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The Role of Productive Water Use in Women's Livelihoods: Evidence from Rural Senegal

Emily van Houweling

School of Public and International Affairs, Virginia Tech, Blacksburg, VA, USA; evh@vt.edu

Ralph P. Hall

School of Public and International Affairs, Virginia Tech, Blacksburg, VA, USA; rphall@vt.edu

Aissatou Sakho Diop

iDEV-ic, Dakar Yoff, Senegal; astoudiop@idev-ic.com

Jennifer Davis

Department of Civil and Environmental Engineering, Stanford University, Stanford, CA, USA;
jennadavis@stanford.edu

Mark Seiss

Department of Statistics, Virginia Tech, Blacksburg, VA, USA; mseiss@vt.edu

ABSTRACT: Enhancing livelihoods and promoting gender equity are primary goals of rural development programmes in Africa. This article explores the role of productive water use in relation to these goals based on 1860 household surveys and 15 women's focus groups conducted in four regions of Senegal with small-scale piped water systems. The piped systems can be considered 'domestic plus' systems because they were designed primarily for domestic use, and also to accommodate small-scale productive uses including livestock-raising and community-gardening. This research focuses on the significance of productive water use in the livelihood diversification strategies of rural women. In Senegal, we find that access to water for productive purposes is a critical asset for expanding and diversifying rural livelihoods. The time savings associated with small piped systems and the increased water available allowed women to enhance existing activities and initiate new enterprises. Women's livelihoods were found to depend on productive use activities, namely livestock-raising and gardening, and it is estimated that one half of women's incomes is linked to productive water use. While these findings are largely positive, we find that water service and affordability constraints limit the potential benefits of productive water use for women and the poorest groups. Implications for targeting women and the poorest groups within the domestic plus approach are discussed.

KEYWORDS: Water supply, women, multiple-use water services, domestic plus, Senegal

INTRODUCTION

In rural sub-Saharan Africa, women often have insecure livelihoods and a lack of income-generating activities. Inadequate water access for productive purposes is one of the factors that increases the vulnerability and poverty of women and their households (Faures and Santini, 2008). This article investigates the potential of 'domestic plus' (van Koppen et al., 2006) water systems to facilitate

livelihood diversification activities and increase income for women. The water systems in Senegal are referred to as 'domestic plus' systems because they were designed primarily for household uses, and also include productive use design features. Livelihood diversification has been explored from many perspectives, but there has been little research investigating how productive use activities contribute to livelihood diversification strategies.

The diverse ways that women use water for home-based productive purposes are generally invisible to policy makers, and not considered to be significant to household livelihood strategies (Zwarteveen, 1997; Waughray et al., 1998). This research contributes a characterisation of women's productive use activities in rural Senegal and provides an analysis of the income and livelihood benefits of domestic plus water systems. In this article, productive use activities are the non-domestic activities or livelihood activities (i.e., livestock-raising, agriculture, and some small-scale commercial service, and manufacturing activities) that rely on the domestic plus water systems or alternative water sources.¹

The 47 rural water systems included in this study typically served multiple villages and consisted of an electric-powered pumped borehole, a water tower, and a small-scale distribution system with any number of public and private taps. Nearly all of the systems in Senegal included productive use design features: 43 of the systems had at least one livestock-watering trough, and 27 had at least one water tank to service small-scale agriculture/gardening.

Following this introduction, the next section introduces the concepts of productive use and livelihood diversification to develop a working synergy between the two ideas. This section also briefly reviews the current state of knowledge about the livelihood benefits of productive use for women. The following sections successively describe the research background and methodology, present the research findings, and discuss how women and the poorest groups benefit from the domestic plus systems. Planning and policy recommendations are then offered. The article concludes with a brief synopsis.

LITERATURE REVIEW

Productive use of domestic water

Rural livelihoods in sub-Saharan Africa are highly dependent on natural resources and water may be one of the largest constraints to expanding and diversifying livelihood activities. Water is a basic need and a productive asset. However, water supply programmes typically focus on providing water to meet basic or domestic needs, such as drinking, cooking, washing, and bathing, and fail to incorporate household-based productive use (Faures and Santini, 2008; van Koppen et al., 2009).

Since the mid-1990s there has been a growing interest in how people use domestic water for their productive activities and how water is tied to rural livelihoods. Case studies from around the world reveal that water is used for productive activities such as agriculture, gardening, horticulture, livestock-raising, car-washing, arts, ice-making, brick-making, pottery, butchery, and other small-scale commercial activities (van Koppen et al., 2009; Smits et al., 2010). An improved awareness of how water provided for domestic use was also used for non-planned purposes led to an alternative approach to rural water provision called 'Multiple-Use Services' (MUS).

MUS describes an approach that seeks to "plan, design, and manage water services with the aim of meeting people's water needs for multiple purposes" (Smits et al., 2010). MUS does not necessarily require new technology, but rather calls for the enhancement and integration of existing water technologies to make greater quantities of water available in a way that is best suited to the needs of

¹ Rain-fed activities, such as agriculture, are not considered to be productive use activities in this paper.

rural households (Smits et al., 2010). Domestic plus systems, which are the focus of this paper, can be considered a basic level of MUS.

Providing more water and creatively designing water services around productive activities can enhance people's livelihoods and contribute a wider range of benefits than traditionally designed domestic systems (Smits et al., 2010). For example, additional benefits from productive use activities include improved health, food security, income generation, and women's empowerment (Renwick et al., 2007; van Koppen et al., 2009).

Livelihood diversification and productive use

Livelihood diversification has been one strategy adopted by individuals and rural households in the Sahel to deal with the increasing uncertainty of agriculture, the withdrawal of state services, and the need for a cash income (Batterbury, 2001; Guérin, 2006; Yaro, 2006). Ellis (1998) defines livelihood diversification as "the process by which rural families construct a diverse portfolio of activities and social support capabilities in their struggle for survival and improving their standards of living". By engaging multiple assets in a plurality of activities, rural households and individuals can spread risks and achieve greater livelihood security. For the poorest households, livelihood diversification provides many small streams of income that act as a safety net and helps households cope with droughts, floods, price fluctuations, and other shocks (Davis et al., 2009).

The role of water use in livelihood diversification strategies remains relatively unexplored. Some studies have shown that households with access to water for productive uses are able to diversify homestead production with small-scale cultivation, kitchen gardens, animal-raising or other small-scale commercial services, or manufacturing activities (van Koppen et al., 2009). For example, in rural Vietnam, Noel et al. (2010) found that a domestic water supply system was used for many types of household-based enterprises such as vegetable cultivation, pig-raising, drink stands, small eateries, tea shops, hairdressing shops, and motorbike washing. While productive use activities are generally not the primary source of a family's income or food, they do play an important role in people's livelihoods (Smits et al., 2010; Noel et al., 2010). According to Renwick et al. (2007), 60-70% of the rural poor are estimated to raise livestock, have access to small cultivable plots (often around their homesteads), and engage in water-dependent small enterprises. Water systems designed to address productive as well as domestic uses may be able to unlock the potential of these activities and encourage additional productive use activities (ibid).

Women and productive use

It is well substantiated that improving *domestic* water access differentially benefits women due to their roles as water collectors and managers within the household sphere. In contrast, there has been less research about how women benefit from productive use opportunities and how the benefits of productive use are allocated within the household. This, in part, stems from the widespread belief that women use water only for domestic activities (Zwarteveen, 1997). Women's small household-based activities such as gardening, brewing, ice-making, and petty commerce have been traditionally overlooked in the water sector (Waughray et al., 1998; van Wijk-Sijbesma, 1998; Moriarty and Butterworth, 2003).

The limited research that has addressed women's productive water use reveals a wide spectrum of benefits for women. Domestic plus water systems have been found to be 'women friendly', 'empowering', and 'gender equitable' (van Koppen et al., 2009; Aladuwaka and Momsen, 2010). Findings from several case studies show that domestic plus systems allow women to diversify their activities and generate alternative income streams (Noel et al., 2010). In Sri Lanka, a large domestic plus water system enabled women to start vegetable cultivation, brick-making, fruit picking and processing, and mushroom and poultry production (Aladuwaka and Momsen, 2010). In Zimbabwe, poor women

earned incomes through gardening and other productive activities based around collector wells (Waughray et al., 1998).

The profits from productive use activities are typically small, but they have positive economic spill over effects for women. Waughray et al. (1998) found that the financial benefits associated with productive use activities in Zimbabwe were reinvested to promote diversification into other income-generating activities. Similarly, in Lege Dini, Ethiopia, the extra milk from dairy animals, and time savings gained from an improved water source, allowed women to organise into collective groups to sell their milk in larger markets (van Hoes and van Koppen, 2005). Caution should be taken when drawing casual claims about the consistency or strength of these relationships because they do not involve comparisons in similar communities without access to domestic plus systems. It could be the case that women without access to domestic plus systems draw on other inputs to diversify their livelihoods or rely more heavily on non-farm activities than women with access to domestic plus systems.

Indirect benefits of women's productive water use were also identified in an eight-country study on MUS conducted on three continents. Van Koppen et al. (2009) found that MUS promoted gender equity by providing more accessible water services for women's home-based activities and reducing the time burden of water collection. In addition, the study showed that many of the household-level, productive use activities were controlled by women (ibid). The authors argued that because women had more say over home-based production, increasing women's earning power in these activities through MUS can translate into greater decision-making power and status for women. Van Koppen et al. (2009) concluded that domestic plus systems were a pro-poor and women-friendly intervention due to the concentration of women's activities near the home and the lack of opportunities women and the poor have elsewhere.

Apart from these few studies, there has been little rigorous research looking at the benefits of home-based productive use on women's livelihoods. Furthermore, little is known about the conditions under which productive use is (and is not) beneficial for women. Women are seen as a homogenous group undifferentiated by class, marital status, age, religion, caste, etc. Beyond these personal characteristics there are also water-system and community-level factors that shape the opportunities women have to engage in productive use activities (Jordans and Zwarteveen, 1997; Moriarty and Butterworth, 2003). For example, in Gujarat, India, women reported that their ability to earn an income from productive use activities depended on their access to a whole chain of inputs, such as land, seeds, fertilisers, animals, training, credit, and extension services (Sijbesma et al., 2009).

The research that follows describes the role of productive use activities in women's livelihoods and income earning strategies in rural Senegal. The article also discusses some key obstacles that women and the poorest households face in taking advantage of their domestic plus systems.

RESEARCH METHODOLOGY

Research background

The data for this study were collected as part of a project of the Water and Sanitation Program (WSP) entitled, *Assessing the link between productive use of domestic water, poverty reduction, and sustainability*. The primary objective of the project was to explore the extent to which, and conditions under which, the productive use of water can reduce poverty, enhance the financial sustainability of water services, and advance important social goals such as gender equality in rural areas. These research questions were addressed using a mixed method research design in 47 systems in four regions of Senegal (Kaffrine, Diourbel, Matam, and Saint Louis). The four study regions were selected to represent a range of livelihoods, and hydrologic and climatic conditions in Senegal.

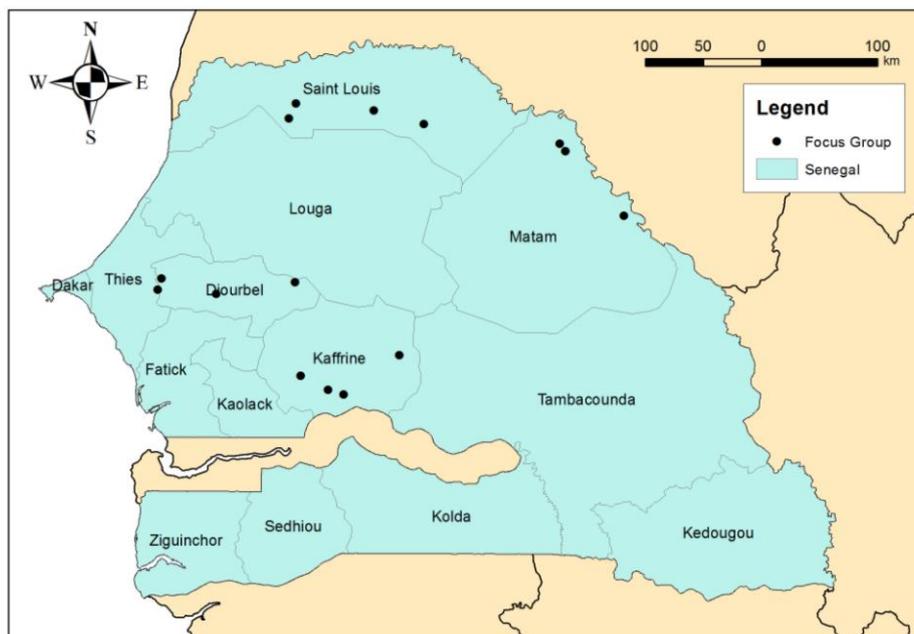
On average, 40 household surveys were completed within each of the 47 communities. In each community households were randomly selected to participate and all respondents granted verbal consent before they were interviewed. The surveys were conducted with PDAs and included sections related to household demographics, water access, water use, income, and assets.

The following instruments were completed in the research communities: 1860 household surveys, 47 village leader interviews, 46 water committee interviews, 44 water operator interviews, 47 engineering assessments, and 15 focus groups with women. The research presented in this article is only a small part of the overall findings and primarily concentrates on the data obtained from the 15 women's focus groups.

Focus group methodology

Focus groups were conducted in 15 of the 47 systems where the household surveys took place (figure 1). Four focus groups were conducted in each of the survey regions, except for Matam where only three focus groups took place. The 15 communities were selected by the regional water authorities and iDEV-ic personnel² to be representative of each region and the diversity within the region.³ The focus groups were designed to understand the benefits of the productive use of water by women, and the conditions under which these activities led to women's empowerment, equality, and poverty reduction. Equally important, the focus groups provided an opportunity to capture women's unique perspectives in a format that allowed for open-ended discussion, debate among participants, and in-depth follow-up.

Figure 1. Map of 15 focus group communities.



In each community the water committee was contacted along with the proper village authorities to ask for permission to carry out the focus group discussions. The women were invited to attend by either

² iDEV-ic was the primary in-country research partner in Senegal.

³ A comparison of selected community and household-level variables between the focus group communities and the other communities in the sample revealed no statistical difference between the two groups, apart from women's income and access to public taps (but not private taps). Women's income was statistically higher in the focus group communities, but there was no significant evidence to conclude that women's productive income was different between the two groups.

the water committee members or village leaders. Participation in the focus groups was voluntary and all focus group participants gave their verbal consent. The need to select women who were representative of all the different types of women (in terms of age, class, geographic location, and livelihood activities) in the community was stressed, but it was admittedly difficult to determine how 'representative' the final group was. This challenge is not unique to Senegal, but is an inherent issue of focus group methodologies.

The focus groups were designed to accommodate around 15 women; however, the groups ranged from 13 to 63 participants with an average of 33 women (table 1). While this large-sized group is not ideal for focus groups, it would not have been culturally appropriate to dismiss some of the women who had taken time out of their day to attend. In the larger-sized groups there were around a dozen women who spoke, but the rest of the women actively participated through verbal and non-verbal expressions of approval or disapproval during the discussions. Rather than seeing this large size as a downfall, we found that it added to the diversity of opinions and provided immediate feedback as to whether the speaker's opinions resonated within the group.

Table 1. Focus group sample frame: key variables.

	Community population	Number of participants	Age of water system (years)	Distance to city	Price of public tap (\$/m ³) ⁴	Price of private tap (\$/m ³)
Median	1805	30	20	25	0.78	0.44
Mean	2096	33	18.5	30.5	0.73	0.52
Minimum	293	13	4	6	0.44	0.44
Maximum	6350	63	37	81	1.00	0.76
Standard Deviation (SD)	1891	15.6	9.6	21.7	0.22	0.12
Number	15	15	15	15	11	12

The focus groups were structured around four basic questions and two participatory activities.

- What are women's primary livelihood activities?
- How do women use water for home-based productive use purposes?
- What constraints do women face in expanding and diversifying their home-based productive use activities?
- How did the construction of the piped water system impact women's lives?
- Participatory community timeline
- Participatory income expenditure activity

⁴ Data on the public tap tariff were averaged at the system level from household survey responses and the single response provided by the water committee. The private tap data were taken from the single response given by the water committee, due to the unreliability of the data provided by the few surveyed households using private taps in each community. In three of the focus group communities, households paid for water by the month. These households paid between US\$2.20 and US\$4.40 per month.

The village timeline activity involved a group discussion about significant historic events in each community. The activity started with the group drawing events that everyone remembered on a large piece of paper with a timeline. After this task, the discussion was directed towards changes in water system infrastructure. The goal of the activity was to identify significant events in women's lives and understand how the water system fitted within the historical framework. This activity also provided a good foundation for discussing changes in women's lives before and after the domestic plus system was constructed.

The income expenditure activity was conducted to understand how the income from home-based productive use activities⁵ was generally spent. Each woman was given 20 small stones (representing 1000 fCFA or about US\$2.22) and instructed to place the stones on prepared picture cards in a way that represented how they spent their income earned from productive use activities. This activity was well received and popular during the focus groups. In most cases, there was a high degree of variation within the group and a consensus was not possible. This variation reflects a range of individual investment strategies and diversification profiles. Between five and eight women in each community completed this activity⁶ and averages based on their individual decisions were taken at the community level.

RESEARCH FINDINGS

Household characteristics

The household survey data show that the average household size in the 47 communities surveyed was 12.8 persons. The level of education and literacy among the survey respondents was low; 86% of respondents had no formal education. The majority of survey respondents were male household heads (58%). Female-headed households represented one-third of the respondents (31%), and the remaining respondents were either another adult female in the household (3%), a brother (2%), or an adult son of the household head (6%).

Figure 2. Example of productive use design features.



Cattle trough



Small agricultural water tank

Livelihoods in the four regions were based on farming activities. More than 80% of households surveyed practised agriculture, and 69% of households raised livestock. In the dryer northern regions of Senegal, livestock-raising was a more significant component of household incomes than it was in the central and southern regions of the country. In Saint Louis, 84% of the population in the study

⁵ While the group was instructed to think only about the income they earn from water-based activities, we suspect that, in the majority of cases, women allocated the stones based on the total income they earn.

⁶ Time constraints made it difficult to allow more than a few women to participate in this activity.

communities owned at least the equivalent of two livestock units, as compared to 59% in Matam, 55% in Diourbel, and 44% in Kaffrine. Wage earning, migration activities, petty commerce, and service activities were also important income-generating activities in Senegal. Based on the household survey data, men had the highest participation rates in agriculture, livestock-raising, migrant wage labor, services, and commerce. Women, on the other hand, participated most frequently in agriculture, livestock-raising, commerce, gardening, and seasonal wage work. Additionally, children played a significant role in agriculture, gardening, livestock-raising, and collecting forest products.

Water resources in study regions

Overall, 44% of people in rural Senegal lack access to clean water (JMP, 2010). Only communities with small-scale piped water systems were included in this study; therefore, the use of public and private taps is higher in the study communities than in the general population.⁷ Almost 85% of the sample households used water from the piped system, relying on either public (55%) or private taps (29%). The water systems included in the study were designed primarily for domestic uses, but included features such as water troughs for livestock and small-scale irrigation systems for collective gardening (figure 2). Public wells were the second most utilised water source (36%) in the research communities, followed by rainwater collection (15%), and hand-pumps (8%). Surface water was especially important to livestock users. The median number of water sources used by a household was 1.4. The median round-trip time to collect water from a public tap (including time waiting at the tap) was 33 minutes during the wet season and 43 minutes during the dry season. High standard deviations for these data indicate that while some water users were not far from their water sources, others had to walk a much longer distance.⁸

Productive use in Senegal

Three-quarters of the households surveyed were engaged in productive use activities. These activities included livestock-raising, agriculture, gardening, and also select commercial and service activities (table 2). The women's focus groups revealed that these activities took place at a smaller scale before the water systems were constructed, with households relying on traditional water sources. Even after the construction of the piped systems, only about one-half (54%) of households used the piped system for these activities, and the others relied predominantly on wells, rainwater collection, and/or surface water. Livestock-raising was the most common productive use activity in Senegal. Almost 70% of households raised livestock, and most of these households used both the piped system and surface water or well water to support their livestock (table 2). However, only 61% of the householders who participated in livestock-raising earned an income from this activity (table 2).

Agriculture was the most important livelihood activity in rural Senegal, but the vast majority of family farms were rain-fed and only 3% of the surveyed households irrigated their fields with any water source (table 2).⁹ Conversely, gardening was only practised by 8% of surveyed households, but almost 70% of these households irrigated their garden crops (table 2). Water was used for small commercial activities in 5% of households and for service activities in 3% of households. Within these two general sectors, water was used most frequently for house construction, selling prepared foods, and small-scale agro-processing.

⁷ JMP (2010) data show that 13% of the rural population in Senegal has access to piped water on their premises, and the same is true for 75% of the urban population.

⁸ Piped system, wet season, round-trip times (minutes): Median 33, Mean 12, SD 57, n=984. Piped system, dry season, round-trip times (minutes): Median 43, Mean 18, SD 68, n=987.

⁹ Less than 1% of households interviewed used the piped system to irrigate their fields.

Table 2. Household participation in income-generating and productive use activities.

	Percentage of households			
	Participating in this activity	Earning income from this activity	Using water for this activity ¹⁰	Using piped water for this activity
Agriculture	84 (n=1860)	46 (n=1562)	3 (n=1562)	1 (n=1562)
Livestock-raising	69 (n=1860)	61 (n=1280)	100 (n=1280)	73 (n=1280)
Commerce	33 (n=1860)	79 (n=609)	14 (n=609)	12 (n=609)
Service activities	21 (n=1860)	61 (n=393)	15 (n=393)	12 (n=393)
Gardening	8 (n=1860)	54 (n=166)	68 (n=166)	48 (n=166)
Manufacturing	2 (n=1860)	93 (n=28)	21 (n=28)	18 (n=28)
Total	97 (n=1860)	91 (n=1802)	76 (n=1802)	64 (n=1802)

Income earned from productive use activities

A median monthly household income of US\$121 was calculated from the household survey data. On average, women provided 13% of the total household income. However, a comparison of women's income, as reported by male and female respondents, shows that female respondents report statistically higher incomes.¹¹ Considering the fact that only one-third of respondents were female there is reason to believe that women earn more income than was captured by the household survey.

The proportion of income earned by women for each activity varies. For example, women earned around three-quarters (73%) of the household income gained from selling livestock products and around one-third of the household income from gardening (30%), commerce (35%), and manufacturing (36%), and one-fifth of the income from agriculture (23%) and handicrafts (20%). Women played a less significant role in the income earned from the sale of livestock and earned only one percent of total seasonal wage income, which is, on average, the largest income-generating activity for households. While women were almost as active as men in agriculture¹² they earned substantially less income from this activity suggesting that men tend to sell the agricultural crops.

¹⁰ Does not include rainwater.

¹¹ Some of women's income is likely to go unreported by men. Women often try to hide the money that they earn to retain greater control over it, and the money women earn from personal ventures is often not considered to be part of the household income. Men's reported incomes may also be unreliable due to the lack of records of their earnings, the desire to hide their true earnings in front of family or friends who might request financial assistance, and a suspicion that the surveyors could inform tax authorities. It should be noted, however, that similar challenges are confronted in all surveys that ask about income in developing countries. The high variances associated with productive income make it difficult to assess whether women's productive income was statistically different depending on the gender of the respondent.

¹² Calculated as the number of men, women, and children in each household involved in agriculture.

Income earned from productive use activities was an important component of household income. In total, households generated 33% of their total income from productive use activities supported by any water source. The number falls to 16% when considering income from productive activities that used the piped water system. It can be assumed that more than 16% of income was linked to the piped water system because it freed up traditional sources to be used for other productive purposes. The sale of livestock and livestock products was the most significant productive use activity for households. Women contributed 14% of the income that households earned from productive use activities, and 16% of the productive use income households earned from activities that used the piped system.

More than one-third (35%) of women's personal income was earned from productive use activities supported by any water source and about one-fifth (19%) was earned from productive use activities supported by water from the piped system (table 3). Interestingly, approximately the same percentage of men's income (one-third) also came from productive use activities supported by any water source. However, considering only piped sources, women's productive use income is more dependent on the water system than men's income (19% vs. 15%) (table 3).

Table 3. Men's and women's income earned from productive use activities.

		Men	Women
Income earned from productive use activities	All sources	\$0, \$72	\$0, \$15
	Median, mean (SD)	(\$246)	(\$46)
		n=1440	n=1109
	Piped sources	\$0, \$33	\$0, \$8
Percentage of personal income earned from productive use activities	Median, mean (SD)	(\$177)	(\$28)
		n=1440	n=1109
	All sources	33%	35%
	Piped sources	15%	19%

Women's productive use activities, data from focus groups

The women's focus groups reveal high participation rates in women's home-based productive use activities and provide insight into the significance of these activities to women's livelihoods (table 4). We suspect that women's productive use activities were under-reported in the household survey due to the discounting of women's smaller income streams, women's tendency to hide their personal incomes, and the higher percentage of male respondents in the household survey.

Livestock-raising and gardening were the two most common productive use activities that women mentioned in the focus groups. Women from all 15 of the focus group communities reported raising livestock, and many regarded it as their most important livelihood activity. During the income expenditure activity, conducted during the focus groups, women also reported investing more money in livestock than in any other single category.¹³ The value of livestock in women's lives cannot be overstated. Livestock are not only an important income source; they also act as a form of savings and insurance, generate social capital, and increase household food security. Women reported selling their livestock if there was a household difficulty or an immediate need for cash. This money might be needed to cover sudden healthcare costs, education fees, or food purchases. In this way, livestock can be viewed as a form of insurance that can easily be converted to cash income when there is an

¹³ The number one investment for women was their livestock, followed by food, health care, commercial activities, education, and clothing.

emergency. Livestock are also central to participation in community life and social exchange networks. Goats and sheep are often gifted or consumed during *Tabaski* and life cycle ceremonies. Some women also make small streams of income selling animal products, primarily milk - but also eggs, yogurt, butter, and cheese.

Table 4. Summary of women's productive use activities from focus group communities.

	Number of communities where women participated in the activity	Percentage of communities where the activity took place
Livestock-raising	15	100
Gardening	9	60
Selling water or ice	8	53
Fabric-dying	5	33
Selling fruit juice	4	27
Soap-making	4	27
Pottery	2	13
Henna tattooing	1	7

Gardening activities were highly sought after by women and practised in 9 of the 15 communities where the focus groups occurred. In all but one of the villages, gardening was primarily a woman's activity. Individual and household plots were the most common, but in five communities women had plots in large community gardens (figure 2). The gardens were typically irrigated using water from the piped system. In one community, the piped system connected directly to a drip irrigation system that supplied water to the women's garden. An irrigation system with a series of water tanks also provided water to two other community gardens. The remaining gardens were manually irrigated by carrying buckets of water from nearby wells.

Gardening is a social activity for women and the community gardens were generally initiated and managed by women's associations. Women grew a wide variety of crops in their gardens and more than 40 different crops were identified in the focus groups. The most prevalent crops grown included onion, tomato, lettuce, okra, pepper, eggplant, cabbage, and hibiscus. In all the communities where women participated in gardening, they sold the majority of their garden products, and saved between one-third and one-half of their produce for home consumption. These crops added an important source of food during the lean months before the next harvest and also provided vegetables that are often lacking in local diets.

The focus group discussions also showed women to be involved in a diversity of other household-based activities that rely on water, including pottery, soap-making, tomato-processing, tattooing, and selling ice, water, and fruit juices. Diokoul Mbelbouck, a community in Kaffrine, presented a good example of the role of water in women's livelihood strategies. A total of 43 women attended this focus group. All the women in attendance were engaged in rain-fed agriculture, 28 gardened, 25 raised livestock, 21 were involved in petty commerce, 11 undertook sewing or embroidery, 8 manufactured soap, and 2 created pottery. Four of these activities (gardening, livestock-raising, soap-making, and pottery) are productive use activities.

Productive use and women's livelihood diversification strategies

The focus groups provide strong evidence that the construction of the piped water systems enhanced women's existing home-based productive use activities and created possibilities for new rural

enterprises. The combination of time savings and improved water access resulted in increased opportunities for women's commercial activities.

Time savings

In all the focus group communities women described the drudgery and time-consuming nature of their daily water collection tasks before the piped system was constructed. In many of the communities this activity dominated women's time. Women, in rural Senegal, are also responsible for all the domestic activities, including cooking, washing, caring for the children, and cleaning. During the dry season, women explained that they had little time to do anything except collect water and tend to household chores.

After the piped water systems were constructed, the women who had spent their days collecting water found they had free time on their hands and many were able to fill it with productive activities. The development of women's income-generating activities after the construction of the water system was noted in all the communities. This trend is related not only to the increased free time that women acquired, but also to the increased availability of water for productive activities. Women described how they filled their time with commercial activities, livestock-raising, and farming. Some women even noted higher yields in their personal fields, which they attributed to increased time to farm and the purchase of new farm inputs with income earned from productive use activities.

Commercial activities

Women reported that commercial activities increased after the piped systems were constructed. The increase in commerce was related not only to the increased time women had to undertake commercial ventures, but also to a synergetic relationship between women's productive use activities and commerce. The data from the focus groups show that the commercial activities women undertook were often indirectly dependent on the income earned from productive use activities. In areas with poor access to financial systems of any kind, productive use activities often provided the initial capital women needed to initiate or expand commercial enterprises.

Commerce, for women in rural Senegal, consists of selling crops, fish, medicines, beauty products, prepared foods, or fruits and vegetables from their homes or at local markets. Women also directly used the piped water to start businesses selling fruit juices or ice. Small commercial activities were popular with women because of the flexible hours and the high degree of control women had over these income streams.¹⁴

Women's income linked to productive use

As reported earlier, one-third of women's income was directly dependent on productive use activities. However, when the indirect links that other livelihood activities have to productive use activities are included in the analysis, we find that this percentage increases. Commerce generated more income for women than any other income stream and we estimate that half of women's commercial ventures were indirectly dependent on productive use activities. Given these facts, it can be approximated that half of women's total incomes were indirectly dependent on productive use activities. This finding shows the importance of understanding the links between productive use activities and overall livelihood strategies.

¹⁴ A high degree of control over income earned from commercial activities was reported by women during the focus groups and confirmed during the household survey. See footnote 16.

Constraints to productive use

Water service constraints to productive use

Water service constraints, namely water quantity, quality, distance, reliability, and tariff structures, prevented women in about one half of the focus group communities from utilising the water system for their productive activities to the extent they desired.

During focus group discussions in nine communities, women reported that the piped system did not provide enough water for them to initiate new activities or expand existing productive use activities. The median age of the piped water systems was 20 years and the systems were reportedly not designed to accommodate the population growth that occurred in the communities. Apart from natural population growth, women explained that after the construction of the piped system, households from other communities moved into the area, and transhumant herders also began to use the piped water for their livestock.

A lack of water for gardening activities was mentioned in seven communities. In Doumga Ouro Alfa, many women switched to arboriculture because there was no longer enough water to grow garden crops. A large fenced community garden in Sadio could not be fully planted because of a lack of water supplied by the piped system, and in a third community women were forced to discontinue their gardening activities due to the lack of water.

In three of these same communities, and an additional two communities, women also identified inadequate water quantity as a constraint to raising livestock. In some communities, households enjoyed relatively easy access to surface water sources for livestock watering, but in others the lack of water in the piped system was a major obstacle to livestock-raising. The quantity of water available also determined the extent of other diversification activities. Many women noted a reduction of productive use activities such as soap making, gardening, and tomato processing in their communities due to the declining availability of water from the piped system.¹⁵

In three of the communities, women mentioned distance to the piped system as an obstacle to enhancing their productive use activities. Women who recently moved and lived on the outskirts of the community complained that they had long distances to walk to reach the water taps. Distance to the water source was a larger constraint for gardening than it was for livestock-raising. Without a nearby water source, water must be carried to the gardens, whereas livestock are mobile and can be taken to alternative sources if the piped water system cannot be easily accessed.

Water quality concerns were noted in two communities where piped water was reported to be too salty for human consumption and crops. In these communities, women still had to walk long distances to collect water from alternative sources and gardening activities were curtailed. Focus group participants in these two communities felt that pastoralists were the greatest beneficiaries of the water systems, because the animals could drink the water without any problems.

Women in three communities described how the unreliability of the piped water systems compromised their productive use activities. Long or frequent breakdowns of the water system were reported in these communities. In one community in Matam, women emotionally expressed how difficult their lives became, and how their productive use activities were jeopardised, when the water system failed for 8 months in 2001. Frequent power cuts in one community in Diourbel made the piped system quite unreliable and necessitated storing large quantities of water. A broken water pipe in another community resulted in the suspension of gardening activities in a women's large garden, forcing the women to switch to rain-fed crops and fruit trees.

¹⁵ Women in the majority of focus group communities perceived that over time less water was available from the piped system.

Water costs and tariff structures also shaped the types of productive use activities women engaged in. In two communities, women reported that the costs of water and the tariff structure prohibited them from participating in gardening activities. In most communities, water for crops was priced lower than water for domestic use, but in Diokoul Mbelbouck water for gardening was priced at the same rate as domestic water (300 fCFA/m³ or US\$0.66/m³) and the women complained that this was too expensive. In another village, a women's group was forced to shut down their garden because they failed to pay their water bills and fell into debt. Water costs were reported to be too high for women to participate in livestock-raising in only one community.

Affordability and other household-level constraints

Water is only one of the many obstacles households face in participating in productive use activities. Women are also constrained by the high costs of initiating, maintaining, and expanding these activities. In regard to livestock-raising, nearly every woman mentioned the high cost of animal food and the lack of fodder near the community. Women must either purchase animal feed for their livestock or pay someone to take their animals to graze in distant pastures. The costs of maintaining livestock, including veterinary care and food, were more frequently mentioned than the initial costs of buying animals. Many women acquire livestock through gifts, dowries, inheritance, or through a system known as *aidale*, where they receive the third birth of an animal they raise for someone else.

In terms of gardening, many women reported that they lacked the initial input costs for seeds, fertilisers, fencing, and equipment necessary to start a garden plot. In Combelane, women explained they do not garden because they lack fenced land, and cannot afford seeds and watering cans. The women in Wendu Bosseabe wanted to expand the size of their community garden, but they lacked the initial capital for fencing. Fencing is an expensive, but necessary input due to large animal herds that will decimate unprotected garden crops.

Apart from these affordability barriers, there are other difficulties that women face in their productive use activities. Female gardeners report a lack of knowledge about certain gardening techniques and challenges dealing with pests, gaining access to land, and reaching markets with their products. Female livestock owners identified theft, conflicts between herders and farmers, and a lack of veterinary care, as significant obstacles to livestock-raising. Although these findings come from the women's focus group, they are assumed to be general for both men and women. The next section discusses gender-specific constraints that women face.

Gender-specific constraints

Some of the challenges associated with home-based productive use activities present special hardships for women, including time availability, control of income, and access to land, markets, and credit. Many of these constraints are not unique to productive use and have been well documented in research on women farmers and rural livelihoods (Jiggins, 1989; Quisumbing and Pandolfelli, 2010; Kristjanson et al., 2010). The barriers that women identified most frequently during the focus groups were their inability to access and control land, and their tenuous control over personal income and household assets.

Gaining access to quality land is difficult for women in Senegal. Women have weak land tenure rights and must negotiate access to land through their husbands. Women's inability to own and control land was mentioned by women in several communities as a constraint to their participation in gardening activities. One woman in Ndangalma exclaimed that, "they [men] took all the land and there is little good land left for women". 'Tired' land that has been farmed for consecutive years without fallow is often the only land near the community that women are able to use for their gardening activities.

Another issue that impacts women's ability to benefit from productive use activities is the lack of control they have over earned income and household assets. This finding is confirmed by other development research (especially, in the field of micro-credit) focused on the inter-household

allocation of resources (Goetz and Gupta, 1996). In Senegal, many women have little control over key household assets such as farming equipment, livestock, and fertiliser. Women are often dependent on their husband's assistance and goodwill to secure the assets they need for their productive use activities.

Discussions during the focus groups revealed that the majority of women made decisions about how to spend their incomes in consultation with their husbands. Very few women had complete control of their income, and about a quarter of women had little control over money they earn. On a positive note, however, women were found to have more control over income earned from productive use activities (commercial goods, livestock products, and garden crops), than they did over agricultural income.¹⁶

DISCUSSION

Leaving out the poorest households?

The costs of participating in productive use activities, discussed above, make it difficult for the poorest men and women to enter and earn income from these activities. Considering the median household income for the survey sample was US\$121 per month, nearly all households are poor according to international standards, but here we attempt to disaggregate the relatively wealthy from the relatively poor, using a wealth index composed of 15 variables from the household survey.¹⁷

The wealth index was used to categorise each household into one of four wealth rankings. The 'poorest households' are at the bottom quartile of the wealth index. The household survey data show that men and women from the wealthiest households earned mean incomes from productive use activities that were more than two-and-a-half times the incomes earned by men and women from the poorest households (table 5).

The poorest households often lack the assets to engage in productive use activities and the income to pay for water for these activities. In the context of domestic plus water systems, productive assets include livestock, land, farming implements, seeds, fencing, fertilisers, as well as the knowledge and information that open up opportunities for people to engage in productive use activities. Most households had at least the basic assets to engage in productive use (land, labour, and livestock) and nearly three-quarters of households participated in productive use activities. However, a quarter of the surveyed households did not participate in productive use activities, and these households were much poorer than their peers. Households not engaged in productive use activities had significantly lower median incomes (US\$854 per month compared to \$1,456 per month) and also fewer livestock units (LSU) (0 LSU compared 3.6 LSU) than households that participated in productive use activities. Wealthier families were also more likely to have speciality assets such as, fertilisers, fencing, and refrigerators¹⁸ that allowed them to expand their productive use activities and earn more income from these activities.

¹⁶ Household survey data show that only 16% of women have control over agricultural incomes when they earned at least half of the income. The same is true for 21% of women selling livestock, 39% of women in commerce, and 57% selling garden products. While not captured in the household survey, during the focus groups women reported they had a high degree of control over income earned from selling livestock products.

¹⁷ These variables include household income, household expenditures, literacy, land ownership, livestock units, cell phones, housing materials, and use of electricity.

¹⁸ Refrigerators allow households to store ice, meat, milk, yogurt, and cold fruit juices for sale.

Households with private taps had more opportunities to engage in productive use activities, particularly gardening, than households without access to private taps.¹⁹ In Sadio, where the majority of households had private taps, the poorest households could not afford them and were forced to use the public taps that cost more (US\$0.66/m³ compared to \$0.44/m³ for private taps). In Yare Lao, when the community garden was closed because women were not able to pay their water bills, the women with private taps could continue gardening around their households.

This research shows that the poorest individuals face entry barriers to starting productive use activities, and do not have the necessary assets to take advantage of the domestic plus systems to the same extent as the wealthiest individuals. This finding is not specific to productive use activities; livelihood studies in other areas also find that asset holdings of the wealthier groups allow them to diversify into higher-end activities than the poorer groups and earn more money from these activities (Barrett et al., 2001).

Table 5. Men's and women's income earned from productive use by wealth index.

Wealth ranking	Total monthly household income Median, Mean (SD)	Women's income earned from productive use Median, Mean (SD)		Men's income earned from productive use Median, Mean (SD)	
		All	Piped water	All sources	Piped water
		Sources			
All households	\$121, \$212 (335) n=1679	\$0, \$15 (\$46) n=1108	\$0, \$8 (\$28) n=1108	\$0, \$71 (\$245) n=1437	\$0, \$33 (\$177) n=1437
Wealth Index 1 (poorest households)	\$78, \$115 (\$132) n=420	\$0, \$10 (\$31) n=271	\$0, \$5 (\$21) n=271	\$0, \$40 (\$99) n=379	\$0, \$19 (\$57) n=379
Wealth Index 2	\$105, \$171 (\$283) n=420	\$0, \$11 (\$29) n=286	\$0, \$6 (\$15) n=286	\$0, \$77 (\$270) n=365	\$0, \$23 (\$83) n=365
Wealth Index 3	\$122, \$194 (\$251) n=413	\$0, \$12 (\$33) n=279	\$0, \$9 (\$28) n=279	\$0, \$66 (\$202) n=355	\$0, \$28 (\$136) n=355
Wealth Index 4 (wealthiest households)	\$227, \$367 (\$499) n=426	\$0, \$27 (\$46) n=272	\$0, \$14 (\$39) n=272	\$11, \$104 (\$349) n=338	\$0, \$63 (\$319) n=338

Evaluating the benefits of domestic plus systems for women

The household survey data from Senegal shows that women have little access to the top income generating activities (service activities, wage earning, and migration work) and tend to compose their livelihoods within the farming sector. This finding is consistent with other research on livelihood

¹⁹ Private connections can be purchased by households and are associated with higher median household incomes. The income for households that use private taps was US\$126/month (n=569), and the income for households that use only public taps was US\$111/month (n=905).

diversification, which shows that high-return non-farm activities are generally dominated by men, while women are more likely to diversify into farming activities that are closely related to their customary roles in the domestic sphere (Gladwin et al., 2001; van Koppen et al., 2009; Momsen, 2010). Considering this context, domestic plus systems in Senegal were found to support women's home-based diversification activities and offer women, with few alternatives, opportunities for income earning.

Domestic plus water systems in Senegal are a gender-equitable intervention. Productive use activities are at least as important for women as they are for men. In terms of participation, about 44% of adult livestock owners were women, and almost twice as many women participated in gardening as men. Women also benefited from productive use activities at the same level as men: one-third of men's and women's incomes were directly dependent on productive use activities.

Moving beyond gender equity, this research offers some support to the existing research that shows domestic plus systems are 'women friendly' interventions (van Koppen et al., 2009). Here 'women friendly' is defined as an intervention that offers women disproportionately more benefits than men. As discussed earlier, women derive a greater share of their personal incomes from the piped water source than men (19% vs. 15%). Women do not have the time and mobility to use alternative (often distant) water sources for their productive activities, and thus are more dependent on the piped system. Women also rely heavily on income earned from productive use activities to initiate other non-water-based income-generating activities, and we estimate that approximately one half of women's incomes are linked to productive use through commercial activities.

As the primary water collectors, women were also the greatest beneficiaries of the time savings that resulted from the construction of the domestic plus systems. Many women reported that the increased free time enabled them to expand their productive use and commercial activities. Finally, while women do not often have a high degree of control over their income and assets in general, they were found to have more control over income earned from household-based productive use activities, than agricultural income streams. The conclusion that domestic plus water systems are a women-friendly intervention remains hesitant due to the lack of a parallel study on how much of men's income is linked to productive use activities. The gender-specific barriers that women face in accessing productive use activities are also of concern, as are the disparities in productive use income earnings between relatively wealthy and poorer women.

PLANNING AND POLICY TO ADDRESS PRODUCTIVE USE CONSTRAINTS

Addressing the barriers that women and the poorest households face in accessing productive use activities has the potential to enhance the benefits of domestic plus systems and also attend to equity concerns. The constraints outlined earlier take place at different levels, and clearly call for different policy prescriptions. Beginning with the water service itself, the most obvious point is that domestic plus systems need to provide enough water to service small-scale productive activities, such as livestock-raising and gardening. Many of the systems in Senegal were under-designed for productive use and also failed to take into consideration population growth. Designs for domestic plus systems need to consider the potential for population to rapidly increase as households outside the target villages relocate to be nearer to the water system.

In order to facilitate productive use activities, water points also need to be located in close proximity to these activities, especially for gardening or small-scale agriculture. Productive use design features included in the piped systems, principally livestock watering troughs and garden irrigation systems, were found to facilitate productive use through convenience and time savings. Considering the importance of alternative water sources for productive use activities, more effort should also be made to enhance alternative water sources and integrate them into water system management schemes. The

Senegal study also shows that system reliability and water quality are important characteristics of a domestic plus system.

As demonstrated in the focus group communities, tariff structures can encourage or discourage productive use. In some communities, productive use was discouraged when the price of water was unaffordable or more expensive than water for domestic needs. To equalise the benefits of productive use, public tap water should not be more expensive than private tap water. The focus group data suggest that the price of 150 fCFA/m³ (US\$0.33/m³) for gardening activities was affordable for women, and when tariffs rose above this level productive activities diminished. More research should be conducted to estimate the willingness and ability of rural households to pay for water for productive use activities.

Addressing general (non-water-system-based) constraints to productive use, calls for an integrated development model. In some cases, communities have many of the ancillary inputs for productive use, such as markets, electricity, and access to credit, but in others they may need to be programmed alongside the water investment. Where these conditions do not exist, water development planners should consider partnering with rural development organisations or women's organisations (Moriarty and Butterworth, 2003; Katsi et al., 2007). Many of the barriers faced in the productive use arena, including access to land, credit, and extension services have long been general difficulties faced by rural development programmes, and creative relationships with organisations active in these capacities can tap into a rich history of addressing these issues. Productive use approaches present an opportunity to integrate disparate rural development programmes around improved water access to enhance rural livelihoods. For example, when community gardens can be programmed into the design of the water system, with land and fencing provided to women, two of the largest barriers women face in entering gardening activities are eliminated.

At the household and individual level, women and the poorest households need opportunities to secure the assets necessary to engage in productive use activities. Some ideas for opening up these opportunities include micro-credit programmes, policies to strengthen women's land rights, extension services, programmes aimed at improving market access, and subsidised productive inputs, such as seeds and fertilisers. Working through women's groups is another proven mechanism for increasing women's control over assets as well as their productivity (Quisumbing and Pandolfelli, 2010). This group approach could be applied towards a women's garden scheme or a collective animal-raising programme. Cases from around the world also demonstrate that women and the poor experience added benefits when water projects are integrated with capacity-building programmes to help them develop their productive activities (Jordans and Zwartveen, 1997; Regmi and Fawcett, 1999; van Koppen et al., 2001; Renwick et al., 2007; Sijbesma et al., 2009).

CONCLUSION

In Senegal, domestic plus water systems provided women with time savings and greater quantities of water which they used to expand their productive use activities and initiate new activities. Women's productive use activities were also found to complement, and help support, small commercial activities. Overall, approximately one half of women's incomes were linked to productive use activities and women earned a higher percentage of their income from the piped system than men. Domestic plus systems in Senegal are a gender-equitable and potentially women-friendly intervention. At present, affordability constraints, poor water system designs, and limited access to productive assets, narrow the range of benefits productive use offers for women and the poorest households. It is recommended that rural water supply interventions adopt a broader mandate to address the different levels of constraints faced by men and women within the domestic plus model.

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REFERENCES

- Aladuwaka, S. and Momsen, J. 2010. Sustainable development, water resources management and women's empowerment: The Wanaraniya water project in Sri Lanka. *Gender and Development* 18(1): 43-58.
- Barrett, C.B.; Reardon, T. and Webb, P. 2001. Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy* 26(4): 315-331.
- Batterbury, S. 2001. Landscapes of diversity: A local political ecology of livelihood diversification in south-western Niger. *Ecumene* 8(4): 437-464.
- Davis, B.; Winters, P.; Carletto, G.; Covarrubias, K.; Quinones, E.; Zezza, A.; Stamoulis, K.; Azzarri, C. and Digiuosepe, S. 2009. A cross-country comparison of rural income generating activities. *World Development* 38(1): 48-63.
- Ellis, F. 1998. Household strategies and rural livelihood diversification. *Journal of Development Studies* 35(1): 1-38.
- Faures, J.-M. and Santini, G. 2008. *Water and the rural poor interventions for improving livelihoods in sub-Saharan Africa*. Rome: FAO/IFAD.
- Gladwin, C.H.; Thomson, A.; Peterson, J. and Anderson, A. 2001. Addressing food security in Africa via multiple livelihood strategies of women. *Food Policy* 26(2): 177-207.
- Goetz, A.M. and Gupta, R.S. 1996. Who takes the credit? Gender, power, and control over loan use in rural credit programs in Bangladesh. *World Development* 24(1): 45-63.
- Guérin, I. 2006. Women and money: Lessons from Senegal. *Development and Change* 37(3): 549-570.
- Jiggins, J. 1989. How women earn income in sub-Saharan Africa and what works against them. *World Development* 17(7): 953-963.
- JMP (Joint Monitoring Programme). 2010. WHO/UNICEF joint monitoring programme for water and sanitation. www.wssinfo.org/data-estimates/table/ (accessed 6 June 2012)
- Jordans, E. and Zwartveen, M. 1997. *A well of one's own: Gender analysis of an irrigation program in Bangladesh*. Colombo, Sri Lanka: International Irrigation Management Institute.
- Katsi, L.; Siwadi, J.; Guzha, E.; Makoni, F.S. and Smits, S. 2007. Assessment of factors which affect multiple uses of water sources at household level in rural Zimbabwe. A case study of Marondera, Murehwa and Uzumba Maramba Pfungwe districts. *Physics and Chemistry of the Earth* 32(15-18): 1157-1166.
- Kristjanson, P.; Waters-Bayer, A.; Johnson, N.; Tipilda, A.; Njuki, J.; Baltenweck, I.; Grace, D. and MacMillan, S. 2010. *Livestock and women's livelihoods: A review of the recent evidence*. Nairobi, Kenya: International Livestock Research Institute.
- Momsen, J. 2010. *Gender and development*. New York: Routledge.

- Moriarty, P. and Butterworth, J. 2003. *The productive use of domestic water supplies: How water supplies can play a wider role in livelihood improvement and poverty reduction*. Delft, the Netherlands: IRC International Water and Sanitation Center.
- Noel, S.; Phuong, H.T.; Soussan, J. and Lovett, J. 2010. The impact of domestic water on household enterprises: Evidence from Vietnam. *Water Policy* 12(2): 237-247.
- Quisumbing, A.R. and Pandolfelli, L. 2010. Promising approaches to address the needs of poor female farmers: Resources, constraints, and interventions. *World Development* 38(4): 581-592.
- Regmi, S.C. and Fawcett, B. 1999. Integrating gender needs into drinking water projects in Nepal. *Gender and Development* 7(3): 62-72.
- Renwick, M.; Joshi, D.; Huang, M.; Kong, S.; Petrova, S.; Bennett, G. and Bingham, R. 2007. *Multiple use water services: Assessing the state of knowledge*. Arlington, VA: Winrock International.
- Sijbesma, C.; Verhagen, J.; Nanavaty, R. and James, A.J. 2009. Impacts of domestic water supply on gender and income: Results from a participatory study in a drought-prone region in Gujarat, India. *Water Policy* 11(1): 95-105.
- Smits, S.; van Koppen, B.; Moriarty, P. and Butterworth, J. 2010. Multiple-use services as an alternative to rural water supply services: A characterisation of the approach. *Water Alternatives* 3(1): 102-121.
- van Hove, E. and van Koppen, B. 2005. *Beyond fetching water for livestock: A gendered sustainable livelihood framework to assess livestock-water productivity*. Kampala, Uganda: CGIAR Challenge Program on Water and Food.
- van Koppen, B.; Moriarty, P. and Boelee, E. 2006. *Multiple-use water services to advance the millennium development goals*. Research Report No. 98. Colombo, Sri Lanka: International Water Management Institute.
- van Koppen, B.; Nagar, R. and Vasavada, S. 2001. *Gender and irrigation in India: The women's irrigation group of Jamba South Gujarat*. Working Paper No. 10. Colombo, Sri Lanka: International Water Management Institute.
- van Koppen, B.; Smits, S.; Moriarty, P.; Penning de Vries, F.; Mikhail, M. and Boelee, E. 2009. *Climbing the water ladder: Multiple use services for poverty reduction*. The Hague, The Netherlands: IRC International Water and Sanitation Centre and International Water Management Institute.
- van Wijk-Sijbesma, C. 1998. *Gender in water resources management, water supply and sanitation: Roles and realities revisited*. The Hague, the Netherlands: IRC International Water and Sanitation Center.
- Waughray, D.K.; Lovell, C.J. and Mazhangara, E. 1998. Developing basement aquifers to generate economic benefits: A case study from southeast Zimbabwe. *World Development* 26(10): 1903-1912.
- Yaro, J.A. 2006. Is deagrarianisation real? A study of livelihood activities in rural northern Ghana. *Journal of Modern African Studies* 44(1): 125-156.
- Zwarteveen, M. 1997. Water: From basic need to commodity: A discussion on gender and water rights in the context of irrigation. *World Development* 25(8): 1335-1349.

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