Mary Renwick, PhD[1]
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I. Conceptualization of MUS for CBA

My perspective. My conceptualization of MUS is strongly influenced by four factors:

- Early work on MUS in the 1980s in valuing multiple-uses of irrigation systems in Southern Sri Lanka while at the International Water Management Institute in Sri Lanka (Renwick, 2001a; Renwick, 2001b, and; Renwick and Molle, 2004).
- Observations in the field—multiple-uses of irrigation and domestic water schemes in south and southeast Asia, Latin America and Africa.
- Global scoping study on costs, benefits, poverty impacts and potential markets for the Bill and Melinda Gates Foundation led by Winrock International in collaboration with IWMI and IRC Water and Sanitation Centre. (see (Renwick, et al. 2007) "Multiple-use water services for the poor: assessing the state of knowledge," at www.winrockwater.org) for a copy of the report and annexes.
- Design and implementation of MUS projects—Niger, India, Tanzania, and Nepal.

Based on this work, I believe there is substantial scope for cost-effectively expanding and solidifying the benefits of domestic and irrigation water services through a multiple-use water services approach. Research has also shown that the potential market for MUS is large (>1 billion poor) (see Renwick, et al. 2007). Personally, I believe there is a need for more rigorous work around MUS as an approach, including its conceptualization, working models, and implementation.

What is MUS?

Rationale. Poor populations need water for a variety of essential uses ranging from drinking, hygiene and sanitation to food production and income generation. Existing approaches to water service delivery typically entail systems that are designed, managed and financed for a single use—for example, drinking or irrigation. But the poor often rely on such single-use systems to meet multiple water needs—needs not considered in the planning or management of the system. An alternative model for water service provision—known as multiple-use approaches to water service delivery—is a consumer-oriented approach that takes people's multiple water needs as a starting point and involves planning, finance and management of integrated water services for multiple domestic and productive uses.

Definitions and concepts[2]

[1] Director, Water Innovation Program, Winrock International. Email. mrenwick@winrock.org; tel. +1(703)209-8286
[2] Renwick et al. 2007

- **Single-use approach**. Single-use approaches involve design, finance and management of water services for a single intended use, such as for irrigation or domestic purposes. In actuality people often use the water supplied for multiple purposes—with possible consequences for human health and sustainability. Single-use approaches are the standard model of water service delivery.
- **Multiple-use approaches**. Multiple-use approaches involve planning, finance and management of integrated water services for multiple domestic and productive uses based on consumer demand. Recognizing the predominance of sector-based services and differences in service delivery models, our typology includes two types of multiple-use services—domestic+ and irrigation+. **Domestic+ approaches** involve provision of water services for domestic as well as productive activities. **Irrigation+** approaches involve provision of water services for irrigation as well as domestic and non-irrigation productive activities.
- **Water services *not systems***. Water service is defined as the provision of water of a given quality, quantity and reliability at a specified place. The definition emphasizes outputs—what people receive—rather than infrastructure that are implied by such terms as 'water supply scheme' or irrigation scheme'. In Renwick, et al (2007), water service levels provided the architecture for evaluating costs and benefits and market opportunities. Different levels of water service support differing levels of domestic and productive activities. For the cost-benefit analysis on MUS, we developed a framework of service levels for analyzing the incremental benefits and costs of different water service approaches, which is described below.

Entry-point(s)—community and household. Although the entry point for MUS could be described at various spatial, hydrological and institutional scales, ranging from household-to- community-to-region or from watershed to basin, we've been operating at the community[3] and household levels. Winrock's work has focused on two target markets:

- At the **community level** to provide multiple-use services to rural communities located in target areas through new installations and upgrades to existing services.
- At the **household level** to encourage households to invest in their own low-cost technologies for multiple uses.

Water source development, technologies and service delivery. From our perspective, water supply options (and associated costs) should be developed based on local water needs, priorities and available water sources. Depending on the local context, options may include development of a single source for domestic and priority productive uses; development (or upgrades) of multiple sources for different uses; or some combination of the above.

Uses. Commonly observed types of uses include:

- **Types of use**
    - Domestic: drinking, other domestic (sanitation, hygiene, cooking, cleaning, etc),

[3] As we learned through our work in India, the use of community interchangeable with village created confusion, as many communities—often defined by socio-economic constructs such as caste--typically comprise a village.

    - Productive: commonly observed uses include: irrigation (ranging from home gardens to irrigated agriculture), livestock, fisheries and water-dependent enterprises (agro-food processing, food prep, etc.)
- **Water requirements** to support various uses in terms of water service attributes: quantity, quality, reliability and distance between source and point of use
- **Nature of use**—considerations for planning, design, management and CBA. It's critical to consider the water service requirements to support various uses and their potential interactions, some of which may be complementary and others conflicting. Hydrologic interactions have implications for water management as well as benefits and costs.
    - In situ–vs. –extractive
    - Consumptive –vs. –non-consumptive
    - Impacts on quantity and quality

Economic verses financial costs and benefits. For CBA it's important to distinguish between economic and financial costs and benefits.

> *"Confusion is often observed between economic analysis and financial analysis. Although the definitions may vary and some concepts attached to each of the two topics be not so easy to tackle, a rough distinction can be established:*
> - ***The financial analysis** consists in comparing revenue and expenses (investment, maintenance and operation costs) recorded by the concerned economic agents in each project alternative (if relevant) and in working out the corresponding financial return ratios;*
> - *The **economic analysis** aims at identifying and comparing economic and social benefits accruing to the economy as a whole, setting aside for example monetary transfers between economic agents." (Source: http://rru.worldbank.org/documents/toolkits)*

It's also important to distinguish from "whose perspective" benefits and costs are assessed. For example, individual, project/program, society-at-large (what scale—community, region, watershed). (See Annex A for two examples showing how financial and costs and benefits are differentiated).

Hypotheses--suggestions for formulation. In general, the formulation of hypotheses is Null –verses- alternative. Generally hypotheses are formulated in such as way as to reject the null. For example,

- Null Hypothesis H_o: the net financial benefits (financial benefits less financial costs) of MUS are equivalent or less than SUS.
- Alternative Hypothesis H_A: the net financial benefits (financial benefits less financial costs) of MUS are greater than SUS.

Example hypotheses from the MUS Global Scoping Study

Hypothesis 1

Null: The net benefits of multiple-use approaches are greater than those of single-use approaches

Alternative: The net benefits of multiple-use approaches are the same or less than those of single-use approaches.

Hypothesis 2

Null: Multiple-use approaches more comprehensively address the multi-dimensional aspects of poverty than single-use approaches.

Alternative: Multiple-use approaches *do not* more comprehensively address the multi-dimensional aspects of poverty than single-use approaches.

Hypothesis 3

Null: The potential market for multiple-use approaches is large.

Alternative: The potential market for multiple-use approaches is small.

In the MUS Global scoping study, we evaluated and tested three basic hypotheses (see side box). When these hypotheses were formulated, we discussed swapping null and alternative hypotheses, which would have been a stronger for statistical analysis and testing, but we ultimately opted for this formulation.

II. OPERATIONAL OR SPECIFICATION OF CONCEPTUALIZATION IN TERMS OF CBA AND PERFORMANCE AND RELATED SCIENTIFIC METHODOLOGIES

Background--MUS global scoping study. As described above, the primary purpose of the MUS Global Scoping study funded by the Bill and Melinda Gates Foundation was to help inform prospective investments in the water sector by assessing the potential of multiple-use water services to sustainably meet the water needs of the poor focusing on the following questions: **What** are the incremental costs and benefits of multiple-use approaches over single-use approaches? **Where** do multiple-use approaches apply and who are the main beneficiaries? The methodological framework we developed to answer the question related to costs and benefits involved first developing a **framework for multiple-use services that defined service levels** and then assessing the **incremental costs, benefits and poverty impacts** of multiple-use approaches for different market entry points (domestic and irrigation) for commonly observed activities/uses (e.g. gardening, livestock and small scale enterprises) that have a proven potential to generate income and to enhance livelihoods, health and social equity.

Methodological framework.

Step 1: Defining Water Service levels--The research team developed a framework of service levels for analyzing the incremental benefits and costs of different water service approaches.

Building on the definitions of "no service" and single-use "basic domestic" and "basic irrigation" services[4], the research team defined three additional levels of water services required to support varying levels of both domestic and productive uses.
Each different service level represents changes in two or more of four variables: quantity, quality, distance and reliability.

To reflect fundamental differences in water service provision, our typology includes separate service level definitions for "domestic-plus" and "irrigation-plus" approaches. In general, domestic+ approaches involve increasing the quantity and reducing distance between source and homestead. Irrigation+ approaches involve reducing distance between source and homestead and improving quality (See Annex B for further information on water service level definitions).

Step 2: Identifying type and extent of uses supported at each service level

- **Identified common water use activities—home gardens, livestock, small-scale enterprises and domestic use of irrigation systems:** To assess incremental benefits (both financial and non-financial), the research team identified the most common additional livelihood

[4] For domestic plus, we relied on the JMP definitions of improved water, including 20 liters per capita per day from an improved (e.g. "safe' source) within 1 km of the household. If one or more of these service thresholds were not met, the household was assumed to have "no service".

activities (home gardens, livestock, small-scale enterprises and domestic uses of irrigation systems). Identification of common livelihood activities was based on a review of the literature (see Annex C for a selected list of studies reviewed to identify uses and poverty impacts).

- **Assessed water requirements for each activity.** Water service requirements to support each livelihood activity were estimated based on literature review and consultation with practitioners. For example, home gardens require 3-8 lpcd per m^2 and livestock drinking includes a wider range of water quantities (cattle 25 lpcd, goats and sheep 5 lpcd, chickens 0.3 lpcd). Other service level criteria, such as quality (required to support drinking and domestic uses), distance and reliability were assessed.
- **Estimated extent of activity that could be supported at each service level for domestic+ and irrigation+.** For each service level, the potential extent of each livelihood activity was estimated. For example, number of cattle, square and meters of garden. Uses and water requirements were validated through consultations with experts in the field.

Step 3: Financial benefits

At each service level, the team calculated the potential income generated from home gardens, livestock, and small-scale enterprises using the following process[5]:

- **Reviewed literature to identify estimated returns by activity area:** Extensive review of literature for existing estimates of net returns for home, livestock and small-scale enterprises based those actually observed in the field supplemented by limited primary data collection (see Renwick, et al. 2007, Annex B for further details on methodology and data).
- **Standardized estimates to allow comparison by:**
    - **Converting to common production units**. All returns were converted into a standardized production unit, such as returns per head of livestock or square meter of garden.
    - **Annualized**. All returns were annualized where necessary.
    - **Currency conversion to 2004 purchasing power parity international dollars (PPP $I)**. Because the data was collected from several countries over many different years, country specific GDP deflators were used to inflate/deflate to 2004 local currencies and then convert to US$ Purchasing Power Parity (PPP) (World Development Indicators, 1994-2006).
- **Estimating average returns per unit activity**: For each of productive use, we conducted statistical analyses of standardized estimates to generate standard summary statistics such a mean, median and standard deviations (see summary statistics in Renwick, 2007 Annex C for each use).
- **Calculating potential income by service level:** To estimate the potential income generated from livelihood activities at each service level, we multiplied the mean income generated by the extent of the activity supported at each service level. For example, based on the literature review, the average annualized return for home gardens was found to be $1.08/$m^2$. To reflect seasonality of home garden production and differences in intensity of production (some households produce year round, others only for one season), one-third of the average annualized return ($0.36/$m^2$) was used to derive an income range. Thus, the

[5] For the purposes of the study, we looked only at a limited range of financial benefits (e.g. financial returns from home gardens, livestock and small-scale enterprises) based on available existing data.

income potential from a $100m^2$ home garden was estimated to be from $36-108/year (see estimates in Annex C below).

- **Validating estimates:** Income estimates by activity and service level were cross-checked with available estimates from the literature, where possible, and were validated by experts in the field.
- **Converting household-level income estimates to per-capita estimates**: For each service level, the range of annual household income estimates per activity were converted to per capita estimates, assuming an average household size of 5, to make comparable to cost data, which is expressed in per capita terms.
- **Incremental income benefits by service level:** Incremental income benefits were estimated taking the difference between income generated at each service level.

Step 4: Financial Costs

Based on available data, ranges of estimated costs were determined for identified technologies and service levels. Costs include hardware, software, and recurrent annual costs (see data at end of section for further details on what is included in each cost component as well as data used for the analysis).

- **Identified technologies[6]:** Based on review of available global data, several key technologies were selected for the cost analysis based on the following criteria: (1) prevalence of use in large segments of the rural population in South Asia and sub-Saharan Africa; (2) potential to support multiple-use services; (3) availability of data (on prevalence and cost). Main technologies evaluated for domestic+ and irrigation+ (estimated number of people currently receiving such services in South Asia and sub-Saharan Africa are listed in parentheses):
  For domestic+
    - Networked piped systems (500 million)
    - Communal boreholes with hand pumps (500 million)
    - Hand-dug wells (>150 million)
    - Infrastructure add-ons to support activities such as livestock troughs, lifting devices and community gardens

  Irrigation+

    - infrastructure add-ons to support domestic and productive activities such as livestock troughs, cattle crossings, bathing facilities, canal steps,
    - communal water storage and home water treatment
    - household storage and home water treatment

- **Hardware costs**
    - **Reviewed literature and conducted limited primary research to identify range of hardware costs:** Conducted an extensive literature review coupled with limited

[6] Although there is significant potential for rainwater harvesting to support multiple use approaches, we have not included rainwater harvesting in our analysis for two reasons. First, rooftop household level rainwater harvesting generally does not reliably meet water needs year round or provide sufficient water to support many productive activities. Second, surface collection of rainwater for productive uses must be used in combination with improved sources to provide domestic needs. More research is need on the potential for rainwater harvesting to support multiple uses.

primary research and expert consultations to identify per capita hardware costs for selected technologies in rural South Asia and sub-Saharan Africa for both new services and incremental upgrades based on starting and ending water service levels (see selected data used for cost analysis at the end of the section).

  - **Standardized estimates to allow comparison.** Standardized estimated of hardware costs for each estimate to make them comparable:
  - **Common units—per capita measures**. All costs were converted, if needed, into a per capita basis.
  - **Currency conversion to 2004 purchasing power parity international dollars (PPP $I)**. Because data was collected from several countries over many different years, country specific GDP deflators were used to inflate/deflate to 2004 local currencies and then converted into Purchasing Power Parity $US I (World Development Indicators, 1994-2006).
  - **Estimated incremental hardware costs by technology and service levels for irrigation+ and domestic+**. For each technology, estimated the average costs of new services and upgrades to existing services to support multiple uses.
- **Software costs.** Software costs for domestic systems are typically on the order of 10% of hardware costs. For multiple use approaches, software costs are likely to be significantly higher because of the need for new management capacity, extension, and related inputs for productive uses and hygiene education, as well as cross-sectoral coordination and new management models to support implementing at scale. Based on the ongoing multiple uses research, the International Water and Sanitation Centre estimates that total software cost (technical assistance and program support costs) for multiple use approaches could be on the order of 30-50% of hardware costs. This estimate is corroborated by evidence from Winrock and IDE's implementation of over 60 multiple-use by design systems in Nepal where total software were on the order of 40-50%. For the purposes of the financial analysis, we assume 40%.
- **Recurrent annual costs:** Recurrent annual costs include operation and maintenance, source water protection and capital maintenance fund and were estimated based primarily on Hutton and Haller (2004),
  - Annual operations and maintenance costs were estimated at 5% of total hardware costs for all systems, except for household piped connections, which were estimated at 30%.
  - Source water protection was estimated at 5% of hardware costs for boreholes and protected wells and 10% for piped schemes.
  - Capital maintenance fund costs were estimated based on the estimated useful life of the capital investment. For example, 25% of capital costs per year for a useful life of 5 years, 15% for 10 years, and 10% for 20 years. In addition, for irrigation plus investments involving home water treatment and hygiene education programs, annual recurrent costs of $2 per capita were included for point-of-use home treatment costs.
- **Repayment periods** were calculated based on the period of time it would take to cover hardware and software costs based on estimated average annual income benefits less annual recurrent costs.
- **Cost-Benefit ratios**
  - Cost-benefit ratios for new services and incremental upgrades were calculated assuming a discount rate of 10% where:

  - Costs were defined as the per capita full capital investment costs in year 1, including hardware and software costs
  - Average useful lifetimes for infrastructure we estimated following Hutton and Haller (2004) and Brikke and Bredero (2003)
  - Benefits were defined as the net present value of the stream of annual per capita mean income benefits less annual per capita recurrent costs (operation and maintenance , source water protection and capital maintenance fund) over the useful lifetime of the infrastructure.
- **Sensitivity Analysis:** To evaluate how variations in net returns might influence the results, sensitivity analysis should be conducted.

Step 5: Non-financial benefits and poverty impacts

Due to time and budget limitations, economic valuation of non-market benefits related to improvements in health and nutrition, time savings and food security were not estimated. Further research is needed to develop a consistent framework for estimating these values.

As a first attempt to system capture non-financial benefits and impacts on poverty, the study analyzed a series of global poverty surveys and approximately 40 credible research studies. Drawing on the sustainable livelihoods framework, assessments were made of the non-financial incremental benefits and poverty impacts of multiple-use water services verses single-use services in terms of four key factors known to impact poverty: food security, health and nutrition, vulnerability/livelihoods diversification and social equity and empowerment (Ravnborg, et al. 2007). Each of these factors can contribute to other improvements in financial, human, physical and social capital, simultaneously alleviating multiple dimensions of poverty," (Ravnborg, et al. 2007). The potential poverty impacts of home gardens, livestock, small-scale enterprises and domestic uses of irrigation water for each factor were qualitatively ranked (low, medium, high).

Ranking of key findings from literature using the Millennium Ecosystem Approach

- **Well-supported**: significant number of high quality that consistently provide corroborating evidence
- **Partially-supported**: number of high quality studies, or numerous studies with only partial data, that provide consistent, but partial corroborating evidence.
- **Inconsistent evidence**: inconsistent findings from studies
- **Anecdotal evidence**: observed but not well studied or documented

To accurately reflect the incomplete nature of the available evidence, the research team utilized a ranking system of key findings based on the quality, quantity and consistency of available supporting data drawing upon the approach used by scientists in the Millennium Ecosystem Assessment Project (Millennium Ecosystem Assessment, 2006):

For each key finding, illustrative examples were provided. (See Renwick, et al 2007, Annex A for a detailed discussion of selected case studies for multiple-use by design, domestic+, and irrigation+ and Annex C for further examples by use and type of poverty impact.)

III. Evidence (or lack) regarding the benefits of MUS compared to single-use approaches

Evidence-base. While there is growing interest in multiple-use services, a key knowledge gap has been lack of information on the costs and benefits of multiple-use services in comparison to single-use services. Some studies and anecdotal evidences have suggested the net financial benefits of multiple-use approaches are greater than single-use approaches.

To test this hypothesis, the Global Scoping Study made the following calculations for new domestic and domestic+ services and for upgrading existing services to domestic+ and irrigation+

- The potential income generated from the most commonly observed productive activities—home gardens, livestock and small-scale enterprises—supported at each service level.
- The costs by service level for new domestic+ services and for upgrading existing domestic and irrigation services, including hardware, software and annual recurrent costs.
- Repayment periods for hardware and software based on average annual financial benefits less annual recurrent costs.
- Cost-benefit ratios with sensitivity analysis to evaluate how variations in net income might influence the results.

Key Findings: Summary of Benefits and Costs

- **Multiple-use services cost more than single-use services but generate greater income and poverty impacts** (see section 4 of the report for more details on poverty impacts).
- **For domestic+, the intermediate multiple-use service level optimizes benefits** (including poverty impacts) relative to costs for new services and most upgrades.
- **For irrigation+, upgrading from the basic irrigation to the basic multiple-use service level optimizes financial benefits relative to costs**, but upgrading to the intermediate multiple-use service level optimizes poverty impacts, including substantial health benefits in areas without domestic water services (see section 4 of the report).
- **Income generated by multiple-use services can enable repayment of initial and ongoing costs for some service levels and technology options**, making multiple-use services more likely to be sustained.
  - Incremental income benefits are sufficient to cover the costs of new piped domestic+ multiple-use services at the intermediate multiple-use service level. Repayment periods for systems at this level of service are between 6-36 months under typical microfinance conditions.
  - Upgrading existing domestic and irrigation services to the basic and intermediate multiple-use service levels can result in sufficient income to repay full investment costs and recurrent annual costs within 3-30 months.
  - Appropriate finance models, including possible subsidies for poorest households, will be required to ensure affordability and equitable access to services.

Key Findings: Domestic +

- **Once basic domestic needs are met (approximately 20 lpcd), each additional lpcd of water generates approximately $.5-$1/year of income**. Based on this analysis, improving water service levels from 20 to 100 lpcd has the potential to generate $40-$80 per capita per year. For a family of five this translates to an additional $200-$400 in income per year.

- Several factors cause variations in income benefits:
    - Differences in the asset base of households (different plot sizes, livestock types and numbers, and opportunities for small-scale enterprises) and extent of home consumption.
    - Differences in the nature and intensity of production (access to inputs, technologies, know-how, credit) and climatic factors.
    - Market prices and access, and financial, technical and managerial support
- For new services, the intermediate multiple-use service level optimizes income benefits (and poverty impacts) relative to costs. Income benefits are sufficient to cover the costs of new piped domestic+ multiple-use services with repayment periods of 6-36 months.
- For upgrades to existing services, the intermediate multiple-use service level optimizes income benefits relative to costs for piped systems and hand-dug household wells. For these two technologies, repayment periods for incremental upgrades range from 7-25 months, depending on the extent of the service upgrade and technology. For boreholes with hand pumps, the basic multiple-use service level optimizes income benefits with repayment periods averaging 12 months.
- In summary: Investments in upgrading domestic multiple-use services should focus on the intermediate multiple-use service level for piped systems and hand-dug wells, where incremental benefits are sufficient to cover capital investment and annual recurrent cost within 7-22 months. An attractive option for boreholes fitted with hand pumps is upgrading to the basic multiple-use service level through in situ add-ons for domestic and productive activities, with repayment period of 1 year.

Table 1. Incremental costs and benefits, repayment periods and benefit-cost ratios of upgrading domestic services

Water services systems	Technology	Capital investment costs (hardware plus software)	Annual income net of recurrent costs	Repayment period (months)	Benefit-cost ratio (10% discount rate)
Level 1 to Level 2: Basic Domestic to Basic Multiple Uses	Boreholes w/ hand pumps: in situ add-ons to support livestock, bathing and community gardens	$25	$22	12	5.4
Level 1 to Level 3: Basic Domestic to Intermediate Multiple Uses	**Range**	**$32-$84**	**$46-$58**	**7-25**	**4.7-8.6**
	Piped systems: increasing quantity and density of standpipes, adding some yard taps	$84	$46	22	4.7
	Hand-dug protected household wells: add improved lifting devices to increase quantity - treadle pump	$32	$58	7	8.6
	- rope pump	$56	$54	13	6.1
Level 2 to Level 3: Basic Multiple Uses to Intermediate Multiple Uses	Piped systems, increasing quantity and adding standpipes & yard taps to expand productive activities	$56	$26	25	3.9

Factors influencing the cost and ease of moving up the water service ladder

- **Population density and economies of scale of water supply**: The higher the population density, the smaller the per capita incremental costs of moving to a higher level of service.
- **Water availability**: Shallow groundwater sources cost less to develop; sources that are less distant are less costly to develop for networked systems.
- **Technology**: Technology choice is an important determinant of costs for both new services and incremental upgrades. For example, the initial costs of gravity-fed piped systems are significantly less than those for deep boreholes. For upgrades, the incremental costs are determined by existing technology and upgrade options.
- **Institutional readiness and implementation capacity**: As institutional readiness and implementation capacity increase, incremental costs (initial and recurrent) decrease.

Key Findings: Irrigation

- **The income generated by irrigation+ multiple use services can enable repayment of initial and ongoing incremental costs for irrigation+ multiple-use service upgrades, particularly at the basic and intermediate multiple-use service levels.**
    - Upgrading services from the basic irrigation to **basic multiple-use service level is the most financially attractive** upgrade investment option, with an average repayment period of 3 months.
    - **Poverty impacts are maximized at the intermediate service level**, where water services near the homestead provide for drinking and domestic needs, as well as productive needs. This service level is also an attractive investment option, with income benefits sufficient to cover investment costs in 12-24 months.
- The results suggest there are significant investment opportunities for upgrading existing irrigation systems to support multiple-use services to improve productivity of sunk investments and enhance poverty impacts, including health benefits. Upgrading services from basic irrigation to basic multiple-use is the most financially attractive investment option, but higher levels of service are also financially viable and generate more significant poverty impacts (including health and social equity benefits).

Table 2: Incremental costs,benefits, repayment periods and of upgrading irrigation services

Water services systems	Technology	Capital investment costs (hardware plus software)	Annual income net of recurrent costs	Repayment period (months)	Benefit-cost ratio (10% discount rate)
		per capita			
Level 1 to Level 2: Basic Irrigation to Basic Multiple Uses	In situ add-ons* to support livestock (drinking troughs and livestock crossings)	$10	$50	3	**27**
Level 1 to Level 2: Basic Irrigation to Intermediate Multiple Uses	Community water storage (including home water treatment and hygiene education) and in situ add-ons for livestock and domestic uses (bathing and laundry)*	$50-$110	$51-$57	12-24	**2.9 - 6.8**
Level 1 to Level 3: Basic Irrigation to Highest Multiple Uses	Household water storage (including home water treatment and hygiene education) and in situ add-ons for livestock and domestic uses (bathing and laundry)*	$98-$165	$58-$63	19-34	**2.2 - 3.9**

Source: Renwick, et. al 2007

Patchy evidence base in some key areas. The evidence base on multiple-use water services is 'patchy' in a number of key areas, including:

- **Research on *actual* verses *potential* performance** for multiple-use water services by design is **limited**. Further research is needed using performance based indicators and full costs of program related to both hardware and software costs. For example, in most cases water alone will not result in significant improvements in health and livelihood benefits without support such as technical training, outreach and education. More research is needed on the nature and cost of this support.
- **Sustainability**. More work is needed to evaluate claims related to enhanced sustainability of MUS over SUS.

IV. Opportunity Areas

In terms of identifying the three most promising next steps to tap untapped opportunities for MUS for practical design and implementation, I suggest the following:

1. **Practical conceptualization—WHAT is MUS?** More work is needed on conceptualizing MUS in practical terms related to design, implementation and operational models. What are the 'working models'?

2. **Implementation**—**HOW to implement MUS**? Through the Global Scoping Study we identified 5 high-potential areas for action (see table below) that have been selected based on financial sustainability; impact on well-being, health, and social empowerment; scalability; opportunities for leverage; and testing and learning opportunities. In addition to growing experience implementing activities in rural areas, Winrock is keen to pilot activities in the peri-urban and urban contexts—an area of significant potential that hasn't been fully explored..

3. **Monitoring and evaluation**. For MUS by design programs, better monitoring and evaluation is necessary to test developing models and corroborate/refute hypotheses and contribute to learning.

Table 3. Opportunity action areas

Opportunity Action Area	Potential Market & Pilot Locations	Capital investment costs/capita hardware and software (per capita)	Annual income net of recurrent costs (per capita)	Benefit-cost ratio (10% discount rate)
Opportunity 1. New piped multiple-use services for currently unserved at the intermediate service level	**137 million** (South Asia: 56 m SS Africa: 81 m)	**$56-$105**	**$41-$50**	**3.4-7.8**
Opportunity 2. Upgrading existing domestic piped systems to intermediate multiple-uses service level	**185 million** (South Asia: 144 m SS Africa: 41 m)	**$84**	**$45**	**4.7**
Opportunity 3. Boreholes with hand pumps: upgrading services to basic multiple-use service level through communal add-ons to support multiple uses	**280 million** (South Asia: 263m SS Africa: 17m)	**$25**	**$22**	**5.4**
Opportunity 4. Upgrading existing household hand-dug wells to the intermediate multiple-use service level through well protection and improved lifting devices	**74 million** (South Asia: 43m SS Africa: 31m)	**$39 - $102**	**$47-$55**	**3.4-8.6**
Opportunity 5. Upgrading existing irrigation systems to basic and intermediate service levels through communal add-ons,	**447 million** (South Asia: 443m SS Africa: 4m)	**$10 - $110**	**$50-$57**	**2.9 - 27**

Source: Renwick, et. al 2007

V. Priority Research Topics

- **Research to aid MUS planning and design,** including
  - Mapping water sources (developed and undeveloped), uses and users. Ideally, this should include physical mapping of resources, water accounting, and social accounting of uses/users and interdependence among uses/users.
  - Water service levels. Further research to corroborate/refute MUS water service levels (e.g. no service, basic domestic/irrigation, basic MUS, intermediate MUS, highest MUS).
  - Water technical options guidance document**.** Synthesis document with menu of technology options to facilitate design and planning, including for example, range of drilling, lifting, transport, storag**e,** treatment**,** and other technology options that

planners could examine to evaluate technology choices. This should include technical limitations, costs, maintenance requirements, etc. (Note: for a good example see "Linking technology choice with operation and maintenance in the context of community water supply and sanitation: A REFERENCE DOCUMENT FOR PLANNERS AND PROJECT STAFF" François Brikké and Maarten Bredero, World Health Organization and IRC Water and Sanitation Centre Geneva, Switzerland, 2003).

- Guidance document on supporting multiple-uses and achieving health, livelihoods and social empowerment benefits (financial and economic) associated with commonly observed uses: drinking/domestic, gardens, livestock and small-scale enterprises, including;
  - Nature and extent of use
  - Potential range of benefits
  - What's necessary to achieve benefits (e.g. improvements in health, income, etc.) in terms of typical support.
  - Examples to add in program design
- Guidance documents on institutional arrangements for multiple-use water services, including: water allocations rules, conflict resolution, cost recovery, etc.

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ANNEXES

Annex A. Example checklists of financial verses Economic Costs and Benefits

A.1 Example 1: Assessing costs and benefits of an integrated energy and sanitation initiative in sub-Saharan Africa. (Renwick, M and P. Sagar-Subedi, G. Hutton. 2007)

Table A.1: Costs and benefits of an integrated energy and sanitation intervention considered for household level and societal level analyses

Level of analysis	Costs	Benefits
Household-level analysis (financial)	✓ Cost of a biogas plant at the subsidized rate ✓ Cost of a pour-flush sanitary latrine ✓ Repair and maintenance costs of plant and latrine ✓ Cost of extra time consumed due to biogas installation ✓ Cost of extra time consumed due to biogas installation and adoption of improved hygiene practices ✓ Cost of hygiene materials purchased by the household ✓ Financing costs, if applicable	✓ Cooking and lighting fuel savings ✓ Time saving due to biogas ✓ Saving in household's health-related expenditures ✓ Income effects of improved health
Societal-level analysis (economic)	✓ Full cost of a biogas plant and latrine ✓ Repair and maintenance cost for biogas plant and latrine ✓ Cost of extra time due to biogas plant and latrine ✓ Cost of hygiene materials purchased by the household ✓ Technical assistance ✓ Program costs related to biogas and hygiene, including financing	✓ Cooking and lighting fuel savings ✓ Chemical fertilizer saving[7] ✓ Time saving due to biogas and latrine (fuel collection, cleaning and cooking, latrine access) ✓ Saving in all health-related expenditures ✓ Time savings due to improved health ✓ GHG reduction ✓ Local environmental benefits

Excerpted from text…

> ***"Overview of the Study and objectives***
> *The main goal of this study is to document and quantify the costs and benefits of the Biogas for Better Life Initiative—an integrated biogas, sanitation, and hygiene program. Costs and benefits are estimated at the household and societal levels, for the Sub-Saharan Africa initiative as a whole as well as for three county-level programs in Uganda, Rwanda, and Ethiopia, which are in varying stages of development. This analysis is intended to aid policy makers in their decision-making process with respect to biogas plant or other household energy interventions as well as sanitation and hygiene interventions. Individual households make decisions based on perceived costs and benefits to the household. It is therefore important for individual households to know whether switching from traditional cooking fuels to a biogas plant, with an attached latrine in some cases, is advantageous. The specific objectives of the study are grouped into two categories:*

[7] Given the very low levels of chemical fertilizer use, fertilizer cost savings are considered only as economic, rather than financial benefits.

Household Perspective (financial):

- *To identify the total costs related to biogas plant installation at the household level, including costs related to installation of improved latrine and adoption of better hygiene practices for participating households*
- *To identify the total benefits resulting from biogas plant installation at the household level, including benefits related to installation of improved latrine and adoption of better hygiene practices for participating households*
- *To identify net benefits, benefit-cost ratios and financial internal rates of return resulting from biogas plant and latrine installations and improved hygiene practices per individual household.*

Societal Perspective (economic):

- *To identify the total costs to society related to an integrated biogas, sanitation, and hygiene program*
- *To identify the total economic benefits to society related to an integrated biogas, sanitation, and hygiene program*
- *To identify net benefits, benefit-cost ratios and economic internal rates to society related to an integrated biogas, sanitation, and hygiene program. "*

A.2 Example 2: Assessing economic returns of labor programs

(see http://rru.worldbank.org/documents/toolkits/labor/toolkit/module7/assessing_economic_returns.html#table7_4)

Table 7.4: Economic vs. Financial Costs and Benefits

Item	**Cost and benefit items**	**Include in financial analysis?**	**Include in economic analysis?**
	Costs		
1	Financial costs of severance	Yes	Yes-adjusted
2	Financial costs of early retirement	Yes	Yes-adjusted
3	Financial costs of redeployment	Yes	Yes-adjusted
4	Marginal productivity of employees in the SOE	No	Yes
	Benefits		
5	Financial savings on wages	Yes	No
6	Financial savings on nonwage benefits	Yes	No
7	Marginal productivity of worker outside the SOE	No	Yes
8	Marginal productivity value of labor savings	No	Yes
9	Increase in privatization proceeds from downsizing	Yes/No	No
10	Increase in privatization proceeds from faster PPI	Yes/No	No

Annex B: Water Service level definitions from MUS Global Scoping Study (see Renwick, et al 2007)

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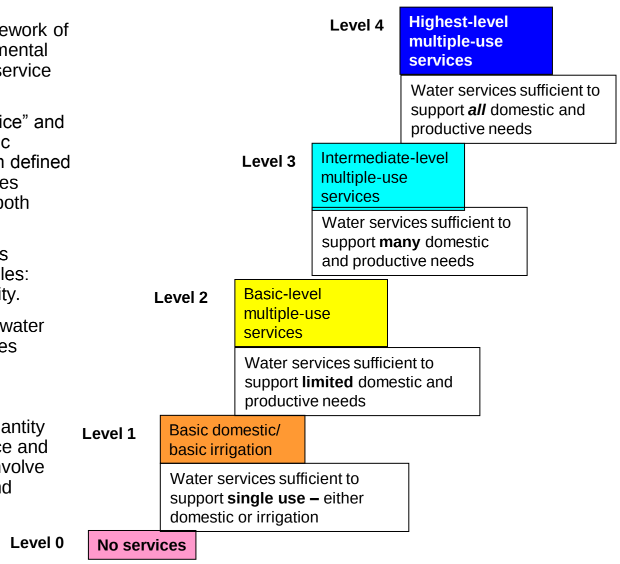
1.3.1 Framework: Water Service Levels

The research team developed a framework of service levels for analyzing the incremental benefits and costs of different water service approaches.

Building on the definitions of "no service" and single-use "basic domestic" and "basic irrigation" services, the research team defined three additional levels of water services required to support varying levels of both domestic and productive uses.

Each different service level represents changes in two or more of four variables: quantity, quality, distance and reliability.

To reflect fundamental differences in water service provision, our typology includes separate service level definitions for "domestic-plus" and "irrigation-plus" approaches. In general, domestic+ approaches involve increasing the quantity and reducing distance between source and homestead. Irrigation+ approaches involve reducing distance between source and homestead and improving quality



See sections 1.3.3 and 1.3.4 for service level definitions

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1.3.2 Water Service Levels Required to Support Multiple Uses

For existing domestic services, supporting multiple uses requires increasing water quantity and reducing the distance to the source.

For existing irrigation services, supporting multiple uses requires improving water quality to support domestic uses, improving reliability, and reducing distance from source to homestead and other access barriers.

Determinants of water service levels	**Domestic**	**Multiple Use**	**Irrigation**
Quantity	**Increasing water quantity to support productive uses** →		
Quality		← **Improving water quality to support domestic uses**	
Reliability		← **Making water availability more reliable to support non-irrigation uses**	
Distance (physical, social and economic barriers to access)	**Reducing distance between water source and homestead to support productive uses** →	← **Reducing distance to homestead, improving physical access to canals and removing social barriers for non-irrigation users to support other uses**	

1.3.3 Domestic+ Water Service Levels Defined

Service level	Overview	Quantity (lpcd)* *Per capita*	Quantity for productive use at *household* level	Needs met and multiple use potential
Highest-level multiple uses	**House and yard connections** Access: at homestead Quantity: > 100 lpcd Quantity: Improved source Reliability: daily	>100	>475	Sufficient for domestic needs Not all but in some combination: Sufficient for livestock Sufficient for gardening (~50m² – >200m²) Sufficient for many small-scale enterprises
Intermediate-level multiple uses	**Improved source very close to home**. Access: < 5 minutes roundtrip, < 150m Quantity: 40 – 100 lpcd Quality: improved source Reliability: daily	40-100	175 – 475	Sufficient for basic domestic purposes Not all but in some combination: Sufficient for livestock (7 – 17 cows) Sufficient for gardening (~25m² – 200m²) Sufficient for some small-scale enterprises
Basic multiple uses	**Improved source, easily accessible** Access: < 15 minutes roundtrip, < 150-500m; Quantity: 15-50 lpcd Quality: improved source Reliability: daily or storage	15 – 50	50 – 280	Sufficient for basic domestic purposes Not all but in some combination: Sufficient for some livestock (15 goats/8-10 cows) Some gardening, especially with re-use(~10-100m²) Some small-scale enterprises
Basic domestic	**Improved source** Access: up to 30 minutes roundtrip, < 1km Quantity: 10-25 lpcd Quality: improved source Reliability: daily or storage	10-25	25 - 100	Sufficient drinking and cooking Hardly sufficient for basic hygiene Not all but in some combination: Insufficient for cleaning house Possibility for re-use for horticulture and very limited livestock (chickens or goat)
No service	**Unprotected or distant improved sources** Access: > 30 minutes roundtrip, >1 km Quantity: < 5 lpcd Quality: unimproved source Reliability: daily	< 10	<25	If improved source, may be sufficient for drinking and cooking but too distant Insufficient for basic hygiene

*lpcd = liters per capita per day

Annex C: Selected list articles reviewed to identify typical uses, costs, benefits and poverty impacts of multiple use approaches

	Geographical Area	Home Gardens	Livestock	Small Scale Enterprises
Domestic plus	**Sub-Saharan Africa**	**South Africa (9)** (Perez de Mendiguren, 2003; Hope, Dixon and von Malitz, 2003; McKenzie, 2003; Perez de Mendiguren and Mabelane, 2001; Soussan et al, 2002; Maluleke et al 2005; Maunder and Meaker, 2006; Gilimani, 2005; Averbeke and Khosa, 2007); **Zimbabwe (3)** (Proudfoot, 2003; Plan International; FAO, 2005); **Senegal (2)** (Brun et al, 1989; Marek et al 1990); **Cameroon** (Bradford et al, 2003); **Sudan** (Plan International); **Zambia** (Plan International); **Mauritania** (Bingham, 2007)	**South Africa (3)** (Perez de Mendiguren, 2003; Perez de Mendiguren and Mabelane, 2001; Gilimani, 2005); **Uganda** (Kabirizi, 2004); **Mauritania** (Bingham, 2007); **Sudan** (Plan International); **Zambia** (Plan International)	**South Africa (3)** (McKenzie, 2003; (Perez de Mendiguren and Mabelane, 2001; Perez de Mendiguren, 2003) **Malawi** (Mulwafu, 2003)
	South Asia	**Nepal (2)** (Pant, 2005; NEWAH, 2005) **India** (Bradford at al., 2003) **Bangladesh (2)** (Helen Keller Foundation, 2001; Marsh 1998)	**India (4)** (Bradford, et al 2003; Upadhyay, 2004; James, 2003; Verhagen, 2004); **Nepal** (NEWAH, 2005)	**India (3)** (James, 2003; Verhagen, 2004; James et al, 1992)
	Other	**Vietnam (2)** (SEI; URS, 2004)**; Nicaragua** (Alberts and van der Zee, 2003); **Global** (Nugent, 2000; IFRI, 2001); **Asia-Pacific** (Helen Keller International, 2001)	**Global** (Gura and LPP, 2003)	**Colombia** (Smits, et. al., 2003);
Irrigation plus	**Sub-Saharan Africa**	**Kenya** (Plan International);l **Sub-Saharan Africa** (Inocencio, 2002)	**Uganda (2)** (Dolan, 2002; van Hoeve and van Koppen, 2005); **Kenya** (Plan International); **Ethiopia (2)** (van Hoeve, 2004; van Hoeve & van Koppen, 2005);	
	South Asia	**Sri Lanka (2)** (Meinzen-Dick & Bakker, 2001; Molle and Renwick, 2005); **Bangladesh** (AVRDC, 2000)	**Sri Lanka (2)** (Meinzen-Dick and Bakker, 2001; Bakker and Matsuno, 2001) **Pakistan (4)** (Jehangir, Madasser, Ali, 2000; Ensink et al 2002; Jensen et al 2001; van der Hoek, 2002b); **Nepal** (Thomas-Slayter and Bhatt, 1994)	**Sri Lanka (2)** (Meinzen-Dick and Bakker, 2001; Bakker and Matsuno 2001)
	Other		**Morocco** (Boelee & Laamrani, 2003)	**Morocco** (Boelee and Laamrani, 2003)
MUS by design	**Sub-Saharan Africa**	**Zimbabwe (2)** (Waughray, et al, 1998; Matthew, 2003)		**Zimbabwe** (Matthew, 2003)