sustainability of projects including the consideration of sustainability of supply, climate resilience, equity, sanitation, public health, and the environment.

Although MUS practitioners acknowledge these limitations, at present they rely entirely on the skill and expertise of the project engineers to mitigate these risks. In the absence of formal mechanisms and standards, MUS could exacerbate existing problems or create new, unintended problems, particularly for “under-represented” stakeholders: future generations, the poorest and weakest sections of society, and the environment.

In this section, we identify problems that could be *exacerbated* or *negatively impacted* by a MUS approach and suggest solutions that could make MUS a more robust approach. In analyzing the limitations of the MUS approach, we distinguish between “risks” – unintended consequences resulting from MUS projects – and “gaps” – elements that are missing or weak in the MUS approach.

Risks: The MUS approach could exacerbate certain water resources and public health problems if poorly implemented. We identified three risks specific to MUS that are a *direct* consequence of the integration of domestic and productive uses in one system.

A) MUS could exacerbate *inequitable* access to water.
B) MUS could result in *unsustainable* use of water resources.
C) MUS could have unintended *public health* consequences.

Gaps: Because MUS is conceptualized as a water service delivery framework, certain elements are missing or poorly integrated into the MUS approach. As a result of these gaps, MUS projects may have some *indirect* consequences.

A) *Climate resilience* is not well considered in the MUS approach.
B) *Ecosystems* are not considered a user in the MUS approach.
C) *Sanitation* is missing or weak in the MUS approach.

In identifying these challenges we do not focus on well-known general challenges inherent in all water projects – high chance of failure, financial unsustainability, water governance, etc. Instead, we focus on problems specific to the MUS approach. Likewise, in suggesting solutions, we have to the extent possible avoided changing the fundamental nature of MUS as a community-scale water provision effort. Thus, we do not focus on larger water governance problems. Instead, we focus on how the MUS framework can be modified to better address the specific weaknesses identified.

Risks Posed by the MUS Approach

The risks posed by MUS become clear when we examine the origin of silos in the water sector. Scholarly histories of the water sector suggest that the separation of drinking water arose from the recognition of the link between water quality and human health. In contrast, irrigation systems developed thousands of years ago from the need to overcome the vagaries of rainfall and stabilize food production. Over time, specialization resulted in a "quantity-quality" divide between irrigation and drinking water professionals. Drinking water projects involve high-quality, reliable water supply, but involve relatively small quantities of consumptive water use. In contrast, irrigation water supply involves large quantities of untreated water – most of which is consumptive. Additionally, the waste streams (domestic sewage versus farm run-off versus industrial wastewater) and associated benefits (health versus income) are quite different. Often drinking water professionals are trained to address water quality challenges, while irrigation professionals are trained to address water quantity issues such as water rights, shortage sharing, etc.

However, addressing these sectoral differences is unlikely to merely be a matter of retraining engineers. In integrating domestic and productive supply into a single MUS system, the original rationale for silos must be revisited and addressed to develop new standards and processes, as most of the "risks" identified result directly from combining these.

A) MUS could exacerbate inequities in access to water.

Context
While differential access to resources is common in many water projects, MUS projects pose some unique challenges because of the combination of domestic and productive uses. Unlike drinking water, differential access to water for productive uses directly exacerbates power and income differences within and between communities. Without adequate protections, there is a real danger that MUS projects may result in "elite capture" of the water resource base.

MUS projects must be implemented in societies where inequality already exists. Under these circumstances, defining what is fair or equitable in a MUS implementation is difficult. Although there are different perspectives of what is "fair" (e.g., comparable initial conditions versus comparable outcomes), most people accept that there are some "unacceptable deprivations" – and lack of access to a minimum quantity of water and food is universally regarded as one such unacceptable deprivation (Crow 2011, Pers. Comm.). However, translating this principle of equity into practice is not easy.

A stated goal of the MUS approach is combating poverty, ensuring food security, and providing safe water for the poorest, most vulnerable sections of society. The problem is that food and livelihood security is tied to access to both water and land (Rijsberman and Molden 2001). Differences in access to land and water may stem from differences in age, gender distribution, social or economic class, political affiliations, or ethnicity. These differences manifest as differential rights to common resources, differential abilities to pay for goods and services, or differential abilities to participate in and influence decision-making.

Challenges

If MUS is to meet its goals of poverty alleviation and food security, it must overcome pre-existing inequities: the poor are poor because they lack livelihood options and live within social structures that exclude them. In this section, we discuss the challenges associated with overcoming gender, spatial, class, and social inequities.

Gender Equity in MUS

In many traditional settings, livelihood programs are often gender-biased. Project design therefore greatly influences the distribution of benefits. MUS projects could improve or exacerbate pre-existing gender stereotypes and also alter the gender dynamic of the community in unpredictable ways. For example, field visits to MUS projects in Ghana and Burkina Faso suggest that shea-butter extraction, pito brewing, and parboiling of rice are activities undertaken by women, while dry season gardening is considered to be mainly the work of men. Similarly, in Nepal, women traditionally have the responsibility of managing kitchen gardens, whereas men manage the field crops. Because the MUS projects in Nepal provided water and drip-irrigated kits close to the homes, kitchen gardens became lucrative sources of income. While this arrangement originally favored women, men are now increasingly involved in kitchen garden work, traditionally a female preserve.

CASE STUDY: GENDER IMPLICATIONS OF MULTIPLE-USE WATER SERVICES PROJECTS

Multiple-Use Water Services Projects aim to meet both the domestic and livelihood needs of communities. Because women and children bear most of the burden of collecting water for domestic needs, access to domestic water supply benefits women. However, the MUS projects could have differential gender impacts depending on which livelihoods are privileged in project design. As one study in Gujarat India shows, not all livelihood options have the same implications on gender equity.

The role of gender in MUS projects was assessed in a recent research study, conducted in nine villages in Gujarat, India. Six of the nine villages were classified as having a source of water, whereas three villages were classified as not having a source of water. In these non-source villages women had to walk more than 1 km in search of water.

The three non-water-source villages were characterized by rain-fed agriculture, severe water scarcity, lack of fodder, and out migration. The women in these villages spent more than two hours each day fetching water. But the quantities available were not enough even to meet their domestic needs, leaving very few opportunities for income generation. In contrast, the six villages with water sources had piped water supply, irrigation opportunities, access to green fodder, wells, and a thriving diary economy. The average daily per capita water use in the water-source villages (36 liters) was twice that of the non-source villages (18 liters).

Rural women need water not only for domestic purposes, but also productive uses. Sometimes the productive water needs of rural women conflict with the water needs of their male counterparts. Thus, how water supplied by a project is allocated between agriculture versus livestock greatly affects the gender impacts of development projects. In the case of agriculture, even though women spend a significant percent of their time on the farm, the decision-making on water provision and the income accrued from agriculture is controlled by the men in the household. In contrast, income from livestock is often managed and controlled by women. In the absence of irrigated agriculture, livestock is the primary source of income for the rural people in India. In non-water-source villages, lack of water affects how much livestock women can rear, but also time spent in finding fodder or grazing areas. Therefore, expanding opportunities for livestock watering empowers women's control and access to resources.

Source: Upadhyay, B. (2004). "Gender Roles and Multiple Uses of Water in North Gujarat." Working Paper 70. Colombo, Sri Lanka: International Water Management Institute (IWMI).

CASE STUDY: SOCIO-ECONOMIC AND INFRASTRUCTURE INEQUITY IN MUS PROJECTS

In Bangladesh the MUS approach has been implemented in three communities, Bashubehar, Magbari and Chandaikona, by the Rural Development Academy (RDA). In these villages, the households are clustered together at some distance away from the farm lands. Between 80-85% of the households traditionally depended on shallow wells fitted with hand-pumps to meet their domestic and irrigation demand. However, the water is high in iron and arsenic. In order address the quality problem, RDA installed deep boreholes fitted with submersible pumps which pump water into overhead tanks for distribution to households via a pipe network. The MUS model provides two tanks for each community, one for domestic use and another for irrigation uses. Community members can opt-in to the project by contributing to the capital costs or continue to use their wells.

The project has a water management committee that is responsible for collecting the 10% community contribution and managing the system. Research conducted in the three communities suggested that these projects produced benefits but also created some unanticipated problems on equity and access.

Benefits:

- Communities were able to increase their irrigation area. The project resulted in an increase in income for participating households.
- The quantity of water for domestic uses increased and the majority of participating households were satisfied with the service.
- The installation of iron and arsenic removal plants reduced the health risks for the beneficiaries compared to their traditional wells.

Problems:

1. The project depended on power availability for pumping, and this affected water availability during power cuts.
2. The water committee was not inclusive and was composed mainly of land owners who could afford the connection fee and often made decisions in their own favor. The committee did not encourage participatory decision-making and most decisions were made by the chairman.
3. More than half of the households could not afford the connection fee and tariffs. This resulted in inequitable distribution of the resource.

In this case study, the MUS approach had many benefits, but could not address existing inequities. Only the wealthy formed the water committee and made decisions which did not favor the poor households (53% of the village).

Fontein, M., W. James, and T. Paul. (2010). “Multiple-use Water Supply Systems: Do the Claims Stack Up? Evidence from Bangladesh.” Practical Action Publishing, *Waterlines*, 29 (1): 52-72.

Socio-economic inequity in MUS

Socio-economic differences pose challenges in MUS projects that are distinct from traditional rural water supply projects because the benefits derived from the project depend on access to additional assets such fertile land and capital. Access to land, social influence, and community norms affect the equity outcomes of MUS projects. There is a real danger that differential access to water for productive purposes could exacerbate income and power differences over time.

Large land owners are better able to effectively use water for productive purposes. Wealthier residents tend to have bigger and more fertile plots and the ability to grow cash crops rather than food crops. Agriculture consumes a lot more water than domestic uses, so land owners are able to "capture" a much greater share of the resource – leaving little water for non-landed users. Land tenure regimes vary considerably across countries. For instance, in Ghana, land belongs to traditional clan heads, unless acquired by the State (Gichuchi 2011; Larbi et al. 2011). The clan head has the right to grant land for communal or individual irrigation; community members who are not in the favor of clan heads may have limited access to land. In India, land ownership is private, but highly unequal. Over 43% of the rural population does not own land; land ownership is differentiated by caste: 77% of Dalits ("untouchables") and 90% of Adivasi (tribals) do not any land (PAC 2008).

In addition to capturing the lion's share of the benefits, the rich are also better able to cope with supply variability. When the sole water source in a community breaks down, the rich are able to get water from neighboring villages, build storage tanks, or dig their own wells. The poor, lacking the financial resources to buy water or transport water from distant sources, suffer. Differences in power or social position also influence access to water. For instance, even if there is in principle equitable distribution of communal irrigation water, the water arbiter often allocates at unfavorable times to poorest households, while favoring his own and other influential families in the community (Abele et al., 2008).

Finally, community norms on resource allocation could also influence outcomes. When deciding how to allocate communal land for MUS projects, communities often have norms based on marital status, age, cultural, or political affiliation. But these traditional rule-making processes may leave out the poorest, most vulnerable members of the community. For instance in one family in Ghana, families with children are often accorded priority in distributing land for small-holder schemes. But this process neglects the needs of widows and the single women without children, who could be even more vulnerable.

Infrastructure inequity in MUS

An important source of inequity in MUS projects arises in differences in access to infrastructure. In mixed-delivery MUS systems, some households received piped water at the home and others access water via standpipes. The cost of water to wealthier households that can afford a piped-connection is much lower than households that must walk to collect water at the public standpipe. Manual collection of water often precludes significant use of water for productive purposes. Thus, technical infrastructure design greatly influences distribution of benefits.

In MUS systems, the issue of fairness in how water shortages will be handled poses a particular challenge. Van Koppen et al. (2006) document the challenges posed by household-level storage. Storage capacity offers individual households the flexibility to adapt to variability in supply but may also encourage hoarding by some households, to the disadvantage of others. When some households have storage and others do not, having a storage tank is equivalent to having a tap on continuously. In such cases, if water is allocated to a particular outlet line for a fixed amount of time, households with storage may end up capturing all the water. In one such instance, in Utah village, South Africa, when users filled rainwater harvesting tanks with water from the main domestic system, other villages were left without any water. In another case in La Palma-Tres Puertas, Colombia, individual households started building household storage tanks to compensate for the infrequent supply. Over time, both the number and size of the tanks increased, so that when water was delivered it was only sufficient to fill the tanks of those who had built their own household storage, leaving the households without tanks with no water (van Koppen et al., 2006).

Priority of appropriation versus type of use
MUS projects could create implicit "water rights" that could preclude poorer households from access to water in the future. When MUS projects have an irrigation component, water supply could be interpreted as the creation of a water right. In this case, how to handle new users into the system poses a challenge. For example, in one system in Kenya, existing MUS users resisted the extension of the system to new households because all available water from the source was fully allocated (Davis, 2011, Pers. Comm.). In this case, the question of who had priority – new domestic water users or existing MUS kitchen garden users who had already made investments in drip irrigation systems – became a source of conflict.

Locational inequity in MUS
When unregulated sources such as rivers, streams, or dams are exploited for MUS projects and more than one community is using the source, inequity could arise between upstream and downstream users. This is an inequity issue because the upstream community has positional advantage. It can unilaterally divert large quantities of water in order to implement a MUS irrigation project, thereby leaving very little water for those downstream. Diversions by upstream communities could also contribute to water quality deterioration downstream. Because MUS projects are designed to be community-scale interventions, they permit upstream users to exert their positional advantage unfairly (albeit unintentionally). In the absence of watershed-scale coordination mechanisms, impacts of upstream MUS projects may not be apparent until construction is complete.

Operationalizing Solutions

Addressing land tenure and social inequities may be beyond the scope of MUS projects. In places where water rights are highly skewed, trying to correct water rights allocations can only be done through political action. Negotiating for water rights on paper is not likely to succeed or be helpful unless the poor have the ability put the right into use. However, there are specific steps that MUS practitioners could take to move the conversation in the right direction. For instance, van Koppen (2011, Pers. Comm) suggests that MUS projects create de facto “baseline rights” – once the poor start using a small amount of water, it creates a basis to negotiate from. Building the infrastructure first is better than a theoretical negotiation over water rights; the poor can then argue to protect that their relatively small water use should be to be given priority in a drought.

In order to operationalize equity into MUS projects we offer two types of suggestions: general approaches to ensuring projects are fair and specific solutions that may work in the context of MUS projects.

Institutions: constitutional rules promoting fairness

It is possible to formalize equity, by building it into the MUS water committee bylaws to ensure that the rights of the poorest are protected. For example, formally recognizing the principle of the human right to a basic quantity of water for domestic purposes could help clarify priorities when deciding shortage sharing rules during a drought. Mandating representation of minority ethnic groups and women in local water committees would ensure that these groups’ interests are protected.

Donors and NGOs initiating MUS projects at the community level should insist on inclusive planning and implementation. However, they should also recognize that communities have different languages, traditions, and cultures: imposing an equity solution externally may not work. Instead, bringing the traditional leaders on board is key. Traditional community laws should be strengthened by increasing awareness of the need for more inclusive, participatory decision making.

Institutions: higher-level coordination

In the case of upstream-downstream equity, use of inter-community alliances to negotiate water rights and allocation between upstream and downstream communities has worked in some places like Nepal. Local government offices could be trained to institute MUS conflict committees that consist of a committee member representing each MUS project. Instituting such a committee would help build recognition for the need for basin level coordination.

Techno-Institutional: communal gardens

In some situations, both land and infrastructure equity can be addressed by the promotion of communal gardens co-located near the water source. These communal gardens would involve relatively small plots of common village land rented out to the poorest, landless families. The proximity to the source would ensure that these households are able to benefit without having to invest in pipelines to their homes. The revenue from renting the community plot could go back into the village development fund, as was done in Kikware village in India. In the Kikware case, the water was allocated from a wastewater pond, which collected and partially treated domestic sewage from the village.

Technical: drip irrigation

Promotion of drip irrigation could help wealthier families limit their water use without adversely affecting their income. For instance, in one (non-MUS) case study in the Waghad medium irrigation project in India, tail-end farmers were able to renegotiate water allocation rules. Although the successful negotiation depended on a number of factors, including trust building and strong leadership, drip irrigation has played an important role in allowing head-end farmers to improve productivity despite lower allocations.

Technical: pipe sizes

Technical design of a project can promote or worsen inequity. In one case study in Kikware, India, following conflicts over allocation, pipe sizes were reduced for all households to ensure equitable allocation. Similarly, in another case in Nepal, negotiations between upstream and downstream communities involved negotiations over inlet sizes.

B) MUS could result in unsustainable use of water resources.

Context

MUS is a service-delivery approach that does not account for the dynamic and variable nature of the water resource base. MUS projects could result in unsustainable exploitation of the resource base because they involve abstracting much larger quantities of water than typical rural drinking water supply projects. If adequate provisions are not embedded into the project implementation, it may create serious conflicts or adversely impact downstream communities during subsequent droughts. If MUS is to upscale, long-term variability and future claims on the resource base must be accounted for.

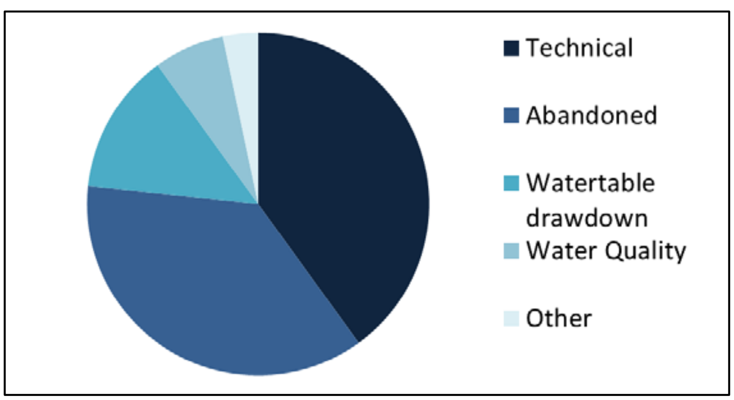

Figure 13. Reasons for water project failure

Source: Abele et al., 2008

The high failure rate of projects is a major problem in the water sector. Many of the problems associated with long-term failure arise from the break-down of service infrastructure – wells, pumps, and pipes – within a few years of installation. While very little data on reasons for failure of projects exists at a global scale, regional studies have been done.

One study in Ethiopia (Abele et al., 2008) found that 43% of projects had either failed or been abandoned. Of the causes of failure, 15% were attributed to water table drawdown. Another 37% of the projects were abandoned, in part because the community had resettled or the water sources had shifted or changed (Figure 13). In South Asia, the failure of drinking water projects because of falling water tables and rising pumping costs has been widely documented. With climate change and population growth, water resources constraints may become more of a problem in the future.

This suggests that the sustainability of the resource base is an important contributor to success and failure of water projects. However, despite its importance, the sustainability of the resource remains a relatively under-addressed area. Most solutions addressing "long-term project sustainability" focus exclusively on appropriate management measures such as cost-recovering tariffs, contingency funds, and designating responsibility for maintaining assets. There is a danger that the focus on service delivery rather than resource management may preclude hiring of engineers and hydrologists capable of understanding and mitigating the water resource implications of MUS projects.

Challenges

Regardless of the factors driving unsustainability, threats to the sustainability of the water resource base can have serious consequences. If the basin has no system of coordinating water use across communities, it could result in: a) water conflicts between communities in dry years; b) the failure of livelihoods, farming, and productive uses that were served by this water supply; c) unreliable supply that could push farmers who have made investments in vegetable gardens/drip irrigation kits into debt; and, ultimately, to d) water rationing and inadequate water availability.

Two types of conflicts that are more likely to occur in MUS projects have been documented: conflicts between upstream and downstream users and conflicts between domestic and agricultural users.

Upstream-downstream conflicts

MUS projects are more susceptible to conflicts over water resources than traditional WASH projects. Most productive uses of water (livestock and irrigated kitchen gardens) involve using water consumptively and the quantity of water provisioned in a MUS implementation (50-100 lpcd) is much higher than a drinking water project (25 lpcd). A number of MUS projects reported conflicts where downstream communities protested the increased upstream diversions and the conflict needed to be resolved before the project could be implemented.

Domestic-agriculture conflicts

A second type of conflict arises from the difficulty enforcing drinking water priority guidelines when domestic and productive water uses are combined in one system. Most governments accord priority to drinking water needs. MUS systems represent a unique challenge to enforcing this priority because water supply for both uses may be delivered through a single system.

At a watershed level, enforcing the drinking water priority is relatively simple if projects can be separated into drinking water and irrigation projects. In dry years, the outlet pipes to drinking water projects can be opened first, irrigation outlets are opened later. But if a large multiple-purpose dam serves both MUS and non- MUS projects, this prioritization system could break down. In Tarata, Bolivia, this specific problem of classifying MUS projects as "drinking water projects" led to violent conflict. In this case, large irrigators protested the MUS system being accorded the domestic water priority, because the MUS system serviced peri-urban farmers owning "kitchen gardens" as large as 1-2 acres.

Project failure due to water resources overexploitation

In much of South Asia and parts of Africa, the depletion of groundwater due to large-scale agriculture already poses a threat to the sustainability of drinking water projects. Many villages are listed as having access to water by the Millennium Development Goals standard and are served by a borewell-based drinking water scheme. But rapidly declining water tables are causing the borewells to fail, forcing villagers to become dependent on tankers (Vishwanath 2010) or to travel to distant water sources. Declining groundwater should be a concern to MUS practitioners. If farmers take loans to invest in drip-irrigation kits, seeds, or fertilizers, failure will leave farmers with a debt burden that they can no longer pay.

Higher costs due to lack of data

The lack of basic data needed to plan and design projects imposes additional costs on MUS practitioners. For instance, the RiPPLE Learning Alliance in Ethiopia (www.rippleethiopia.org) laments the lack of a standard system to gather and monitor data and information on available water resources, water infrastructure, water demand, and current access to these services. As a result, each organization must invest in collecting basic data, and different organizations use different approaches to collect primary and secondary data leading to inconsistent conclusions. Often budget constraints force implementers to make crude hydrologic assumptions in project design, further increasing the probability of failure.

CASE STUDY: CONFLICTS OVER DRINKING WATER PRIORITY IN TARATA, BOLIVIA

In Tarata, Bolivia, Bustamente et al. (Moriarty et al., 2004) report a case of violence that erupted over the expansion of productive uses in a peri-urban system near Cochabamba, Bolivia. Tarata, a small town of about 1700 households, receives water from the Laka Laka Dam, a multi-purpose dam which is shared with irrigators in nearby Abanico. When the dam was first constructed in the 1990s, the allocation was 5.8 Mm^3 to irrigators and 0.25 Mm^3 for domestic water supply in Tarata. The problem is that the water quality in the dam was discovered to be too high in sediment content to be suitable for domestic uses. Because Tarata also gets domestic supply from other sources, the city began selling the water to peri-urban areas where residents began to use poor-quality water for productive purposes. Peri-urban agriculture plots began to expand.

The original agreement between the irrigators and city was to prioritize drinking water, which was originally a small fraction of water use. However, over time two things happened: dam storage capacity, and hence water availability, declined drastically because of sedimentation; water availability dropped 25%. At the same time, demand from “domestic users” increased after the city of Tarata sold the poor quality water to peri-urban municipalities where users began to use the water for kitchen gardens. The conflict over the MUS system arose from:

1) The lack of a definition for how water rights should be prioritized when “urban water uses” were expanded beyond domestic uses to productive uses. The idea of high-priority domestic water being diverted to kitchen gardens angered the irrigators so much that they vandalized two drinking water pipelines into Tarata.
2) The original agreement specified that only users who had contributed to the dam construction were entitled to the water (i.e., the city of Tarata). The subsequent resale of water rights to peri-urban neighborhoods was therefore questioned.
3) During the period that Tarata was underutilizing its allocation from the dam (because the quality was so poor), the irrigators had expanded their water use and even sold rights to land which was not authorized to receive Laka Laka water so that irrigation rights were oversubscribed.

Source: Moriarty, P., J. Butterworth, B. van Koppen. (2004). Beyond Domestic: Case studies on poverty and productive uses of water at the household level. Delft, the Netherlands, IRC International Water and Sanitation Centre. Technical Paper Series, no. 41, p. 243.

CASE STUDY: UPSTREAM-DOWNSTREAM CONFLICTS : TORI DANDA

The case study illustrates the challenges faced during MUS project design and implementation with regard to resource allocation and how such conflicts could be resolved. The Tori Danda community, located in the western part of Syangja District of Nepal, has 29 households in grouped into three clusters. The upper, middle, and lower bands house different ethnic sub-groups: Giris, Brahmins, and Thakuris. Despite the fact that Tori Danda did not have enough water, a third of the total water consumption was for kitchen gardening and animal watering.

Identifying the MUS potential in combating poverty in the area, International Development Enterprises (IDE) through the Smallholder Irrigation and Marketing Initiative (SIMI) planned to implement a MUS project at Tori Danda community. However, due to conflicts between the three clusters over sharing of the resources, the project did not have a smooth take off.

IDE and SIMI staff first organized a community meeting to assist the community to implement a MUS project by rehabilitating an old reservoir of 2,700 liter capacity which was designed for domestic use. SIMI also proposed adding taps for Thakuri households and constructing a new reservoir (10,000 liter capacity) exclusively for irrigation to be shared with neighboring fields. The Giri households decided they were not interested in the project because they had sufficient water. The Brahmins and Thakuris were interested but did not trust each other. The upstream Brahmin cluster had customary right to take water first before the downstream Thakuris. Both Brahmin and Thakuris could not agree on owning and sharing the MUS project.

After six months had elapsed without any agreement, the SIMI staff constituted a water users committee, which negotiated a compromise by meeting with community members in each cluster and promising to install flow regulators to ensure equal sharing of the water. Both clusters eventually signed on, formally agreeing to share water equally, and released land for the construction of the reservoir. Having resolved the conflict, both clusters contributed 34% of the total project cost of US $1,941, while SIMI provided 48% of the cost which resulted in the rehabilitation of the old reservoir and construction of a new reservoir. Tori Danda community is considered to be a MUS success where residents experienced an annual increase in household income between $214 and $2143. Also, 9 of 11 interviewees in the village responded that women were now involved in making decisions about land preparation, variety selection, and hiring of labor.

Source: Khawas, N.S., M. Mikhail. (2008). Impact of Multiple Use Water Services in Tori Danda Community, Nepal. International Symposium on Multiple-use water service. Addis Ababa, Ethiopia, 4-6 November 2008.

Mikhail, Monique. (2010). “Opportunities Revealed by the Nepal Multiple-use Water Services Experience.” *Waterlines* 29 (1): 21–36. Accessed online at http://sei-us.org/Publications_PDF/SEI-NepalMultipleUseWater-10.pdf.

CASE STUDY: MALI – FAILURE DUE TO UNSUSTAINABILITY

In Mali, several MUS projects have failed because of overexploitation of the resource base. Yadiang and Ogodouroukoro, with populations of 2,473 and 612 respectively, are located in the north-eastern part of Mali. These communities depend on ground water extracted through hand-dug wells or boreholes for meeting the community's demand. Yadianga has two hand dug wells and four boreholes while Ogodouroukoro has three hand-dug wells and a borehole.

The boreholes were drilled and fitted with hand pumps by World Vision, Mali under the partnership of West Africa Water Initiative. Under cost sharing and community participatory agreements, the community contributes labor and US$175/well– an estimated 5% of the capital cost of the borehole, while World Vision covers the rest of the 95% capital cost. At the two sites, water from the hand dug wells and boreholes are used for domestic uses, washing, and animal watering. Research in the communities revealed that domestic water consumption accounts for 11% of the water use while the largest portion of the consumption goes to animal watering.

However, after completion of the project, it was observed that in Yadianga, only 17% of the households were accessing water from the boreholes, even though all had contributed to the initial capital cost of the facility. Reasons attributed the low use of the boreholes included breakdown of hand pumps and decrease in borehole discharge which always resulted in long queues of people wanting to fetch water. Further research indicated that the reduction in discharge was due to excessive livestock dependence on the boreholes water during the dry seasons (Gleitsmann et al. 2007). There are a few MUS programs in Mali but due to challenges of well drying from overexploitation, communities are advised to use the water for only drinking.

Source: Madamme Ly Fatoumata Kone, National Director of Hydrology in Mali, Pers. Comm, 2011.

Operationalizing Solutions

Because MUS, as currently envisioned, is a service-delivery approach focused on the provision of water to the poorest communities (as opposed to a basin-scale water resources management approach), MUS projects are ill- equipped to address issues that necessitate coordination at higher scales.

The vast majority of the MUS projects reviewed did not address the issue of resource sustainability in detail. However, a few different approaches to water resources management were documented. These approaches broadly fell into four categories, which are not mutually exclusive and sometimes must be undertaken simultaneously. Additionally, all of these mechanisms require data, monitoring, enforcement, and public availability of information:

A. Higher level (watershed or basin) coordination
B: Formal Institutions
C. Informal social norms
D: Technical design

A) Higher-level (watershed or basin) coordination

Some regions already have formal water licensing systems. In such cases, a formal permit to abstract water must be obtained from the government. If these already exist, MUS project managers should <u>use existing structures</u> to ensure that water allocation and shortage-sharing rules are clarified to the extent possible. This does not necessarily imply the existence of a strong centralized river basin organization run by water resources experts. For instance, several interesting cases of “bottom-up” coordination between upstream and downstream communities are documented in the MUS projects in Nepal implemented by IDE (e.g., Chattiwan Tole Cluster, described below). Here, there is a formal permitting scheme, which is documented by the Village Development Council. However, the water rights in implementing MUS projects were renegotiated directly between the concerned parties and registered officially later (see Case Study box).

B) Formal institutions:

Formal rules to limit water use were documented from various case studies that could be helpful to MUS practitioners. Formal rules typically involve rule-setting on the part of the water user committees and may include setting prices, penalties, and rotation schedules. Some of these include:

Pricing: The quantity of water use may be restricted indirectly by volumetric pricing. An interesting feature reported in a MUS project in Senegal involved a dual tariff structure (Davis, 2011). Cattle being brought to the trough were charged a lower rate than water carried away to the home in buckets. An attendant at the standpipe would enforce the dual pricing.

Rationing: In some MUS cases water extraction is limited by some form of rationing. Rationing rules typically involve specifying the frequency and time for which each outlet would be opened.

C) Informal social norms:

The use of informal social norms is also common. These involve users adjusting their own behavior based on verbally agreed upon or culturally acceptable norms such as the types of crops and volume of irrigation permitted. Although informal norms may occasionally involve consequences such as a penalty imposed by the village committee, often the consequences of public shaming or having to argue the case before the village council serve as a sufficient deterrent.

In other cases, informal norms may involve a convening of the elders in neighboring communities to ensure that agreements are negotiated on a case-by-case basis. In many areas, such tribal councils already exist and discussing the project and negotiating an equitable allocation agreement in advance of a MUS implementation may be possible.

D) System technical design

In some cases the quantity of water extracted by a MUS project may be physically limited by technology choice – a pipe of a certain size, a check dam embankment of a certain height. These may be designed to comply with water use agreements or permits discussed earlier.

Figure 84. Drip Irrigated Vegetables in Ozar, India

Photo credit: Veena Srinivasan

Technical: drip-irrigation kits

In addition to constraints at the project level, promoting drip-irrigation could be a practical way to bound water use. Indeed, many MUS implementations have already promoted drip irrigation kits with the view of productive uses with very little water. However, if drip-irrigation kits form an integral part of MUS projects, attention to the stability of the technology and supply chain issues is warranted. Some cases surveys suggest as many as half of the drip-irrigation kits were not being used in MUS projects, either due to blockages or breakdown of the water conveyance system and non-availability of spare parts (Abele et al., 2008).

CASE STUDY: HIVRE BAZAR: SOCIAL NORMS IN PROMOTING WATER SUSTAINABILITY

Hivre Bazar is considered one of the biggest success stories of the participatory watershed movement in India. A 1992 household survey showed that more than 90% of the families in the village were below the poverty line. There was bitter partisan fighting and high rates of alcoholism. Poor farmers depended on rain-fed agriculture while the richer farmers were borewell-dependent, running their pumps around the clock. No government official was willing to visit the village.

In the short space of twenty years, Hivre Bazar has been completely transformed. Today, no family in Hivre Bazar is below the poverty line. Nearly 100 families that had migrated to urban areas have returned to settle in the village. There is no shortage of drinking water or irrigation water. The village has won numerous awards.

The transformation has been attributed to the village head, Poppatrao Powar, who was elected in 1989. One of the first tasks he undertook involved construction of soil and water conservation structures to allow for more infiltration into the aquifer and less soil erosion. However, the story of Hivre Bazar is only partially about the physical works associated with watershed treatment. An equally important component of its success has been the establishment of social norms on wise use of water. Over a period of 20 years the villagers have evolved seven core principles to ensure that water resources are conserved and water is used wisely. These are:

1) Ban on tree-felling. 2) Soil and water conservation by the placement of boulders and rocks to minimize soil erosion. 3) Ban on bore-wells for irrigation – only open dug wells for irrigation. 4) Voluntary labor by every landed family to manage the watershed and common lands. 5) Ban on open grazing. 6) Ban on alcohol consumption and sale. 7) Ban on water-intensive crops like sugarcane and banana.

In addition, the villagers have worked with the local groundwater department to develop clear principles on how many irrigated crops are permitted per year based on that year's annual rainfall. This ensures that all water use remains within the natural recharge rate. The micro-watershed is one of the very rare places in this arid part of India where groundwater levels have remained stable. Because the village drinking water scheme runs on borewell water, drinking water is implicitly prioritized. There has been no drinking water scarcity in the last 11 years, in contrast with the surrounding villages.

Source: Veena Srinivasan Field Visit, July 2011.

CASE STUDY: NEGOTIATED AGREEMENTS ENFORCED BY INFRASTRUCTURE LIMITS

The Chattiwan-Tole cluster in Nepal provides an example of an informal water permitting project that was enforced by limiting the pipe size from a communal spring to the MUS project. The project was implemented by the International Development Enterprises (IDE).

The MUS system is fed by the Chitradurga mul, a perennial spring licensed to a family that registered the source with the Village Development Council (VDC) many decades ago and constructed paddy fields which are fed via canals from the spring. The canal, which supplies the family and its tenants, is operated via a Water User Association (WUA). The system is completely gravity-fed and the discharge of the spring is sufficient and does not change significantly from season to season. So there has been little need to regulate or monitor water use or constitute a Water User Association (WUA) within the MUS. Additionally, nearly 50 households depend on the spring for their domestic needs; these communities have a written agreement to use spring water for their domestic needs.

The Chattiwan-Tole farmers lobbied the VDC to allow them to construct a half-inch pipe from the spring to their homestead cluster. The subsequent construction of the MUS system depended on written consent from the VDC and the consent of the family. Although the downstream farmers were initially uncomfortable about the expansion of water use by the Chattiwan Tole farmers, the “fixing” of the maximum quantity abstracted by the use of a half-inch diameter pipe following protracted negotiations reassured them somewhat. The family was assured that sufficient water would be let into the canals to irrigate their fields. The pipe feeds two large storage tanks (total storage of 7000 liters), each of which has an outlet to a hybrid pipe located within each cluster. Each household has a flexible hosepipe located at the village tap which can be used to irrigate the field. Any water overflowing from the storage tank feeds back into the stream.

The Chattiwan-Tole case demonstrates two specific mechanisms to allocate water resources: first, a negotiated written agreement which in effect represents a permit to the community and second, the choice of a half-inch pipe and storage tank volume that physically limits the quantity of water the community can take.

Source: Mikhial M., and R. Yoder. (2010). “Multiple Use Water Service Implementation in Nepal and India: Experience and Lessons for Scale-Up.” http://sei-us.org/publications/id/11.

C) MUS could have unintended impacts on public health.

Context

MUS projects pose a number of unique public health challenges that go beyond lack of sanitation hygiene and wastewater treatment inherent in the water sector. Proponents argue that a major goal of planned MUS projects is to mitigate the public health risks of unplanned multiple uses of water. However, these concerns have been not formalized and practices to mitigate public health challenges have not been standardized in any way. Indeed, at present, identifying and mitigating the health risks is left to the skill and expertise of the practitioner. There is a real concern that poorly planned MUS projects could cause public health problems.

The public health risks associated with exposure to unsafe drinking water are well known. Infectious waterborne diseases such as typhoid and cholera remain a serious problem in many regions of the world and are prone to epidemics. In addition to the usual risks posed by pathogenic waterborne diseases, MUS projects pose additional public health risks that are unique, arising directly from the MUS goal of satisfying people's multiple needs in peri-urban and rural areas (Koppen et al. 2009).

MUS projects incorporate water uses beyond drinking, hygiene, and sanitation, including livestock watering, horticulture, crop irrigation, tree growing, fisheries, pottery, brickmaking, arts, and butchery. But these activities may generate new waste streams and create disease pathways that could adversely impact public health. If MUS is to upscale, MUS practitioners must be made aware of the potential public health hazards and plan for both *current* and *future* waste streams and take steps to protect public health and mitigate these risks.

Challenges

MUS projects could create public health risks from increased pollution from small-scale industry, livestock, and crop production, fecal contamination, and vector breeding sites.

Industrial contamination

If the productive use of water is small-scale industry, effluents (particularly chemical effluents) may not be treated, monitored, or reported.

Industrial water pollution is a major source of damage to ecosystems and human health throughout the world. Even small-scale industry can introduce a variety of different pollutants, including:

• Microbiological contaminants like bacteria, viruses, and protozoa;
• Chemicals from industrial activities like solvents and organic and inorganic pesticides, polychlorinated biphenyls (PCBs), asbestos, and many more;
• Metals such as lead, mercury, zinc, copper, and many others;
• Nutrients such as phosphorus and nitrogen;
• Suspended matter including particulates and sediments;

• Temperature changes through the discharge of warm cooling-water effluent; and
• Pharmaceuticals and personal care products.

Worldwide, it is estimated that industry is responsible for dumping 300-400 million tons of heavy metals, solvents, toxic sludge, and other waste into waters each year (UN WWAP Water and Industry). The amount of industrial water pollution in different countries varies greatly, based both on the amount of industrial activity in the country and the types of pollution-prevention and water-treatment technologies used by industrial facilities.

In many developed nations, significant progress has been made in reducing direct discharges of pollutants into water bodies, primarily through increased treatment of industrial wastewater before it is discharged. An OECD report found that in member countries in the past several decades, “industrial discharges of heavy metals and persistent chemicals have been reduced by 70-90% or more in most cases” (OECD 2006). In developing countries, on the other hand, more than 70% of industrial wastes are not treated before being discharged into water (UN Water Statistics). Even where pollution control laws exist, pollution enforcement, particularly in rural areas, is often weak.

Livestock contamination
MUS projects could pose public health risks from locating livestock watering places close to the water bodies. This is a problem prevalent in many “traditional” rural communal water bodies. In places where the same water source was used for livestock watering and domestic supply, if domestic water treatment is not carefully done, significant public health problems can occur. For instance, one NGO working in the Central Himalayan region of Uttarakhand, the Alaknanda Ghaati Shilpi Federation, reported that contamination in water bodies in their region was resulting in tapeworms and cysts in the brains of children aged 6-12 years. Preliminary investigations revealed that the sheep from a nearby breeding farm also drank water near the source and their excreta were contaminating the channel where the drinking water supply pipelines drew water. The water supply department lacked adequate water purification and filtration. Often chemicals such as chlorine and potassium permanganate were in short supply. (Alaknanda Ghaati Shilpi Federation, Pers Comm, 2011).

Nutrient and pesticide contamination
The vast extent of agricultural activities around the world contributes significantly to both economic productivity and water-pollutant loads. Since the 1970s, there has been growing concern over the increases in nitrogen, phosphorus, and pesticide runoff into surface and groundwater. A comparison of domestic, industrial, and agricultural sources of pollution from the coastal zone of Mediterranean countries found that agriculture was the leading source of phosphorus compounds and sediment (UNEP 1996a). Furthermore, nitrate is the most common chemical contaminant in the world’s groundwater and aquifers (Spalding and Exner 1993) and nitrate concentrations are increasing. According to various surveys in India and Africa, 20-50% of wells contain nitrate levels greater than 50 milligrams per liter, and in some cases as high as

several hundred milligrams per liter (cited in FAO 1996). Beyond nitrate contamination, agricultural activities are also linked to the salinization of surface water, eutrophication (excess nutrients), pesticides in runoff, and altered erosion and sedimentation patterns. The Food and Agriculture Organization (FAO 1996) has compiled a summary of common agricultural impacts on surface water and groundwater resources.

Vector breeding sites
Water-based diseases come from hosts that either live in water or require water for part of their life cycle. These diseases are passed to humans when they are ingested or come into contact with skin. The two most widespread examples in this category are schistosomiasis, which results from contact with snails that serve as hosts, and dracunculiasis (Guinea worm), which results from ingesting contaminated host zooplankton. Disease continues to spread where irrigation projects produce habitat that favors the host snails. Major outbreaks of schistosomiasis often follow the construction of large dams. In the Sudan, the construction of Sennâr dam led to the infection of nearly the entire nearby population.

Additionally, increased outbreaks of malaria and dengue fever were reported in some MUS projects due to the increase in breeding sites. In Senapuk, Nepal, greater productive use of water brought an increase in *Anopheles* mosquitoes and malaria as there were more pools of standing water around the village. In northeast Thailand, an increase in dengue fever was observed in the 1980s when water storage in jars was first promoted (van Koppen et al. 2006).

Operationalizing Solutions
In order to better address public health concerns related to MUS, we offer a series of recommendations below. These recommendations recognize that the original separation of drinking water and irrigation into separate administrative jurisdictions arose in part because of the recognition that drinking water must be of high water quality - so MUS projects must have an explicit plan to address drinking water quality. Projects may choose to treat all the water to a higher standard or promote point-of-use treatment.

Where contamination is the main concern, we suggest the following:

1) Raise awareness on water quality issues associated with industrial production, livestock, fertilizer use, and pesticide use. Training on water quality issues must be part of all MUS projects. Often the local population may not understand the cause-effect links between diseases and water quality. Early training on these will allow the population to respond effectively.

2) Ensure source protection from human and livestock contamination. There are many different ways in which this can be done: a) construct livestock watering facilities a sufficient distance away from public standpipes; b) protect sources such as boreholes and springs by covering them or otherwise barring livestock access; c) ensure that sewage outfalls and latrines are located a sufficient distance from water sources.

3) Disseminate affordable water-quality-testing kits to help communities monitor their own drinking water sources. Training MUS practitioners to use these and institutionalizing periodic testing into their practices is critical.

4) Promote point-of-use or communal treatment for domestic water where necessary. If the source of water is highly contaminated, one possibility may be co-locating communal "chlorinated water dispensers" at the water source (Kremer et al., 2008).

Where vector breeding sites are of concern, we suggest careful siting of MUS projects away from potentially affected communities. Some success has been reported with placing mosquito netting over jar tops in household storage or keeping small fish in the irrigation ponds (Vinnakota and Lam 2006). Promoting better drainage to carry water away from the homesteads is also beneficial (van Koppen et al. 2006).

Gaps in the MUS approach

In addition to the three risks identified above, there are certain gaps in the MUS approach. These are elements that are either missing altogether or are marginal to the MUS approach. In this section, we discuss the consequences of leaving out these elements and suggest some ways to integrate them into MUS.

A) Climate resilience is not considered in the MUS approach.

Context

Climate resilience is an important issue in MUS. Even without climate change, natural hydrologic variability poses a challenge. MUS projects are typically small, community-based projects that seek to improve the livelihoods of the most vulnerable populations. Most MUS projects do not create large surface water storage structures that can hold water across years and the populations they serve have very little ability to withstand multi-year drought. Climate change poses an additional threat to these vulnerable populations, over and above the natural variability in water resource availability.

Climate change is already impacting the availability of water globally. The most dramatic impacts of climate change will be felt in the water sector, affecting how, when, where, and how much water falls, how long it remains, and demands for water (Pachauri and Reisinger 2008, Bates et al., 2008). The earth has already seen a rise in global surface temperatures, and it is possible that the rate of warming is also accelerating. Current climate models predict that by 2100, rising greenhouse-gas concentrations will likely increase global mean surface air temperature between 1.1˚C and 6.4˚C compared to a 1980-1999 baseline (Meehl et al. 2007). Over the next 100 years, the intensity of extreme events, such as floods and droughts, will likely increase. In regions that are projected to see less precipitation, the increase in the intensity of precipitation events will be offset by a reduction in the frequency of these events (Meehl et al., 2007). Increased drought conditions in these regions will likely lead to growing water scarcity.

General Circulation Models predict a range of changes in global and regional climates, but these projections are at too low of a resolution to be used in direct planning for regional water availability and supply changes. Projections from climate models provide ranges of particular impacts based on potential greenhouse gas emission scenarios. They result in a range of impacts that are uncertain, but can provide general trends of warming and variation in precipitation. This variation in the timing, frequency, and intensity of precipitation events, along with rising temperatures, will have diverse impacts on regional water systems that cannot always be easily anticipated or measured.

Challenges

Climate change and social variability are already pushing farmers from rural areas and to pursue non-farm forms of livelihood. Several authors have documented the way in which seasonal and longer term migration to urban areas has become a way that many in South Asia have supported families in rural areas (Chopra and Gulati 2001; Mudrakartha and Madhusoodhanan 2005). The urbanization of the world, where more people live in cities than in rural areas, has thus been an adaptation strategy for insecure rural livelihoods arising from water, land, and resource insecurity. Further climate variability and impacts on water availability have the potential to increase livelihood insecurity in rural areas.

Operationalizing Solutions

It is important for MUS projects to incorporate climate resilience into the planning and design of MUS projects. Given the absence of clear guidance on how to use climate projections at the community scale, the only viable pathway to improving climate resilience is by focusing on strategies that can better address hydrologic variability. Improving climate resilience includes both institutional as well as technical solutions.

Institutional: adaptive management

MUS projects must allow flexibility to deal with climate variability. Water committees must pay explicit attention to climate variability. Equitable shortage-sharing agreements must be built into the rules.

Institutional: shared data

Incorporating climate resilience into MUS project design will require more information about the quantity of water resources available and amounts of water used by all water users. The problem is that in most developing regions, there are multiple users and managers of water, from community borewells, household wells, dug wells, and surface reservoirs, and often limited or no reporting requirements. The information on the status of these various supplies is held by individuals and groups, but is not commonly available. The lack of shared information on the water system cripples the ability of all water managers to plan in the face of uncertainty. Hydrologic data that is made available by all users in terms of depth to groundwater, quality of water, and surface water storage can help the multiple water users better assess the state of the system, plan for chronic or short-term water scarcity, and better manage limited water supplies.

Technical: source diversification
Given the variability in climate, MUS projects need to use multiple sources in addition to multiple uses. In particular, the use of both surface and groundwater conjunctively has long been understood to be an important mechanism in overcoming variability in surface water supplies. Groundwater is known to be a buffer against drought in many regions of the world. Managed well, groundwater can help balance seasonal scarcity of water. However, there is a real danger of groundwater overdraft eroding this "buffering capacity" and many regions around the world are seeing catastrophically declining groundwater tables. In such cases both augmentation of groundwater recharge and restrictions on use are necessary.

Increasingly, traditional systems of water management throughout the world are being revived as important climate resilience strategies. For example, dug out wells once common in much of the rural developing world are now considered an important strategy for water security; they capture water for long enough periods to allow rainwater to percolate into the ground. Farm ponds also serve a similar purpose. In South India, the system of temple tanks is also being revitalized to counter excessive overdraft of groundwater leading to salinization of coastal aquifers.

Technical: additional storage
Water storage becomes increasingly important in situations where water availability is concentrated in shorter periods of time, and when both floods and droughts are a problem. During periods of heavier precipitation, more of this water needs to be captured and stored when possible to help balance out inter- and intra-seasonal water scarcity. In a MUS context, numerous options for storage exist and should be explored as part of a climate-resilient system, including dug wells, farm ponds, community or household water storage tanks, and underground storage.

B) Ecosystems are a missing "user" in the MUS approach.

Context
The MUS framework currently focuses exclusively on meeting anthropogenic water needs. By adopting a purely "service delivery" approach to meet human water needs, with no regard to the limits of the natural system, MUS projects could damage critical ecosystem services. The natural environment is an important but highly underrepresented voice in the conversation about MUS.

Freshwater ecosystems in rivers, lakes, and wetlands contain just a fraction—one-hundredth of 1 percent—of the Earth's water and occupy less than 1% of the Earth's surface (Watson et al. 1996:329; McAllister et al. 1997:18). Yet these vital systems render services of enormous global value: fish for food and sport, biodiversity, mitigation of floods, assimilation and dilution of wastes, nutrient cycling and restoration of soil fertility, recreational opportunities, aesthetic values, and transportation for both people and goods. Research suggests that freshwater ecosystems are disappearing at an unprecedented rate. Myers (1997:129) estimates that half of the world's wetlands were lost in the 20th century. Another review of 344 internationally recognized wetlands sites showed that 84% were either threatened or experiencing ecological changes from anthropogenic causes (Dugan and Jones 1993: 35-38).

Humans already use over half of the available freshwater supplies globally (Postel and Daily 1996), and this fraction is likely to rise. The concern is that further expansion in drinking, agricultural, and industrial water abstraction will damage freshwater ecosystems, and along with them the numerous life-supporting services natural ecosystems provide. The loss of ecosystem services could have unintended consequences on the livelihoods and cultures of the very same populations that the MUS projects are supposed to serve.

Challenges

From our reading of MUS case studies, we found very little or no mention of the quantity of water reserved for ecosystems needs, though there are documented quantities of water for domestic, industrial, and agricultural use (e.g. in Faurès et al., 2008; Ezeji 2008). The natural environment is not recognized as a legitimate water user during MUS project planning and implementation.

However, integrating environmental concerns into the MUS framework is not a straight-forward matter for several reasons. First, complexity: the causes of ecological degradation tend to be complex and attributable to multiple factors: water quality, water quantity, habitat fragmentation. Second, scale: the spatial and temporal scale of ecosystem degradation rarely coincides with water management regimes. Ecosystem boundaries rarely fall within the jurisdiction of a single water agency and the time-scale of degradation is cumulative and rarely attributable to a single borehole.

<u>The complexity problem:</u> There are multiple, complex pathways of ecological destruction that could arise from MUS through decreases in water quantity and quality.

Water quantity: Water depletion, habitat destruction, and invasive species are three of the biggest threats to ecosystem functioning. In most developing regions, any water use within the basin – whether for human consumption or by evapotranspiration by natural vegetation or agriculture – comes out of the same resource base. Both surface-water and groundwater-dependent ecosystems are vulnerable to excessive extraction of water for human uses. As currently conceived and designed, the MUS framework usually estimates water needs for human and livestock populations. This ignores the fact that natural vegetation and aquatic species require water to survive too. Moreover, even if decreases in average water quantity itself may not be fatal, the timing of these flow decreases may be important. For example, the complete drying of rivers during the dry season or a drought is catastrophic for aquatic ecosystems; fish need a minimum volume of flow every single day, not an average flow.

Finally, land use practices also result in the destruction of aquatic and terrestrial ecosystems. Deforestation may result in soil erosion and siltation of water bodies so that water storage capacity decreases over time. Conversion of natural landscapes to kitchen gardens, new homes, or productive agriculture all result in habitat losses, impairing ecosystems and adversely affecting the species that depended on these landscapes. Land use changes and depletion of surface water systems can also disrupt native ecosystems to the extent that invasive species can thrive, exacerbating these impacts.

Water quality (pollution): Municipal and industrial uses typically consume less water than irrigated agriculture; most of the water eventually returns to the environment, but at a diminished quality. Water quality problems arising from pollution due to residential sewage or industrial discharge may also result in ecological destruction. Lake eutrophication and “dead rivers” that only carry sewage are already common in developing world cities. In many parts of the world, non-point-source pollution is increasingly a problem. The rising use of chemical fertilizers to boost crop yields and soil erosion from deforestation and land disturbance generally all contribute to decreases in water quality. Soil salinization (due to over-irrigation) and salt water intrusion (when groundwater over-extraction occurs in coastal areas) are severely affecting surface vegetation in many places.

Water quality and quantity combined: Although these have been listed separately, water quality and quantity are often inter-linked. Reduction in flows reduces the dilution ability of natural water systems, making water quality a problem, even if there is no change in actual pollutant loading. Likewise, decreases in groundwater levels in coastal regions may result in salt water intrusion, and large-scale irrigated agriculture may result in soil salinization. Wastewater return flows, from both domestic and agricultural uses, typically impair the quality of receiving water bodies.

Scale problems

The second challenge with integrating environmental concerns into MUS projects is that the spatial and temporal scales of decisions and observed impacts on the ecosystems do not match. Ecosystems cross community boundaries and the impacts on ecosystems are cumulative and not easily attributable to individual water projects. Including the environment into MUS requires a holistic understanding of the linkages between the land and water in the watershed. In contrast, because MUS are focused on servicing user needs, the user community, not the watershed, is the unit of analysis. Additionally, the service delivery focus of MUS projects does not lend itself to including environmental considerations, which really have to do with water resources availability.

In order to mitigate environmental impacts, conservation priorities would need to be defined. But even if the environment were to be considered as a user in MUS projects, the details must necessarily vary from case to case. What is the purpose of conservation? Is it to preserve the natural system even if at a lower level of flow? Is it to ensure a minimum dry season flow? Is it to protect specific species? Is it to protect a specific area which provides habitat for a number of species? The specific steps incorporated would depend on these larger objectives.

Operationalizing Solutions

The scale and complexity of environmental problems implies that they cannot be easily addressed within a typical MUS implementation. To seriously address environmental concerns, MUS projects would also have to pay attention to the watershed as a whole, which may require embedding MUS projects within a participatory watershed management project or at the very least obtaining agreement between all users in the watershed on local conservation priorities.

In cases where MUS projects are implemented in biodiversity-rich areas, such an effort may be critically needed. In such areas, MUS practitioners may be able to address environmental concerns by joining forces with local conservation efforts or aligning with payments for ecosystem services (PES) schemes. A range of technical, data, and economic activities can be undertaken to protect ecosystems within the context of a MUS implementation.

Raising awareness

Raising awareness among MUS practitioners is an important first step. This may involve convincing project engineers that ecosystem water use is legitimate and confers additional benefits on the community, in the form of ecosystem services. A second challenge lies in demonstrating linkages between human action and ecosystem degradation. Even if populations value ecosystem services, the cause and effect may not be clear. Often sand is mined from rivers for construction purposes, crops are cultivated on hill slopes, trees are cleared along the edges of water bodies for fuel and farming. These activities negatively affect natural water flow and result in erosion, silt accumulation and turbidity, and flooding. Environmental education and training is needed to help users understand these linkages.

Environmentally friendly project design

MUS projects could incorporate environmental protections into the project itself, either in the form of dedicating some percentage of the water developed to instream flows or groundwater recharge projects, or dedicating funding toward environmental protection or wastewater treatment.

Water quantity accounting

Better data on water availability and use would enable engineers and hydrologists to apportion the quantity of water that can be taken from the system for drinking, irrigation, and other uses so that the ecosystem could still be sustained. Environmental impact assessments may be used to determine the minimum water flow required for sustaining aquatic and surface vegetation.

Water quality monitoring

MUS projects could induce prolonged changes in quantity and quality issues such as salinity, nitrate pollution, and accumulation of heavy metals. Developing low-cost monitoring kits and simple communication tools to help local communities monitor the state of their natural environment would be informative.

Giving environment a "voice"
It is important to give the environment a "voice" in water committee decision-making, especially when there are critical ecosystems involved. Environmental concerns could be embedded into the water committee bylaws if local stakeholders prioritize this. At the community level, where customary water management and laws exist, it may be possible to find ways to incorporate these concerns into the formal rules to ensure success.

Aligning incentives through PES schemes
If stakeholders do not prioritize the environment, the only option available is to align farmer incentives with conservation goals. In such cases, one way to factor in the environment within MUS is work with payment for environmental services (PES) schemes which can pay farmers for investing in positive environmental practices.

C) Sanitation is neglected in the MUS approach.

The MUS approach proposes a new set of linkages in the water sector, in effect decoupling sanitation and hygiene from water, while adding livelihoods. As a concept, MUS slices the water sector in a particular way, weakening previous associations (drinking water and sanitation/hygiene), while strengthening new ones (domestic water and small-scale agriculture). There is a concern that the MUS approach may further set back sanitation funding.

Context

Over the last few decades there has been increasing recognition of the importance of sanitation in a comprehensive approach in the water sector. The term WASH was coined by the Water Supply and Sanitation Collaborative Council (WSSCC) specifically to recognize the inter-linkages among the water, sanitation and hygiene components of an integrated approach to tackling water related diseases. In September of 2000, when the United Nations General Assembly adopted the Millennium Development Goals, improving access to water was recognized as a key principle and included as Target 10 of Goal 7: "Halve by 2015 the proportion of people without sustainable access to safe drinking water" (UNDP 2003). The lack of recognition of sanitation at this time led WSSCC to initiate a WASH advocacy campaign. In recognition of the critical role of sanitation in protecting human health, the World Summit on Sustainable Development in 2002 expanded this target to include improving access to basic sanitation: "We agree to halve, by the year 2015, the proportion of people who are unable to reach or to afford safe drinking water (as outlined in the Millennium Declaration) and the proportion of people who do not have access to basic sanitation. . ." (United Nations 2002).

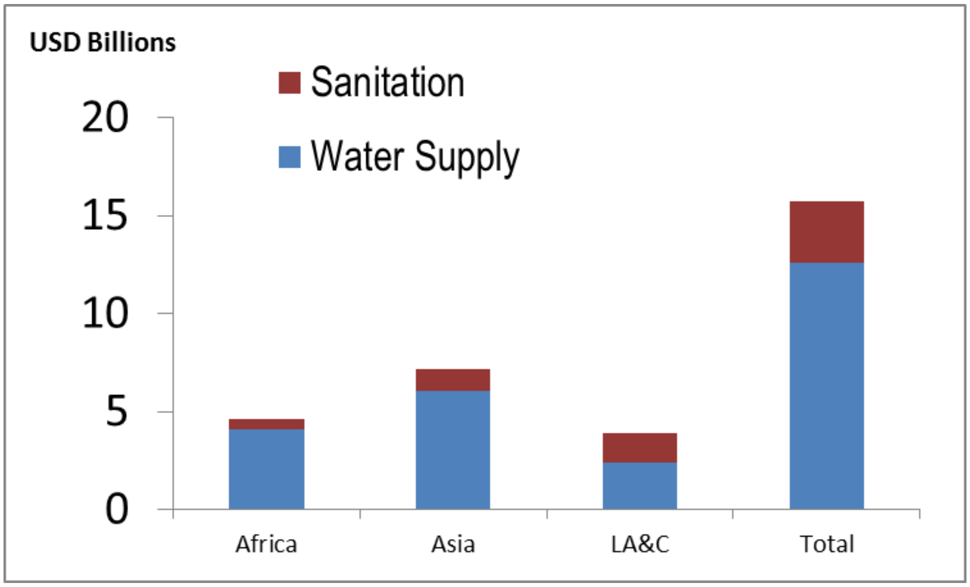

Figure 15. Total annual investment in water supply compared to total annual investment in sanitation in Africa, Asia, Latin America, and the Caribbean, 1990–2000

Source: WHO and UNICEF 2000.Global Water Supply and Sanitation Assessment 2000 Report

Worldwide, waterborne diseases remain the leading killers of children under five years old; more people die from unsafe water annually than from all forms of violence, including war (WHO 2002). Additionally, severe and repeated cases of diarrhea contribute extensively to childhood malnutrition. Untreated sewage is a serious concern globally, with the UN estimating that over 80% of the sewage in developing countries is discharged untreated into water bodies (UN WWAP 2009). Human waste can pollute sources of water available to the community and impact the ability of that water to serve agricultural and livelihood needs. Numerous studies have documented the negative impact of poor water quality due to pollution on livelihoods and food production, including reducing the productivity of aquaculture and livestock breeding (Palaniappan et al., 2009).

The links between sanitation and human health are well established. Sanitation plays a critical role in stopping the spread of waterborne disease. Diagrams detailing the spread of diarrheal disease demonstrate that safe sanitation, because it stops the fecal-oral route for spread of disease at its source, is effective at closing off a number of areas of potential transmission. The World Health Organization (WHO) has compiled studies showing that hygiene education and sanitation are significantly more effective at reducing diarrheal disease than improved water supply (Table 1).

Table 1. Percent Reduction in Diarrhea Morbidity by Various WASH Interventions

Hygiene Education	45%
Point of Use Water Treatment	35–39%
Sanitation Improvements	32%
Water Supply Improvements	6–25%

Source: WHO 2004: http://www.who.int/water_sanitation_health/publications/facts2004/en/index.html

Unfortunately, for many decades, sanitation and hygiene have been largely ignored or underfunded (Figure 15), despite the fact that in almost every country in the world, more people live without adequate sanitation than live without safe drinking water. For years, international agencies, development banks, donors, country governments, and NGOs have put fewer resources and attention toward sanitation and hygiene as compared with water. This has left 2.6 billion without sanitation in 2004, a relatively minor improvement in the total number of people without sanitation in 1990.

Challenges

Despite the importance of sanitation, there is controversy about the value of incorporating sanitation into MUS. Indeed, MUS proponents suggest three separate arguments on why sanitation does not need to be part of MUS; 1) requiring sanitation interventions in MUS projects would further expand the scope of what is intended to be a specific and targeted intervention in the water sector; 2) MUS projects boost income that can be used by beneficiaries on sanitation – so MUS indirectly improves sanitation; 3) in any case, the MUS approach does not preclude sanitation; sanitation and hygiene interventions can and have been included when appropriate.

We argue that achieving sanitation for all global citizens is a key development imperative. The human health benefits of sanitation are compelling. The argument that sanitation and hygiene will follow income growth represents a philosophic shift away from the Millennium Development Goals which view the satisfaction of basic needs as key contributors to development, rather than outcomes of development. There is a good case that sanitation interventions should be undertaken as part of or in parallel to MUS projects for three reasons:

1. There are real dangers to leaving the sanitation component out of MUS projects. The failure to incorporate or address sanitation could lead to waterborne disease, eliminating the health gains of MUS projects from improved nutrition.
2. Neglecting sanitation and wastewater management could also lead to widespread pollution of the water sources and eventual project failure. Polluted water that cannot be used for drinking, bathing, industry, or agriculture effectively reduces the amount of water available in a given area, directly impacting water quantity. The more polluted water is, the more

difficult it is to treat it to useable standards. Similarly, polluted water can reduce or eliminate the viability of many livelihoods; both adequate *quality* of water and adequate *quantity* of water are needed to support livelihoods (Palaniappan 2010).

3. At the same time, there are many opportunities to undertake sanitation interventions as part of MUS implementation in ways that boost the nutrition, livelihood, and health benefits of a MUS project. The MUS approach offers opportunities for water reuse that do not exist in traditional drinking water projects. By combining domestic and productive uses, MUS offers a unique opportunity to match water quality to water uses.

Operationalizing Solutions

Eco-sanitation

Eco-sanitation, a method promoted by various development agencies including the Stockholm Environmental Institute (SEI) and *Deutsche Gesellschaft für Technische Zusammenarbeit* (GTZ), is based on closing the nutrient loop in sanitation and moving away from conventional waterborne sanitation. In addition, a core tenet of eco-sanitation is that human excreta contains valuable nutrients that can be used to help enhance food security when treated and handled properly.

According to Esrey et al. (2003), ecological sanitation (EcoSan) can be defined as a system that prevents disease and promotes health, protects the environment and conserves water, and recovers and recycles nutrients and organic matter. There are numerous technologies and approaches that are recommended through an EcoSan approach, including dry toilets as well as small-scale wastewater treatment through alternative approaches. There are many overlaps in the goals of EcoSan and MUS in terms of improving nutrition and health. These two philosophies are also complementary in the scale of intervention at the community level.

Wastewater reuse – "locally closing the loop"

If you provide domestic water to a settlement, there is going to be wastewater. Agriculture can often use lower quality water and could potentially reuse this wastewater. Because MUS projects combine domestic and productive water supply, MUS offers the potential to develop low-cost "closed loop" solutions that use domestic waste streams for agriculture. If done safely, these could boost both the public health and nutrition outcomes of MUS projects.

CASE STUDY: ARBORLOO ETHIOPIA

The Arborloo Toilet is an excellent example of a low cost sanitation option developed in East Africa that can provide food security as well as improve household sanitation. Catholic Relief Services (CRS) first introduced the Arborloo in Ethiopia in 2005 in order to break through barriers to achieving sustainable and scalable sanitation such as the high cost of conventional pit latrines in relation to the low income and assets of the rural poor.

Arborloo is a shallow pit latrine topped by a smaller-than-usual concrete slab, which is moved every year or less, with the old site used to plant vegetables or fruit trees. Once filled, the pit is topped up with 15 cm of good topsoil. A new pit is dug and the slab and superstructure are moved to the new pit. The standard design is suitable for use by one family of 5-to-6 people for a year. The pit is also an ideal size for tree planting. Soil and ash are added to the pit after each use, which helps with the composting of the excreta and keeps away smell and flies.

Anecdotally, CRS reports success, with villages embracing the concept enthusiastically and reported quadrupled yields of papayas or squash. The Arborloo is only appropriate where there is sufficient land to relocate latrines (therefore not possible in urban or peri-urban areas).

Source: Catholic Relief Services

Applying wastewater on agricultural fields is already practiced in the developing world, although there is a lack of reliable information to support the extent of this practice (Jimenez et al. 2010). There are limited reporting standards in place, and farmers are generally reluctant to report in the event that the practice may reduce product sales. Over the last few decades, land application of partially treated or untreated wastewater has been documented in Paris, China, India, Vietnam, Mexico, and many other countries. In some countries, regulations have been set to ensure that recycled water is safe for agricultural use. However, most wastewater reuse projects are large scale, involving centrally collected and treated sewage used in peri-urban farms. MUS offers an opportunity to incorporate wastewater reuse into rural water supply and sanitation projects.

Figure 16. Arborloo built by Catholic Relief Services
Photo credit: Catholic Relief Services

Figure 9. Wastewater collection pond used for irrigation in Kikware, India
Photo credit: Ratnakar Pawar

Although there are cultural and legal barriers, solutions exist.

- Many cultures are very resistant to direct use of wastewater. One solution may be applying the water to non-food crops, such as cotton, or biofuels.
- National laws often discourage wastewater reuse. There have been a few attempts to incorporate sanitation and wastewater reuse in Colombia, but these are currently illegal. Inconsistent regulations or impossibly high (and unnecessary) water quality standards pose a problem.
- Often in rural settings, land is not a constraint and settling ponds and low-cost secondary treatment is feasible.
- There is a need for affordable water quality testing kits in recycling efforts, particularly where there are industrial effluents.

CASE STUDY: WASTEWATER REUSE IN KIKWARE, INDIA

One of the few existing examples of the incorporation of wastewater reuse and sanitation concerns into a MUS implementation by IDE International is the case of Kikware village in Maharashtra, India. While a lot of the initial work in Kikware was essentially a watershed management program (see Hivre Bazar), Kikware at the same time implemented the government-sponsored Sant Gadge Baba Village Sanitation Scheme. This project meant to create incentives for community action on sanitation and encouraged communities and schools to become involved in breaking the fecal-oral contamination chain by changing behavior. Some of these implementation activities included the construction and use of dry-pit latrines, garbage disposal, soak pits, and promotion of hygiene practices.

As part of the sanitation campaign, the villagers were encouraged to move animals and compost pits from the village out to their farms. Then, most households constructed a 3 foot by 3 foot by 5 foot soak pit by their houses, which was then filled with gravel. A pipe was inserted to carry water from the bathroom and kitchen to the center of the pit. The remaining houses were connected to village gutters to remove wastewater.

Every 100 feet, the drainage system was covered with chambers where the drainage was collected for solids to settle. In order to avoid problems with festering wastewater, Kikwari villagers decided to establish a wastewater recycling system. The drainage water was piped to a collecting tank at the edge of the village. The drainage system was designed to avoid choking due to household debris, and, as such, connecting latrines or septic tanks to the greywater drain is not allowed. From the primary collection tank where all heavy materials settle, the greywater passes through two sand filters and is stored in a second tank.

Every day approximately 13,000–14,000 liters of recycled water is collected. It is then used to irrigate a 1.5-acre community garden. The collected wastewater was auctioned to the local women's self-help group which used the water in a communal plot. Both the land and water rents went to the village council's coffers. The women's group decided to cultivate the plot with fruit trees and sell the produce to augment their incomes. A second wastewater collection tank was built near the primary school, which uses the same type of recycling system and irrigates the ornamental plants around the school.

Source: Mikhail, M, and R. Yoder. (2010). "Multiple Use Water Service Implementation in Nepal and India: Experience and Lessons for Scale-Up." http://sei-us.org/publications/id/11.

IV. MUS in the Context of the Water Sector

The Water Sector Funding Landscape

As has been discussed previously, management of water resources has been hampered by the variety of specialized approaches to water management and development. In the last several decades, many different approaches to integration in the water sector have emerged: Integrated Water Resources Management (IWRM); Participatory Watershed Management (PWM); Payments for Ecosystem Services (PES); Water Sanitation and Hygiene (WASH); and most recently, Multiple-Use Services (MUS) (Figure 18).

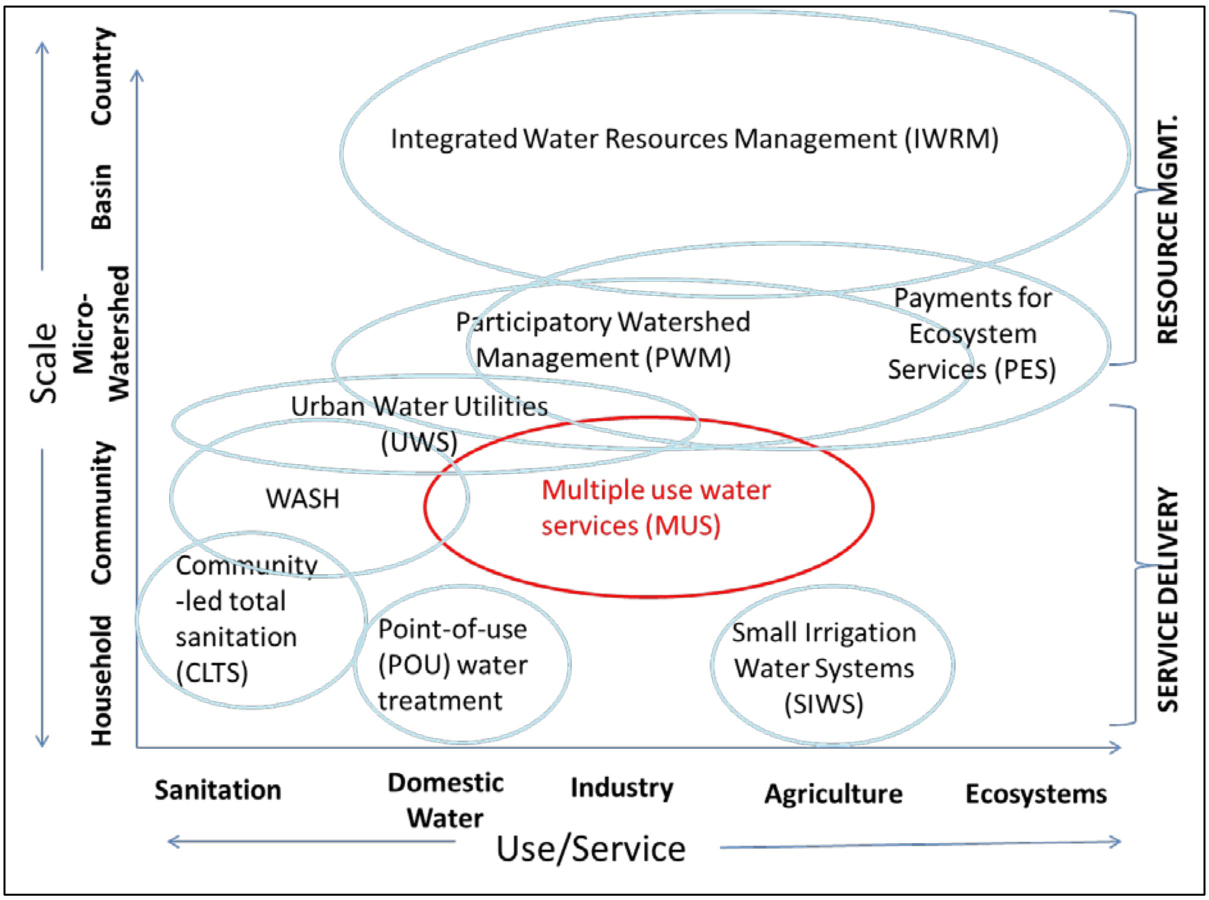

Figure 18. Landscape of water sector approaches

Each of these approaches is slightly different in terms of their emphasis and scale of interventions in the water sector. We elaborate on these differences further in the sections that follow. Given the extremely complex environment, it is challenging to develop a water framework that serves all purposes for all people. Therefore, it is important to understand the niche served by MUS projects and how MUS complements other approaches.

Four types of distinctions in water sector approaches can be discerned: the scale of the project, the uses targeted, the project goals, and the tools used.

Scale

A primary way of distinguishing between the different approaches is the scale of operation. The scale of operation dictates the complexity and size of the project, the level at which decisions are made, and metrics of success. For example, point-of-use treatment (POU) methods aim to improve water quality at the point of use, within a household. Accordingly, success is measured by the improvement in household water quality by comparing households that use POU methods versus those that do not. At the other end of the spectrum, Integrated Water Resources Management (IWRM) aims to achieve co-ordination between agencies at the basin or state level. Success is very difficult to measure at this scale because comparisons would have to be made between countries that have undergone IWRM versus those that have not. At the national scale, there are too many confounding factors to attribute differences in observed outcomes to IWRM alone. This accounts, in part, for the difficulty that IWRM practitioners have had in defining metrics of success. Multiple-use Water Services falls in the middle of the scale-spectrum. Many MUS projects occur at the community scale, so the benefits and costs of MUS can be understood by comparing similar communities within a watershed. Indicators would accordingly use community-scale metrics such as fraction of households participating, or total income generation.

Uses

A second way of distinguishing between different water sector approaches is by considering the types of uses. Most water sector approaches target one or two uses, such as drinking water and sanitation or small or large agriculture. WASH interventions typically including drinking water and sanitation but not agriculture or livestock. Others, such as “Payments for Ecosystem Services,” explicitly include environmental or ecosystem uses. MUS targets domestic, agricultural, and small-scale industrial water use, but does not appear to consider the environment. Some MUS projects have had a sanitation component, but sanitation doesn’t appear to be integral to the MUS approach.

Goals

In terms of goals, different approaches address either “water services delivery” or “water resources management.” Water services delivery frameworks typically try to solve the problem of getting water to the end user at the time, quantity, and quality needed. This is also known as the “last mile” problem. On the other hand, water resources management frameworks try to solve the problem of managing the resource sustainably and allocating water to the appropriate agencies, sectors, or regions. In water resource management approaches, the “last mile” problem is left to the individual agencies to solve. In water services delivery approaches, the resource problem is considered to be either minor or handled by some other agency. This distinction between water resources management and water services delivery (Muller 2011, Pers. Comm.) is a practical way to bound interventions in the water sector.

Integrated Water Resources Management (IWRM) focuses on sharing and allocating the resource base via regulations, water rights, or other forms of water resources allocation across stakeholders, users, departments, political entities, and the like. Even where IWRM offers guidelines on water delivery, such as for rural water supply schemes, these guidelines are concerned more toward the supply side rather than the demand aspects of the schemes. Participatory Watershed Management, like IWRM, stresses sustainable management of water resources by a local watershed community. In Participatory Watershed Management (PWM) the water users are also the managers. In contrast, van Koppen et al. (2009) describe MUS as a "people before resources" approach. MUS projects focus on people, their need for water, and their development goals and addresses how best to meet these. MUS interfaces between service providers and users and achieves "integration where it matters most" at the level of the use community, but there is a need to also achieve integration at higher scales (van Koppen et al., 2009).

Tools

A final difference is in the type of activities or tools used in each approach. Although the complexity of the water sector means that any water sector approach must include both "soft" (management institutions) and "hard" (infrastructure or technology), the different approaches appear to favor certain tools over others mainly for historical or ideological reasons.

IWRM may involve a range of institution building (creation of a basin-level organization, a new water-permitting scheme) or infrastructure (small dams) or economic incentives (pricing, water rights auctions) or even land and watershed management. However, our global review of IWRM interventions suggests that, in practice, very little new infrastructure has been created through IWRM. In contrast, MUS interventions as currently practiced are invariably linked to a specific water supply scheme. That is, there is always tangible infrastructure associated with a MUS intervention. MUS practitioners emphasize that MUS addresses both the "hardware" and "software" components, but the software components of MUS are not as well articulated as the technologic solutions.

One of the criticisms of IWRM has been has been that its objective for coordinating water allocation at the basin scale is an ambitious, if not impossible goal. The MUS approach ignores the allocation problem by focusing exclusively on the needs of human users, without addressing the bigger challenge of water entitlements. However, MUS does not attempt to address the problem of basin-wide coordination. In "open" basins, where water resources are not fully allocated (much of Africa), this may not be a problem. But in "closed" basins, where all the water is already fully allocated, ignoring water allocation will pose a problem.

Literature Review of IWRM

In the last twenty years, Integrated Water Resources Management (IWRM) has been the dominant paradigm in the water sector. In the following sections, we review the recent literature on IWRM to see what lessons can be learned from IWRM that could inform MUS. We review the history, concepts, and implementation of IWRM, and then discuss our assessment of the scale, type, and success of IWRM as represented by the case studies posted on the Global Water Partnership website.

Definition of IWRM

IWRM is a conceptual framework and process addressing resource use at a variety of scales. IWRM appears to be widely endorsed on the international level, though critics have challenged the utility of the concept and its actual value on the ground. Both critics and proponents have raised important questions about IWRM: its meaning, how it is implemented, how successful it is in practice, and how it can be improved. In this brief review, we introduce IWRM as currently defined and summarize some of the major critiques of it by water sector experts. We also present an independent review of what IWRM has meant in practice and draw some conclusions.

The Global Water Partnership (GWP) leads international efforts to promote and implement IWRM. GWP describes itself as “an international network created in 1996 to foster the implementation of IWRM” and “GWP was founded by the World Bank, the United Nations Development Programme (UNDP) and the Swedish International Development Cooperation Agency (Sida)” (GWP 2010). GWP defines IWRM as a process which promotes the coordinated development and management of water, land, and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

GWP (2009) describes IWRM as having the following objectives:

- consider the integrated and interconnected nature of the resource,
- provide mechanisms for negotiation and conflict resolution among different stakeholders,
- encourage adaptation and accommodate shifting physical, political, and economic realities.

The primary assumption informing IWRM is that water is finite and inextricably linked to many other critical resources, so water management should be integrated with other practices, such as agriculture and industry. IWRM promotes collaboration across previously fragmented sectors, toward the goal of holistic resources management. Although not explicitly referenced in the GWP definition quoted above, IWRM is generally understood to promote stakeholder participation in decision-making.

GWP notes that IWRM includes various complex tasks and activities, generally performed by different actors. These include water allocation, river basin planning, stakeholder participation, pollution control, monitoring, economic and financial management, and information management.

GWP's webpage lists five key concepts underlying IWRM:

- Multiple uses. Water is a resource for drinking and washing but is also necessary for livelihoods.
- Holistic management. Both the supply of and the demand for water should be considered when creating management strategies.
- Multiple perspectives. Water is an economic, social and environmental good.
- Participatory approach. Local communities must help make decisions about their resources.
- Women involvement. The role of women in collecting, distributing, and managing water must be recognized.

IWRM: Development and History

IWRM is not a new concept. Some trace its history as far back as the Tennessee Valley Authority in the 1930s, with the current incarnation of IWRM dating back to the UN's 1977 Mar del Plata conference. But the origin and legitimacy of IWRM remains a subject of debate.

On one hand, GWP (2009) claims that IWRM was formally adopted at the 1992 Earth Summit. The GWP definition of IWRM dates back to principles adopted at the 1992 Dublin Conference, which focused on the need for an approach "to meet development goals without sacrificing environmental sustainability." GWP argues that since the late 1980s, there has been a growing realization among water managers that water problems had become more complex, requiring a new management paradigm. Many of IWRM's key elements were already being practiced by the early 1990s; the Dublin principles were merely a formal restating of widely accepted practice. Similarly, Ferreyra et al. (2008) trace IWRM's development to the "bottom-up alternatives that emerged during the 1980s in North America as part of the trend towards more holistic and participatory styles of environmental governance."

On the other hand, Biswas (2008) ascribes IWRM's current form and popularity to heavy promotion by donors and international organizations, despite the fact that it has not been formally endorsed or approved by the UN. Biswas (2008) notes that the 1977 Mar del Plata UN conference was a formal intergovernmental meeting; its Action Plan, which referenced IWRM, was endorsed by all members of the 1977 UN (Biswas 2008). However, the foundation of the current IWRM is the Dublin Principles. Biswas notes that the 1992 Dublin Conference, held in preparation for the 1992 Earth Summit, was a meeting of experts rather than government representatives, so the Dublin principles were never formally endorsed by the community of nations and therefore lack legitimacy in the international community.

Critiques of IWRM

IWRM has been severely criticized by a variety of prominent experts for its lack of specificity. IWRM has been variously described as a process (GWP); a perspective (van der Zaag 2005); a management system (Dukhovny and Sokolov 2005); a buzzword (cf. Medema et al. 2008), or, more critically, a meaningless phrase with no practical value (Biswas 2008). Van der Zaag (2005) calls IWRM “a relevant, yet elusive and fuzzy concept,” but one that inspires water managers to think creatively.

These IWRM critiques fall into three categories. :

1) IWRM as a concept is too nebulous to be of any practical use. Indeed, the very concept of a single framework that can capture the diversity of the water sector in terms of the resource base, hydrology, economic conditions, institutions, and cultures is ludicrous. Moreover, it offers no roadmap to action.

2) IWRM is a “donor-driven” process that ignores the interests and priorities of the communities it hopes to serve.

3) The current view of IWRM as an evolving, iterative process with no clear beginning or end is too vague for objective assessments. Given the fuzzy nature of the concept, there is no way to evaluate whether IWRM implementations have in fact been successful.

Critique #1: IWRM is a nebulous and catch-all concept, lacking a roadmap to action.
Asit Biswas, winner of the 2006 Stockholm Water Prize and other honors, is perhaps the most outspoken critic of IWRM (cf. Biswas 2004, Biswas 2008). Biswas argues that IWRM’s vague and amorphous definition contributes to its popularity, as water managers can claim adherence to IWRM – tapping into the large pool of financial and other resources made available to IWRM practitioners – while continuing business as usual. Biswas (2008) criticizes the IWRM definition at length for failing to provide any guidance on how to operationalize the concept, parsing the GWP definition with a close reading, and contesting each element. For example, he questions GWP’s use of “promotes” in the definition, to ask who promotes the concept, how it is to be promoted, whether simple “promotion” of the concept is sufficient to improve water management, and how promoting the process actually leads to implementation. Biswas subjects each element of the GWP definition to similar scrutiny, questioning the feasibility of cross-sector management or cooperation given the reality of differing objectives and levels of expertise. Butterworth et al. (2010) similarly argue that IWRM’s lack of specificity has led to “little agreement on fundamental issues like what aspects should be integrated, how, by whom, or even if such integration in a wider sense is possible.”

More broadly, Biswas questions whether IWRM can be operationalized and effectively implemented in a heterogeneous world, with different cultures, social norms, physical attributes, skewed availability of renewable and non-renewable resources, investment funds, management capacities, and institutional arrangements. Under such diverse conditions, he questions whether it is even possible that a single paradigm of integrated water resources management can encompass all countries, or even regions, with diverse physical, economic, social, cultural, and legal conditions.

GWP (2009) responds to these arguments by stating, “IWRM is a means to an end, and it is the goals to be accomplished and the context – the existing physical and institutional systems – that determine what elements of integration are important, and when they are needed.” GWP’s webpage is vague on the details of implementation: there is not one correct administrative model. The art of IWRM lies in selecting, adjusting, and applying the right mix of these tools for a given situation. Agreeing on milestones and timeframes for completing the strategy is critical for success. Implementation may take place on a step-by-step basis in terms of geographical scope and the sequence and timing of reforms. Scope, timing, and content of measures can be adjusted according to experience. This offers room for change, improvement, and process adjustment, provided that the proper bases for sound decision-making have been established. In developing a strategy and framework for change, it is important to recognize that the process of change is unlikely to be rapid.

GWP argues that the absence of a single clear path for implementation reflects the reality of variable resource and institutional conditions across and often within countries. To address the diversity problem, GWP provides a “toolbox” with 54 different “tools” for implementing IWRM. The tools include policies, institutional frameworks, participatory and regulatory capacity, ecosystem assessment, water use efficiency, conflict resolution, and many more. The tools include illustrative case studies from all over the world.

However, critics remain unconvinced. Biswas (2008) asserts that “global interest in the Toolbox, for all practical purposes, has basically disappeared,” partly because the examples included in the Toolbox have not been independently evaluated or shown to be replicable. He lists 41 different issues identified by different academics or institutions as appropriate for integration under IWRM, noting that this simply is not achievable in practice. Among other problems, Biswas (2008) cites limited data availability, noting that many countries lack sufficient, reliable data to implement IWRM successfully.

Critique #2: “Donor-driven” agenda lacks local constituency and does not reflect stakeholder priorities.

Experts have noted “disappointing levels of adoption” of IWRM and questioned the appropriateness of IWRM for countries with limited water management capacity and weak water infrastructure (Butterworth et al., 2010), suggesting that good governance, including active stakeholder participation and government transparency, are necessary *preconditions* for IWRM to succeed (van der Zaag 2005). Ashton and Turton (2005) note that “effective implementation of IWRM in an international river basin requires a high degree of mutual support, trust, and interaction between the relevant water resource management agencies, as well as clear agreements on the extent to which each county may exploit the available resource.”

GWP (2009) agrees with the importance of institutional reform: "countries still in the process of developing their water resources also need to invest in creating the institutions and building the capacity necessary to manage infrastructure and protect the resource from over-exploitation." However, GWP appears to interpret institutional reforms as being part of the IWRM process. In many countries the focus has been to encourage countries to adopt national water management laws. The problem with this approach is that in countries with weak institutions, IWRM simply becomes an externally imposed national water management policy with limited local support or buy-in. Butterworth et al. (2010), quoting Mollinga, notes that such donor-driven efforts make IWRM a "concept in search of a constituency."

Muller (2011), another critic of IWRM, argues that these donor-driven efforts do not reflect the interests and priorities of local stakeholders: IWRM should not replace legitimate governments with "donor-controlled water Parliaments" that block legitimate local development decisions. In particular, Muller contends that IWRM was prescribed as a water management agenda for the world without mentioning the words "build," "construct," "infrastructure," "store," or "dam," an ironic prescription from donor countries which enjoy extensive water infrastructure to manage relatively favorable hydrology. Muller claims that the Dublin 1992 principles which form the foundation of IWRM as it is currently practiced were rejected at the Rio conference on Sustainable Development in 1992. Yet the donor community promoted a version of IWRM that was based on the Dublin Principles rather than Rio's Agenda 21, which explicitly included "development." Reviewing the failures of IWRM in Africa, Muller (2010) argues that the approach to water management that emerged in the mid-90s instead reflected the Washington Consensus in terms of the economic and institutional approach, the rejection of multilateralism, and the primacy given to environmental objectives rather than the carefully balanced "sustainable development" approach of Rio.

Although Muller promotes an agenda of unfettered, large-scale infrastructure development in Africa and celebrates Chinese no-strings attached investments in dams in Africa, his criticism of IWRM's donor-driven agenda is not unfounded. Whatever the priorities of local stakeholders in Africa may be, GWP's own annual report (GWP 2010) describing IWRM efforts in many African countries lends credence to critics' descriptions of IWRM as an externally imposed management effort. For example:

> *"In Benin, four years of lobbying and workshops culminated in the adoption by the Government, in July 2009, of a new water policy based on the IWRM approach. GWP Benin led efforts, working with parliamentarians, ministries, civil society, local communities, and water user organizations, and establishing a task force. GWP Benin also arranged for consultants to review the first draft of the policy and organized a national workshop to validate the final draft. Now, the focus is on the water law soon to be brought before Parliament. GWP Benin continues to lead, arranging workshops and face-to-face discussions with the Parliamentary Commission to explain the importance of a proper legal framework for water management."*

Ultimately, such top-down approaches, while easier to implement than a multitude of locally driven efforts, do not reflect IWRM's core mission of stakeholder participation.

Critique #3: There are no metrics to evaluate success or prioritize interventions.
GWP envisions IWRM implementation as an iterative process that it refers to as the "Integrated Water Resources Management Cycle" (Medema et al., 2008). Many critics suggest that, as a process of change which seeks to shift water development and management systems from their currently unsustainable forms, IWRM is too vague and dynamic to lend itself to objective assessment.

Determining whether IWRM has been implemented successfully requires a beginning, an ending, and clearly defined metrics or criteria. But, despite many years spent promoting the concept in countries around the world, IWRM's main proponents still have not developed a clear set of indicators to measure the effectiveness of IWRM in practice. While IWRM has been implemented aggressively around the world, especially at the national level in the form of national water policies, the success of IWRM – in terms of actually integrating water management practices with other resource management practices and improving public and ecosystem health – is less clear, as discussed in the following section.

GWP's Toolbox (www.gwptoolbox.org) includes five different "assessment instruments," but these focus on tracking the IWRM process rather than broader societal impacts. For instance, GWP (2010) tracks its multi-year support for implementation of IWRM in countries around the world, generating "development of IWRM plans in 10 countries" in Africa and adoption of such plans by five countries. Another survey of the status of IWRM, funded by the African Development Bank and carried out by GWP Eastern and Southern Africa, showed gradual, but mixed progress in IWRM. In most of the 26 countries surveyed, an enabling environment is in place or being established, but legislation lags behind and financing is inadequate. GWP argues that these national-level activities have important ramifications in increasing awareness, improving policies, and raising budgets.

GWP (2010) claims increased water sector spending as a measure of success: "while it is difficult to measure impact, the higher profile of water financing clearly indicates the value of this work." Biswas (2008) counters that the hundreds of millions of dollars invested by donors and international organizations in promoting IWRM explains the global reach of IWRM and its current prominence in water management circles. In other words, the donor funding prompted IWRM planning around the globe; the planning did not attract the investment. Biswas further contends that while the concept of IWRM is popular (because of donor funding), the popularity of IWRM as a concept should not be confused with its performance on the ground. Indeed, existing IWRM assessments focus more on the progress milestones in the IWRM process itself. There do not appear to be performance indicators associated with measuring the effectiveness of IWRM efforts on the ground, such as on conflict reduction, equitable water allocation, economic development, and human or ecosystem health.

There are no measures to evaluate IWRM plans for their consistency with IWRM principles in GWP's Toolbox. However, independent studies show that implementers frequently offer lip service to the principles of IWRM while continuing to further their own agendas. Nesheim at al. (2010) compared four transboundary river basin management systems implementing IWRM (the Tungabhadra basin in India, the Sesan in Vietnam-Cambodia, the Tagus running through Portugal-Spain, and the Glomma in Norway). The authors found that though the IWRM emphasizes ecological sustainability, in practice lower priority was accorded to ecosystems in the four river basins. These findings highlight disconnects between the theory and practice of IWRM, confirming what others researchers have reported in other countries.

It should be noted that the lack of metrics does not mean that every IWRM project has failed. Indeed, the very diversity of IWRM efforts has meant that individual IWRM efforts have often been successful, particularly at the micro-scale. The difficulty is in being able to attribute these successes to the concept of IWRM or replicate them elsewhere.

Global Review of IWRM Implementation Case Studies

The literature reflects a range of interpretations of IWRM, giving credence to the criticism that IWRM is a nebulous concept that has been appropriated by a host of academics, international organizations, and donors to apply to various water management initiatives that might well have occurred in its absence.

The GWP Toolbox webpage includes links to hundreds of case studies of IWRM efforts. Recent reviews of these cases do not appear to exist. Older reviews, however, suggest that very few of the case studies demonstrate implementation of the IWRM concept as a whole. Dukhovny and Sokolov (2005) note that in 2002, only three case studies of 64 reflected complete IWRM implementation, and they report that a 2004 assessment found that only three projects out of 35 reviewed actually implemented IWRM's advanced water management practice; most of the rest simply involved planning efforts.

Given the ambiguity of IWRM's definition, it is not surprising that the degree to which IWRM has been implemented as an actual management practice is subject to debate. Interviews with IWRM implementers reinforced this view that most project implementers were simply reframing whatever they were doing as IWRM.

We analyzed the case studies in the GWP online database to develop a global picture of how IWRM has actually been implemented to answer several basic questions: How does the concept of IWRM function in practice? At what scale is IWRM implemented? What does it mean to implement IWRM? Are there metrics against which IWRM practices can be evaluated? Our analysis lends credibility to claims that IWRM has not lent a unifying framework for integrated management of water resources.

Methodology
To conduct this analysis, we downloaded the case summaries of all 184 case studies on the GWP website. The case studies were classified into eight geopolitical regions:

1. Sub-Saharan Africa
2. Middle East/North Africa
3. Asia
4. Central/South America
5. North America
6. Australia
7. Central/Eastern Europe
8. Western Europe

The cases were then coded (assigning a 1 or 0 value to a variable) to evaluate two aspects of IWRM implementations globally: 1) at what scale IWRM was implemented, and 2) what types of activities were undertaken as part of the IWRM implementation. While a given IWRM implementation could occur at only one scale, it could involve a range of activities. After reading the case summaries, we found that all IWRM efforts fell into one of the following scales:

1. Transboundary (usually between two countries sharing a river basin)
2. Country (usually involving creation of a national apex body, plan or policy)
3. State (usually involving creation of a state apex body, IWRM plan or policy)
4. River basin
5. Watershed
6. Urban local body (municipality or town council)
7. Rural community (village council)
8. Water utility
9. Industry

Figure 19 shows the number of cases from different geopolitical regions from the GWP database. Although not every IWRM project is in the GWP database, we assume that these case studies are generally reflective of the distribution of IWRM efforts worldwide. Very few cases were in Australia or North America. The data indicate that the scale of IWRM efforts varied considerably across geopolitical regions.

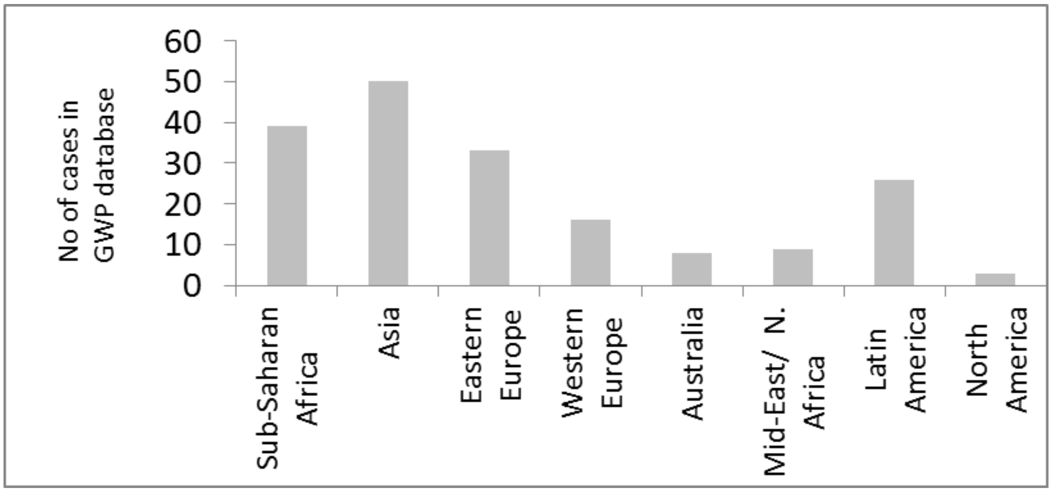

Figure 19. Number of cases by region in GWP database

The pie charts (Figure 20) also show dramatic differences in the scale at which IWRM is implemented across the world. Country-level IWRM efforts (both national and transboundary) accounted for almost two-thirds of such efforts in Africa and Eastern Europe, versus between a quarter to a third in Asia, Australia, and Western Europe. Similarly, barely a quarter of the IWRM efforts in Africa were at the local scale. Indeed, sub-Saharan Africa is surprisingly different from Asia and Central/South America, where two-thirds of IWRM efforts occurred at the local scale.

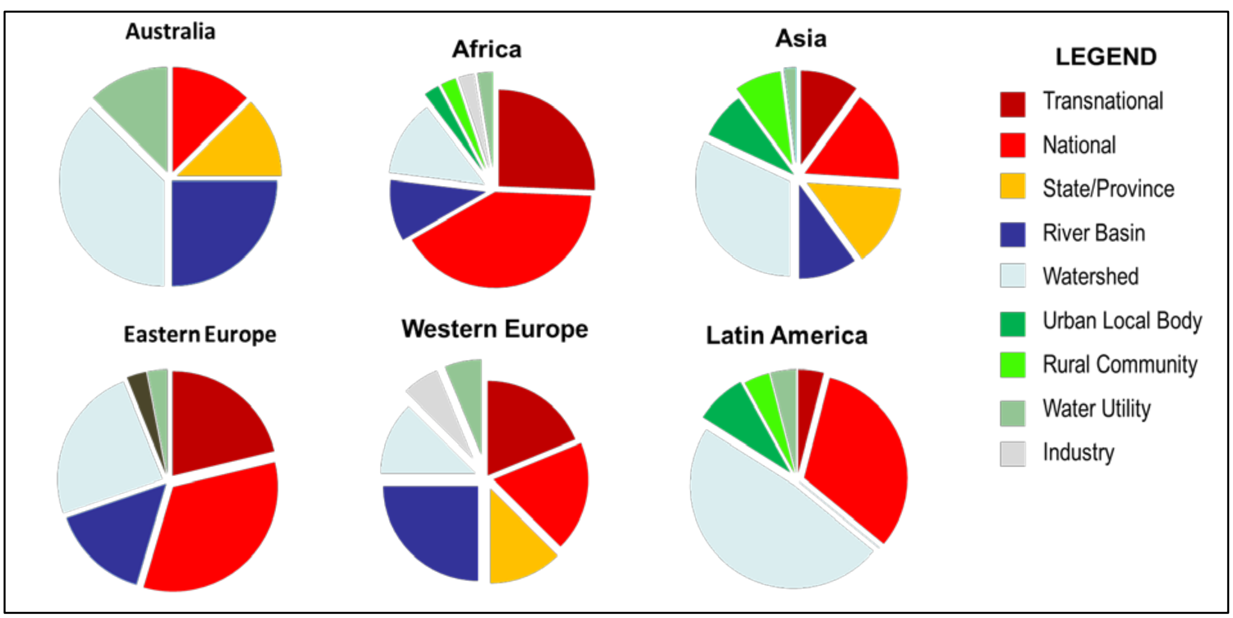

Figure 20. Scale of IWRM implementations in GWP database

The charts in Figure 21 list the percentage of IWRM cases in a specific region that implement a particular measure.

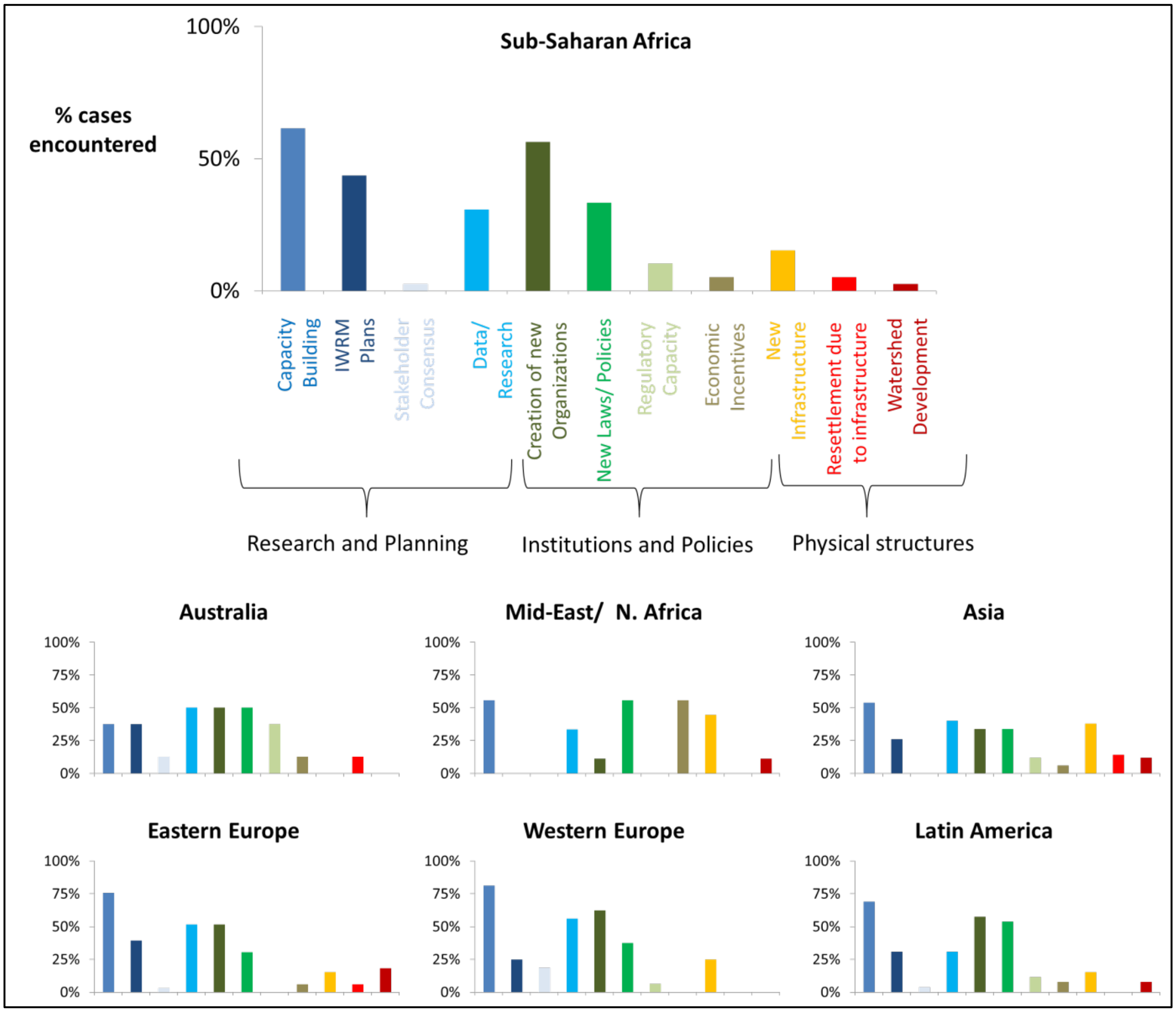

Figure 21. Types of activities undertaken by region in GWP database

Note: Categories are the same for each region so axes labels are not repeated

The data suggest that:

- The vast majority of IWRM efforts have focused on more general capacity-building measures like research, staff training, and planning. However, there are regional differences. In Asia and Australia, almost all cases had at least one measure like a watershed development (check dams, gullies, etc.), or economic incentives. In Africa, there was almost no action on the ground.
- IWRM efforts are shaped by local interests. In South Asia, where there is a long history of participatory watershed management, the distribution of IWRM projects reflects this trend.

For example, almost 15% were watershed management projects and another 15% involved resettling refugees from dams. Likewise, many IWRM efforts in Western and Eastern Europe were in compliance with the European Union Water Framework Directive, which requires member states to systematically develop River Basin Management Plans. Other projects evolved from the need to come up with protection plans for Ramsar wetlands or Natura 2000 sites. In Australia, many cases claimed by IWRM were actually part of independent efforts to establish catchment management or conservation efforts. While IWRM proponents would argue that these are consistent with IWRM's mandate to be responsive to stakeholder priorities in diverse places, there is no unifying thread that could justify grouping these cases into a single framework.

- The success of IWRM efforts depends on the strength of local institutions and governance. Where there are strong governance systems and democratic institutions, IWRM has been much more decentralized, the activities have been specific, and results have been tangible. Where the governments and institutions are weak, the projects have been much more focused on national-level capacity building. For instance, the distribution of IWRM activities in Europe and Sub-Saharan Africa (Figure 21) indicates that Europe and sub-Saharan Africa both have the same types of activities. But a review of the case studies reveals that the nature of capacity building was vastly different, as illustrated by the following edited case summaries on the GWP website:

The Netherlands: Room for water in the Alblasserwaard/Vijfheerenlanden:

An open planning process was introduced, in which all parties claiming space could get acquainted with the future water problems on the one hand, and on the other hand could give their views on how to solve them through multifunctional use of the limited space. In the coming years, this framework plan will be worked out in detailed plans and implemented"(Heymans undated).

Benin: IWRM Initiation:

The GWP re-affirmed its support to the IWRM planning process in the country under a Partnership for Africa's Water Development programme (PAWDII). Active and constant advocacy actions were conducted by CWP Benin targeting the main sectoral ministries involved in water management and its uses (water, environment, agriculture, transport, decentralization, tourism, etc.) and other governmental institutions" (Houanye et al., 2010).

Discussion of the Global IWRM Review

Our analysis offers several lessons on water governance and management that can help make MUS more robust.

First, a grand unifying global program may appeal to international funders looking to streamline efforts, but offers little guidance to practitioners in improving either water management or people's lives. To some extent, the diversity of IWRM efforts reflects the diversity of problems in the water sector: different regions of the world have different problems and different capacities to address them. Proponents suggest that the ambiguity of IWRM allows for considerable flexibility in applying its principles and objectives to water challenges in different parts of the world, but this very ambiguity highlights IWRM's lack of prescriptive and empirical rigor. The problems of groundwater depletion in Punjab or disappearance of the Aral Sea are sufficiently different from water problems faced by the rural communities of sub-Saharan Africa or the pollution issues in the Danube River of Europe as to make the push for a single unifying framework questionable.

Second, the idea of promoting stakeholder-driven, holistic management at the basin scale is laudable, but may be unrealistic. Such a goal may be impossible to achieve in practice, both because of the tremendous difficulties encountered in implementation and because holistic management would require massive bureaucracies that would be less responsive to stakeholder input. Implementing projects at a scale that is close enough to the community to make stakeholder participation meaningful and bureaucratic management tractable, yet large enough to account for the cross-scale problems (given that water does not respect political or communal boundaries) is a considerable challenge, one that IWRM tries to address, but may have ultimately failed to achieve.

Finally, the absence of metrics for success and accountability makes it difficult to judge IWRM objectively. The current definition of IWRM lists desirable qualities in a water management process, but does not prescribe how these can be achieved. Instead, the choice of activities is left completely to the stakeholder process. Thus, if the IWRM process results in the construction of a particular dam or service delivery system, it must be right because the stakeholders agreed to it. There are no external measures of success that can judge if IWRM produces more sustainable, equitable, resilient water systems. This approach may work well in countries with strong institutions, traditions of democratic governance, and robust legal systems, where there are sufficient checks and balances outside of the IWRM process. However, in countries with weak governance, the process is amenable to "elite capture," making reliance on a purely process-based approach questionable.

Lessons for Multiple-Use Water Services (MUS)

Our review of IWRM suggests that there are four broad lessons that could be helpful for MUS practitioners.

MUS needs to be clearly defined.
Many have effectively criticized IWRM's fuzzy, elusive definition and lack of clear metrics. MUS needs a clear definition that distinguishes it from other approaches and is sufficiently specific to provide guidance for practitioners.

MUS needs to be bounded in scope and scale.
One of the problems with IWRM was the massive scale of the intervention. The MUS approach is more likely to succeed if it could address a specific and bounded set of problems. MUS projects need to be clear about what constitutes a MUS project and, more importantly, what does not.

MUS should offer a clear, actionable roadmap to action.
MUS needs be flexible enough to cover a wide range of hydrologic, socio- economic, and institutional situations, yet find a way to offer a reasonably specific framework for action in specific places. MUS will only be successful if it has a clear set of goals and a roadmap to achieving those. Additionally, clear criteria to recognize successful MUS projects are necessary.

MUS should be accountable to the communities.
A major critique of IWRM was that it was too far removed from local communities to be accountable to them. It is important that MUS projects remain accountable and reflect the interests and priorities of local stakeholders and avoid being a donor-driven process with no constituency.

MUS could offer opportunities for bottom-up coordination.
MUS projects need to account for the fact that local institutions (e.g., on water rights and enforcement) are weak, and creating a basin-level organization that achieves top-down coordination may not always be feasible or desirable. Instead, MUS should promote "bottom-up" coordination structures, where representatives of multiple MUS water committees voluntarily form a watershed-level committee.

V. Recommendations

The concept of Multiple Use Water services has emerged as a way to realize the poverty alleviation potential of water projects. By connecting livelihoods to water supply, MUS seeks to improve nutrition, boost income, and help people climb the water ladder to make more sophisticated use of water beyond their basic health needs. As international institutions promote MUS as a new framework for funding and project design in the water sector, it is important to better understand both the opportunities and challenges of the MUS framework.

Through this report, we have explored the current state of MUS implementation and theory globally, evaluated some key missing elements in the MUS framework, and also considered lessons learned from other integration attempts in the water sector. From this critical review, we have arrived at a set of recommendations to make the MUS framework more robust and sustainable, so that ongoing MUS implementation moving forward can avoid the pitfalls and be successful over the long term.

Section IV demonstrated that a key lesson from previous integration efforts was the need for clearer definitions and outcomes. Greater effort needs to be made to clearly define MUS, so that practitioners, funders, governments, and other stakeholders can identify the key elements of MUS projects in terms of scale, process, priorities, and also outcomes. Section III identified numerous additional issues related to MUS implementation. Scaling up MUS or increasing the number of MUS projects in the field will bring to the fore issues of water conflicts, sustainability of the water resource, and the climate-related impacts on MUS projects. MUS projects also face barriers in regard to water quality and public health that emerge by connecting domestic and productive water uses and sources. The MUS framework also needs to have clearer strategies to address inequity in the distribution of water resources and in MUS projects.

To address the gaps outlined in Section III of this report and the lessons gained in Section IV, we identified a set of recommendations to make the MUS framework more robust and sustainable. We understand that MUS cannot solve all of the problems in the water sector, but the goal of this report is to ensure that as MUS implementations increase, key issues of sustainability, climate resilience, equity, and public health are addressed in ways that strengthen and improve project outcomes and the ultimate goals of development efforts – to create long term sustainable change to improve people's lives.

In this report, we offer recommendations at two levels: recommendations appropriate for individual MUS projects and recommendations appropriate at the programmatic level. This is consistent with the "two-pronged" approach recommend by the MUS group (van Koppen et al., 2009). Project-level recommendations aim to operationalize sustainability, equity, environment, and water quality in individual MUS projects. Program-level recommendations aim to create the support structure to make MUS implementations in a region more successful, robust, and sustainable. Project-level recommendations are those that can be undertaken by any local organization working to implement a MUS project. Program-level recommendations are geared toward funding organizations, multi-lateral institutions, governments, agencies, large NGOs, and other MUS supporters who want to create an enabling environment and tools to improve the sustainability and success of MUS implementations in a particular region or globally.

The primary ways that MUS projects can be made more robust and sustainable is through improved design of technological and institutional systems. At the programmatic level we recommend: knowledge sharing and tools, improved data and research, clearer definitions of success and accountability, and better coordination and enabling legislation.

MUS Project-Level Recommendations

Technical design
The choice of technologies in design of projects provides opportunities to embed equity, sustainability, climate resilience, and other priorities into MUS projects. Projects can be designed in numerous ways to provide incentives for particular uses or enhance sustainability and climate resilience. Pipe sizes, check dam heights, conjunctive use of surface and groundwater, and location of the access points with respect to communal gardens are examples of technical design choices that can influence project outcomes. There are several categories of technologies which can help enable and reinforce particular outcomes. These are described below:

Design for water resource sustainability
Technology can play an important role in sustaining the water source both at the point of use as well as at the community scale. At the point of use, boosting the productivity of water use by using less water to accomplish the same goal, for example through drip irrigation, can help users achieve livelihood goals with very little water. Other technologies can help limit water use: for example, through volumetric monitoring of water use, triggering valves to shut down when a certain amount of water use is exceeded, instituting pipes of a certain size. Technology can also limit water use by the MUS project as a whole: for example, by limiting the height of a check dam embankment, outlet size from a local spring, or pump size from borehole.

Design for equity
There are numerous methods to promote equitable water distribution and benefits of MUS through technical design. Communal gardens co-located near the water source could allow poor, landless families to grow gardens near the water source, saving them the effort of transporting water from the source to their property or paying to build pipelines to their homes. Monitoring of water use through timed shut-off valves could help even out distribution of water. Limiting pipe sizes could ensure a more equitable distribution of resources. Increased drip irrigation could assist wealthier households in reducing water use and allow a greater portion for lower income households.

Design for climate resilience
Given variability in climate, MUS projects need to promote source diversification in the supply of water, including conjunctive use of both surface and groundwater. Groundwater can provide a buffer against drought, but needs to be well managed. In many parts of the world, traditional systems of water management are being revived as important climate resilience strategies, including dug out wells, farm ponds, and temple tanks. These systems provide surface storage while also increasing recharge of groundwater. Water storage becomes increasingly important in situations where water availability is concentrated in shorter periods of time, and community or household water storage tanks and underground storage should all be considered as part of MUS systems.

Institutional Design
Designing effective management institutions within MUS projects can "hardwire" equity, sustainability, and climate resilience into MUS projects. Institutions include both operational rules (water rotation scheduling, tariff structure, staff hiring practices, etc.) as well as constitutional rules (fair voting rules, representation of all major stakeholders including the environment, etc.). Institutions can address water conflicts, improve water use efficiency, ensure equity, and include environmental priorities in decision-making. Some examples of the ways in which institutions can be effective in promoting these goals include:

Formal rules
Water user associations or committees can develop formal rules to ration water, develop priorities to elevate particular uses over others, and schedule crop rotation. For instance, depending on the irrigation needs and water availability, more frequent but shorter rotations may be appropriate or it may be appropriate to have each household build their own storage.

Principles of equity can also be formalized in MUS committee bylaws. For instance, water user committees could formally recognize the principle of a "human right" to a basic quantity of water for domestic purposes. This in turn would require creating appropriate mechanisms to ensure a minimum quantity of water is affordable and available to the poor. Institutions could also develop ways to give the environment a "voice" in water committee decision-making.

Informal social norms
Informal social norms are verbally agreed upon or culturally accepted principles that may be enforced through peer pressure or through village council decisions. Informal social norms could include the types of crops planted and watering schedules that conserve water and help the community develop within existing resource limits. Informal social norms, by definition, are norms that communities accept and reinforce. However, MUS implementers could encourage existing norms or promote new ones by visually presenting and publicizing information on the shared nature of water resources, which crops use less water, the impact of deep borewells using fossil water, and how certain water application technologies like sprinklers result in inefficient water use.

Pricing
Pricing can be an effective way of limiting water use. In these cases, institutions can develop formal rules and mechanisms to regulate water use efficiency and incentivize behavior in ways that reflect the environmental, sustainability, or equity goals of the community or region. Dual tariff pricing can elevate one use over another as a priority for a particular resource. Pricing rules can be set by water use committees or water user associations, and be enforced with monitoring by a human attendant or technological monitoring.

MUS Program-Level Recommendations

Knowledge Sharing and Tools
Improving the transfer of knowledge through staff training and tools will assist practitioners in understanding clearly the MUS implementation approach, address environmental sustainability issues, and ensure public health and water quality.

Despite a decade of work on the MUS approach, many implementers globally do not know the concept, what it entails, or how to incorporate it into their work. To operationalize MUS, advocacy materials that encapsulate how to implement MUS in a variety of topographic, socio-economic, and hydrologic settings are needed.

The danger that drinking water quality may be compromised is a major concern in MUS projects. Additionally, opportunities to reuse wastewater and incorporate sanitation will require more information on the public health and water quality implications of this effort. Many rural areas lack adequate water quality testing facilities and reliable supply of treatment chemicals. There is also a gap in understanding of the sustainability and environmental dimensions of MUS projects. MUS promotion efforts should develop some trainings, tools, and knowledge-sharing efforts to move forward MUS implementation in ways that are effective and protect public health and the environment.

Guidebook and tools for MUS
A process guidebook that defines MUS, key technologies, and institutional designs will be helpful in bounding the concept of MUS and developing a broader constituency for MUS. This can provide an opportunity for a larger number of practitioners and support organizations to incorporate MUS designs and lessons into their on-the-ground efforts. Although some work is already being done in the form of a guidebook and advocacy videos on the MUS group website, current efforts could be formalized via a computerized decision-support system. Such a decision-support tool would encapsulate both technologies as well as the institutional arrangements that have been successful on the ground.

Drinking water treatment and sanitation decision tool
Since point-of-use treatment in MUS systems is more likely, households and communities need more information about the types of household drinking water treatment systems that can be

effective, as well as information on how to undertake these approaches safely and effectively. Similarly, many different sanitation approaches already exist that can effectively be integrated into MUS projects and expand its nutrition and public health benefits. A decision support tool on the choices available, their costs, scalability, and where they would be most beneficial could be part of MUS advocacy, training, and implementation. For example, Arborloo toilets are an innovation that allow for planting of fruit trees in shallow dug pits for sanitation. These could be incorporated into certain MUS projects in places where dry sanitation is culturally acceptable, land is readily available close to the homestead, and conventional toilets are not affordable. However, practitioners need to know what technologies exist and which ones would be suitable in different situations. Such a decision-support tool could be an expanded version of the prototype currently being developed by the Pacific Institute at www.washchoices.org.

Water quality testing kit and trainings on wastewater reuse
MUS practitioners need ways to ensure that water is safe to drink, and when reusing partially treated wastewater, how to assess the health risks of that wastewater and how to institute a multi-barrier approach to ensure public health. This may involve training the MUS water committee staff to use water quality kits, how to interpret and communicate the information, and what steps to take when water quality falls below acceptable thresholds.

Trainings on environment and sustainability linkages
MUS projects will be impacted by climate variability and its changes to water supply and demand. In turn, MUS projects will impact water supply available for other communities and ecosystems. It is important for MUS implementers to understand the inter-linkages of the water sector, especially surface water-groundwater linkages, the impact of over-pumping of groundwater aquifers and opportunities to improve recharge, impacts of use by one stakeholder on the availability for others, and the impacts of climate change on water supply. MUS practitioners may need to understand the links between human activity and ecosystem degradation and the important role that water that remains in waterways plays in ecosystem functioning. Environmental education and training is needed to help users understand these linkages.

Data and Research
Better data and research are necessary for effective and sustainable MUS implementation, the scaling of MUS to more areas, and for adaptive management of water resources. Clearer information would enable engineers and hydrologists to apportion the quantity of water that can be taken from the system for drinking, irrigation, and other uses so that the ecosystem could still be sustained and also plan in the face of climate change impacts on water supply. Improved data would help in conflict resolution and water rights allocation decisions across different communities in a watershed. However, in many regions basic hydrologic data such as topography, precipitation, recharge rates, and stream flow rates needed to design projects at a certain level of reliability simply do not exist. Each NGO must invest resources in acquiring these data and hiring consultants to make estimates.

Data repositories
There is an opportunity to achieve economies of scale by investing in data repositories that make such data available to all water sector practitioners. This does not necessarily involve collecting new data; collating and archiving data already being collected for various projects and making it freely available is a useful first step. The challenge is in archiving data in a stable, central repository that is invulnerable to being destroyed during political conflict or natural disasters. For instance, the data repository could be a Wikipedia-style repository, updatable by any member of the public, but subject to quality control based on transparency and validity of the sampling and survey methodologies. Such a database should remain accessible to both donors and local communities over the long term.

Participatory hydrologic data collection
Additionally, there are opportunities to expand data collection efforts beyond centralized, governmental data collection. In many areas, participatory hydrologic monitoring is being piloted as a way to make communities responsible for their own gaging stations and monitoring networks. Giving communities a sense of ownership over monitoring equipment may help avoid many of the problems associated with centralized monitoring: theft of equipment, staff fudging the data to avoid making trips to distant communities, or budgetary constraints. The increasing reach of mobile phone networks is creating new opportunities for such community-based water data monitoring in the developing world. The data may be either uploaded automatically via mobile phone networks or sent manually via SMS messages from far-flung communities. The data could then be aggregated in a central server and be made freely available to all water sector practitioners.

Water quantity accounting
Better data on water availability and use would enable engineers and hydrologists to apportion the quantity of water that can be taken from the system for drinking, irrigation, and other uses so that the ecosystem could still be sustained. Environmental impact assessments may be used to determine the minimum water flow required for sustaining aquatic and surface vegetation.

Water quality monitoring
MUS projects could induce prolonged changes in quantity (lowering of water levels) and quality issues such as salinity, nitrate pollution, and accumulation of heavy metals. Developing low-cost monitoring kits and simple communication tools to help local communities monitor the state of their natural environment would be helpful.

Independent academic studies
Much of the research on MUS is from within the MUS community. There are very few peer-reviewed academic studies. There is a need for independent, carefully structured, third-party studies to test the claims made by MUS practitioners listed earlier in this report. These should carefully evaluate the costs and benefits of MUS projects relative to other water sector

approaches. These studies should also analyze the equity, long-term sustainability, and public health implications of MUS projects.

Success and Accountability
One of the lessons from IWRM was that more effort needs to be made to clearly define success and hold funders and implementers accountable to communities so that the projects undertaken reflect the interests and priorities of stakeholders.

Develop holistic measures of success
It is necessary to have some measures of whether MUS projects are achieving the stated goals. However, in developing such metrics, several considerations are relevant:

- Assessment/measurement is expensive, so it doesn't make sense to keep collecting data where the linkages are already well established in the literature. Instead, assessments should focus on the extent to which the objectives of the project have been achieved.
- Narrowly defined metrics could skew the priorities of MUS implementers toward trying to achieve those targets.
- MUS projects may be only one of several initiatives simultaneously undertaken in a community. Primary education and health care may also be implemented alongside. MUS projects, if successful, could have multiplier effects because of increased disposable income within the community – so it may be difficult to isolate the effect of the MUS project alone.
- MUS is explicitly designed to be a community-based approach; therefore beneficiaries' self-assessment of whether they are better off is important.

Keeping these in mind, a blend of subjective and objective measures would be most appropriate. Objective metrics could include monetary productivity of water, quantity and reliability of supply, Gini coefficients of water allocation, increase in household income before and after the project, and percentage of household contribution to project capital costs and maintenance. Subjective metrics could include a community scorecard approach.

Expand time-frame of measurement: Many projects fail in the long term after the projects have ended and funders/implementers have moved on. Funders need to go beyond the project mindset to revisit their projects after ten years, provide incentives for ongoing sustainability, and extend time-frames to be more accountable to communities.

Bottom-up Coordination and Enabling Legislation
MUS projects operate at the community scale, yet with increases in abstraction and decreases in water supply, conflicts and over-abstraction of water resources may become a problem. As MUS projects increase in a particular region, there may be a need for higher level coordination. It may be appropriate to address these through other non-MUS funding approaches such as participatory watershed management (PWM) or Integrated Water Resources Management (IWRM), which could institute formal licensing schemes. However, when such higher level coordination is not possible, some MUS projects have already demonstrated that "bottom-up coordination" is

possible by constituting a watershed committee made up of representatives from each MUS water committee to negotiate details of inter-community sharing and put in place conflict resolution mechanisms.

Additionally, if MUS is to scale beyond pilot projects, regulatory roadblocks at the national and state scale will need to be addressed. These include:

- Modifying laws that deem MUS projects illegal, because some or all productive uses are deemed illegal.
- Adjusting unnecessary and impossibly high standards, where they prevent efficient use and reuse of the resource.
- Adjusting technical standards or creating new ones where necessary to support MUS projects.
- Overcoming the single-water-use mandates in departments so that they are better equipped to address problems specific to MUS projects.
- Developing payment for environmental services (PES) schemes which can pay farmers for investing in positive environmental practices.

Looking Forward

Multiple Use Water Services is a promising framework for funding and implementation in the water sector that can address basic health as well as livelihood needs of the rural and peri-urban poor. While the MUS approach has its roots in how communities have historically interacted with their local water sources, it seeks to overcome the current fragmented approach by government bureaucracies and funding streams in addressing the domestic and productive water needs of communities. At the same time, the MUS approach has some limitations that can have significant consequences if there is international effort to fund and implement MUS projects globally.

In this report, we analyzed the gaps in the MUS approach, including equity considerations, environmental sustainability, climate resilience, ecosystems, sanitation, wastewater reuse, and public health. We also critically evaluated previous efforts at integration in the water sector, particularly IWRM, to identify lessons learned. From these analyses, we arrived at a set of recommendations for making MUS implementations more robust and sustainable at the project level and at the level of MUS promoters and funders. At the project level, MUS implementers can address sustainability, equity, and climate resilience through specific technological and institutional systems. At the programmatic level, MUS supporting institutions, funding organizations, and governments can provide a supportive environment for more successful projects by better knowledge sharing and development of tools, improved data and research, clearly defining success and accountability, and better coordination and enabling legislation. In addressing existing key limitations, Multiple Use Water Services can avoid the failures of past approaches and ensure sustainable progress toward addressing the needs of the global poor.

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