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Costs and benefits of multiple uses of water: a case from Ethiopia

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This paper presents a study conducted under the RiPPLE project[1], with the objective to provide better insight in the costs and benefits of multiple use water services. In this study, the costs related to the provision of water services and the benefits related to water use were analysed for two cases in the East Haraghe zone, Ethiopia, each taking a different path towards multiple use services. In the Ido Jalala case, domestic water supply services were upgraded to enable small-scale irrigation, while in the Ifa Daba case, irrigation services were upgrades to also cater for domestic water use. In both cases, water was used for multiple uses by the community members, regardless of the water services provided. The study shows that in the studied cases, the benefits of multiple use easily outweigh the costs involved in providing water services. It also shows that with relatively small additional costs, single use water services can be upgraded to multiple use water services, which facilitate multiple uses, bringing along relatively high additional benefits.

Introduction

Interest in multiple use water systems and services is on the rise in Ethiopia. In recent years, several implementing organisations, mainly NGOs, have been implementing and upgrading water systems that do not only cater for domestic water use or irrigation, but that address the multiple water demands of communities. The sector stakeholders from East Hararghe, united in the East Hararghe Learning and Practise Alliance (LPA) agreed this is an interesting development and felt a need for better insight in the linkages between the provision of water services and growth, especially in the costs and the benefits of multiple use services.

To date, little research has been done on how additional costs and benefits of going from single use water services to multiple uses water services relate to each other. The research that has been done so far is mostly based on projections and estimates (Slaymaker et al, 2007). Under the RiPPLE[1] project, a study was therefore conducted to assess the costs and benefits of going from single to multiple use water services. The objective of this study was to provide a better insight into the costs and benefits of multiple use water services, by analysing the costs and benefits of going towards multiple use water services in several cases in East Hararghe zone, Ethiopia. The hypothesis was that with relatively small additional costs, single use water services could be upgraded to provide multiple use water services, which generate relatively large additional benefits that exceed the additional costs. This paper presents the main findings of this study.

Methodology

Water services can be regarded as the delivery of a certain quantity of water with a certain quality, reliability and accessibility. Water services are shaped by the water "system", consisting of infrastructure and organisational and institutional arrangements. The development and maintenance of these hard- and software components of water services involve costs. The use of the water provided through the water services will result in benefits (see figure 1).

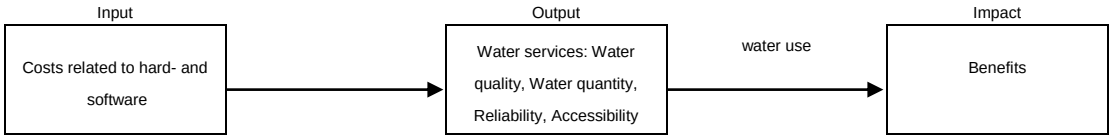


Figure 1. Costs of water services and benefits of water use

This paper looks at the costs of going towards multiple use water services and the resulting benefits. This is done by comparing the additional costs and benefits of steps towards multiple use water services in two cases: one case in which originally only domestic water supply services were provided, and one case in which originally only irrigation services were provided (see figure 2).

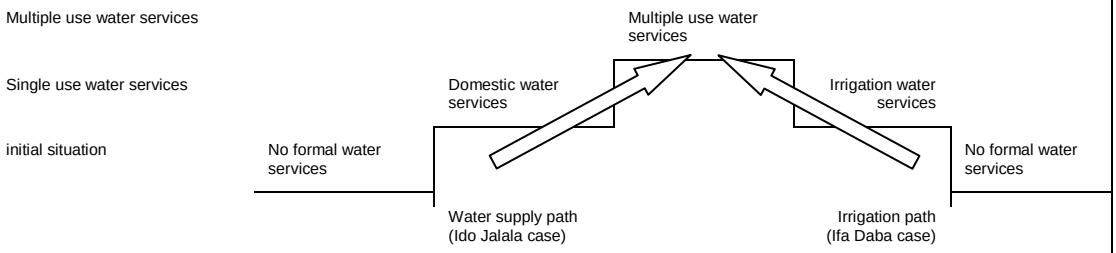


Figure 2. Towards multiple water services

Costs taken into account

The following costs are considered in this paper: Capital investment costs in assets (CapIn), which include all costs involved in the design and construction of a water system; Operating and minor maintenance expenditure (Opex), concerning all costs related to operation and maintenance to keep the system going; and Support costs (SupCo), which include activities supervision of the system's operation and maintenance, resolution of conflicts, refresher training of system users and caretakers and extension work.

In general, costs related to water service vary over the lifespan of the system, as illustrated in the figure below. In order to compare the costs with the annual benefits, the costs will have to be annualised. The CapIn over the lifespan of the system will thus have to be divided over the lifespan of the system. The Opex and support costs, which may vary from year to year over the lifespan of the system, have to be averaged over the lifespan of the system.

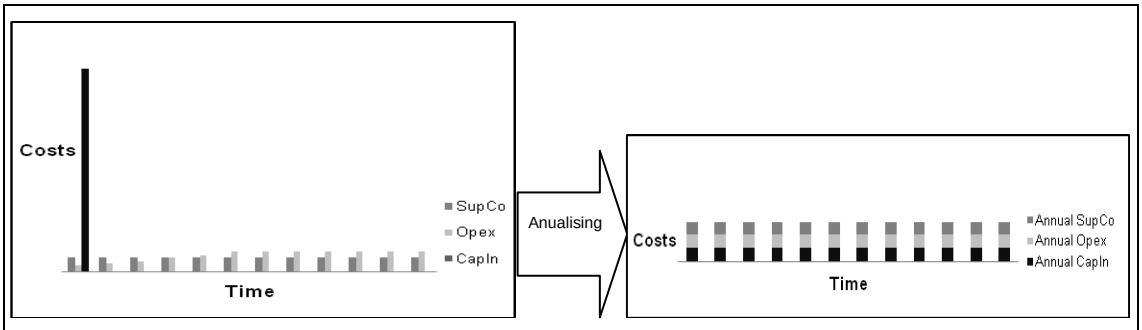


Figure 3: Annualising costs

Unless the total Opex over the entire lifespan of a system are know, it is difficult to determine the average annual Opex based on actual data. Opex can in that case be estimated to be 10% of the annual CapIn costs (5% operation and maintenance costs + 5% source protection (as per Hutton and Haller 2004).

Support costs for different water services can be estimated based on the recurrent expenditure of zonal and woreda government agencies that support community managed water supply and irrigation systems. To determine the different support costs for different systems, the expenditures can be divided over the systems in the area, according to the relative time that support agents spend on providing support services to specific systems.

Benefits taken into account

The paper considers both health benefits, resulting from water for domestic use, as well as benefits resulting from productive uses of water, with a focus on benefits from small-scale irrigated agriculture. Furthermore, time saving benefits related to improved water services have been taken into account.

It is estimated that 88% of global cases of diarrhoea, a diseases which kills around 2 million people each year, can be attributed to unsatisfactory water, sanitation and hygiene services (WHO, 2004; UN / WWAP, 2003). An increase in quantity and quality of water and the use of this water for domestic purposes, including hygiene and sanitation, can contribute to a decrease in expenditures related to diseases and an increase in time available to be spent on economic activities and education. The health benefits related to water services presented in this paper are based on:

- The value of estimated number of days missed due to diarrhoea or dysentery over the course of 1 year before and after changes in water services
- Estimated costs of treatment over the course of 1 year, before and after changes in water services

Irrigated crop production generally brings higher benefits than rain-fed crop production. The availability of larger quantities of water, with a better accessibility and reliability can stimulate change in cropping pattern, increase crop production per unit land and expansion of the cropped area. This can lead to improved household food security, improved nutrition, expenditure saving and increased household income. The benefits from irrigated agriculture in this paper are expressed as additional net benefits in market value of the produce from irrigated agriculture, as compared to rain-fed agriculture.

Besides the benefits generated by the use of the water provided, one of the main benefits of improved water services, is time saving. The time saved can increase leisure time, or can be used for economic or educational purposes. For this paper, time saving benefits have been determined by comparing the time spent on fetching water before and after water services improvements and converting this time into money.

The case study areas

Water is often used for multiple uses, whether water services allow for this or not. In order to get a better understanding of the influence of the type of the water services (domestic, irrigation, multiple use) on the costs and the benefits, other factors that can influence costs and benefits had to be kept as constant as possible. Therefore, cases in the same woreda with similar water supply technology and implemented by the same organisation, were selected: Ido Jalala and Ifa Daba, in Gorogutu Woreda, East Hararghe Zone, Oromia Region, Ethiopia.

In both cases, an unprotected spring was initially used for domestic uses, animal watering and small scale traditional irrigation. From the initial situation, the two cases have taken a different path towards multiple use water services. The Ido Jalala case has followed the water supply path with irrigation upgrade, while the Ifa Daba case has followed the irrigation path, with domestic water supply upgrade. (see Figure 2)

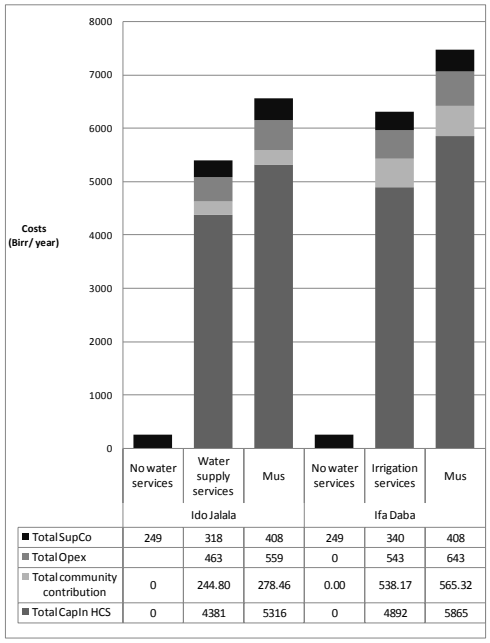
The spring in Ido Jalala with a discharge of 0.4 l/s, was capped in 2005 by the Ethiopian NGO HCS and a domestic water supply system was constructed serving 70 households. People continued traditional irrigation by using the run-off water from the domestic system and the water from other nearby springs. Soon after the implementation of the domestic water supply system, the community requested HCS to assist in developing an improved irrigation system, linked to the domestic water supply system. Although first steps towards this have been made, so far this irrigation system has not been finalised yet, so people are still mainly irrigating in the traditional way by using the run-off from the springs.

In Ifa Daba, the spring with a discharge of 1.4 l/s was used as the source for an irrigation system, which was constructed in the year 2004 by HCS. Since the implementation of the irrigation system, the community consisting of 121 households has been using the system for fetching domestic water as well. In 2007, a stand post, directly connected to the capped spring, was added to the system to facilitate fetching water for domestic use. The stand post which was initially placed in a swampy area, which prevented the users from collecting their water from the stand post, was reallocated in the beginning of 2008.

Results and discussion

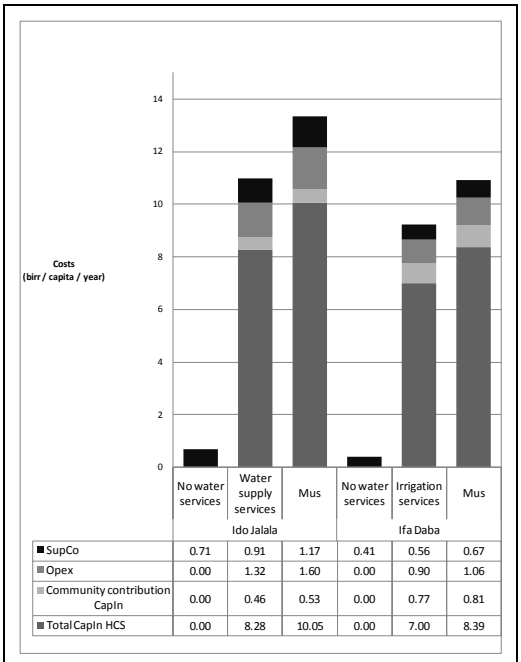
Costs

The figures below give an overview of the annual costs of water services per system (figure 4) and per capita (figure 5).



	Ido Jalala			Ifa Daba		
	No water services	Water supply services	Mus	No water services	Irrigation services	Mus
Total SupCo	249	318	408	249	340	408
Total Opex		463	559	0	543	643
Total community contribution	0	244.80	278.46	0.00	538.17	565.32
Total CapIn HCS	0	4381	5316	0	4892	5865

Figure 4. Annual costs of water services



	Ido Jalala			Ifa Daba		
	No water services	Water supply services	Mus	No water services	Irrigation services	Mus
SupCo	0.71	0.91	1.17	0.41	0.56	0.67
Opex	0.00	1.32	1.60	0.00	0.90	1.06
Community contribution CapIn	0.00	0.46	0.53	0.00	0.77	0.81
Total CapIn HCS	0.00	8.28	10.05	0.00	7.00	8.39

Figure 5. Annual costs of water services per capita

The graphs show that the total costs are higher for Ifa Daba than for Ido Jalala, although the costs per capita are slightly lower in the Ifa Daba case than in the Ido Jalala case.

The SupCo are covered by the woreda and zonal irrigation and water offices and bureaus. The CapIn is covered mostly by the implementer HCS, with the community contributing to some extent as well, as shown in the graphs. The communities also have to cover the Opex. In the two cases, water committees have been established, which have the task to set the water fee, collect the fees and use the money for the operation and minor maintenance. In neither of the cases, separate water tariffs have been set for different water uses. This is largely due to the fact that the case study systems are all gravity systems, which means that providing for the additional water use requires limited increases in operational costs. In case of motorised systems, the additional Opex cost would be much larger since the fuel cost (be it electricity or fuel) to pump up and distribute the extra water needs to be covered ,as well as the extra operating cost for the pump operator and the deprivation costs of the pump and generator.

In Ido Jalala fee collection has only started in October 2007. At that time, the fee was set at 1 $Birr^{Year\ 2000}$ per household per month. This is about 12 $Birr^{Year\ 2000}$ per year per household, which is higher than the 6 to 8 $Birr^{Year\ 2000}$ required per household per year to sustain domestic water supply services and multiple water services respectively. However, collection of the water fees has been a problem, as not all users are willing to pay. In Ifa Daba, the water committee has not been successful in setting a water fee and collecting revenues, although the Opex requirements are estimated to be 4.5 to 5.5 $Birr^{Year\ 2000}$ per household per year in the case of irrigation and mus respectively.

It should be noted that the figures presented in figure 4 and 5 are made assuming a lifespan of the system of 20 years in each situation. It could be argued that in a case where no water fees are collected for operation and maintenance, the lifespan of the system will decrease. If the lifespan of the system would be half the expected lifespan, the annual CapIn would double. Providing multiple use water services could enhance sustainability, hence increase the system lifespan and decreasing the annual costs. Unfortunately,

determining the actual lifespan of the different water services was beyond the scope of this research and was therefore not taken into account.

Water use and benefits

In both cases, water from the spring was used for multiple uses, including domestic use, watering livestock and small-scale traditional irrigation, whether the water services allowed for this or not. The study has focussed on health, irrigation and time saving benefits related to water services, as described below. Although the study did observe an increase in number of livestock and a diversification in the types of livestock kept with the move towards multiple use services, this was not expressed in monetary terms and will not be considered in this paper.

Domestic water use and health benefits

With the implementation of the single use (domestic) water services in Ido Jalala, the household consumption for domestic use increased from about 20 to 37 litre per household in Ido jalala. In Ifa Daba, domestic water use per household hardly increased with the implementation of the irrigation system (from 30 to 34 litre per household per day).

In the current situation in Ido Jalala, the amount of money spent on diarrhoea related deceases is found to be 82 Birr $^{\text{Year 2000}}$ per person per year lower than in the initial situation. The health benefits related domestic water supply services could therefore be considered to amount to 82 Birr $^{\text{Year 2000}}$per person per year, which is more or less in line with Hutton and Haller (2004), who estimate health benefits of improved water supply in Sub Sahara Africa to be around 89 Birr $^{\text{Year 2000}}$. In Ifa Daba, no health benefits were found with the implementation of the irrigation system.

Irrigation

In Ido Jalala, the total traditionally irrigated area in the initial situation was 2.5 ha, irrigated by a total of 40 users. With the implementation of the domestic water supply system, the irrigated area was brought back to 1.56 ha, serving 25 users, because more water was allocated to be used for domestic use. This brought along a decrease in the irrigation benefits, from a total of 105,325 Birr $^{\text{Year 2000}}$ to 65,828 Birr $^{\text{Year 2000}}$ per year. So far, the step towards improved irrigation has not yet been made in Ido Jalala. In the case of Ifa Daba, the irrigated area increased with 32% as a result of the implementation of the irrigation system. It has been assumed that in the case of the improvement of the irrigation component of the system in Ido Jalala, a similar increase would take place, which would result in benefits of 86,893 Birr $^{\text{Year 2000}}$ per year.

In Ifa Daba, the area that was irrigated by 40 users in the initial situation, covered 5 ha. After the implementation of the irrigation system, the number of users increased to 53, irrigating a total area of 6.625 ha. However, the implementation of the irrigation system has gone hand in hand with a change in cropping pattern, replacing part of the chat cultivation with potatoes, pepper, cabbage, tomatoes and coffee. Because chat cultivation is at first sight more lucrative than vegetable cultivation, this has resulted in a decrease in net benefits from 110,843 to 74,103Birr $^{\text{Year 2000}}$ per year, while it would have increased to 157,087 Birr $^{\text{Year 2000}}$ per year in case the cropping pattern had not changed. However, when chat was the main irrigated crop, women had to go to the market to buy vegetables for the family's consumption. With the introduction of vegetable cultivation, time is saved and family's nutrition improves. The time saved for not having to go to the market to buy vegetables, and the health benefits associated with the consumption of more vegetables have not been taken into account in this analysis. In reality, the benefits of change in cropping pattern are therefore likely to be higher than indicated here. Since the change in cropping pattern in the case of Ifa Daba is not considered to be caused by the introduction of the irrigation system, the benefits that would have been achieved in case of chat cultivation were used in this analysis.

Time saving

In both cases, the majority of the communities used the spring as their main source of domestic water supply, both before as well as after the intervention. The time saving benefits are therefore not that much related to a decrease in distance, but rather to an increase in accessibility because of the installation of a tap, which made it easier and less time consuming to collect water.

In Ido Jalala, the time saving benefits of the domestic water services were estimated to be 123 Birr $^{\text{Year 2000}}$ per capita per year. In Ifa Daba, the implementation of irrigation had led to time saving benefits of about 65 Birr $^{\text{Year 2000}}$ per capita per year. With the implementation of the irrigation system, the accessibility of water for domestic use improved. The accessibility is likely to improve further with the implementation of the

domestic water supply component, which will result in more time benefits. Since the domestic water supply component was only installed recently, the time saving benefits for the irrigation system with the domestic water component (multiple water services) could not be determined directly. It is therefore assumed that these benefits will be in line with the time saving benefits in the case of Ido Jalala.

Whether or not the time saved is indeed used for productive activities or for education has not been taken into account. It could be argued that all time saved helps improve quality of life, especially for women and girls who are primarily responsible for collecting water in this area, and should therefore be considered as a benefit, whether or not the time is used 'productively'.

Overview of the total benefits

The graphs below give an overview of the benefits in the two cases per system (figure 6) and per capita (figure 7) per year. The graphs show that in Ido Jalala the decrease in irrigation benefits is compensated by the increase in time saving and health benefits, related to the implementation of the domestic water supply system. In Ifa Daba a big jump in additional benefits is made with the upgrading of the water services to include domestic use, with an increase in health and additional time saving benefits.

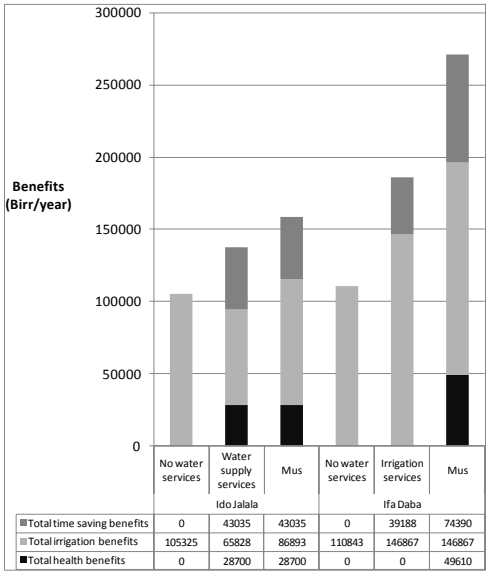


Figure 6: Annual benefits of water services

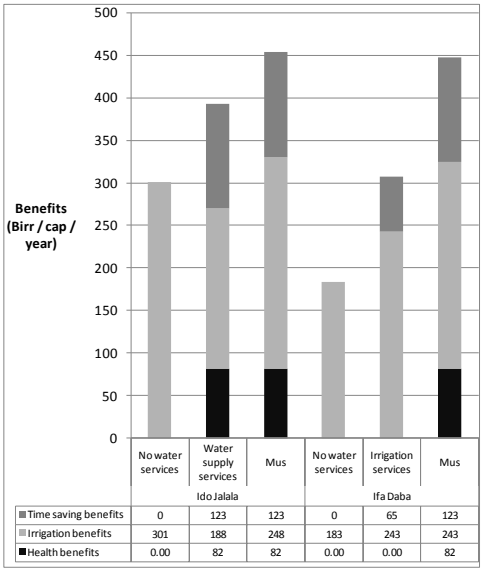


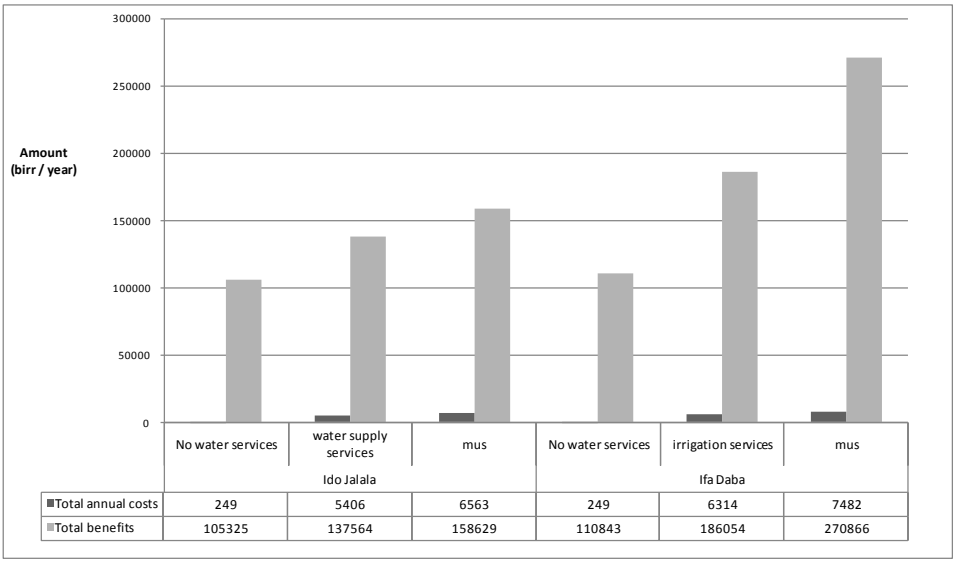
Figure 7: Annual benefits of water services per capita

It should be noted that not everyone benefits equally from irrigated agriculture, be it traditional or improved, whereas all community members benefit from improvements in water supply, both through improved health as well as through time saving.

Comparing costs and benefits

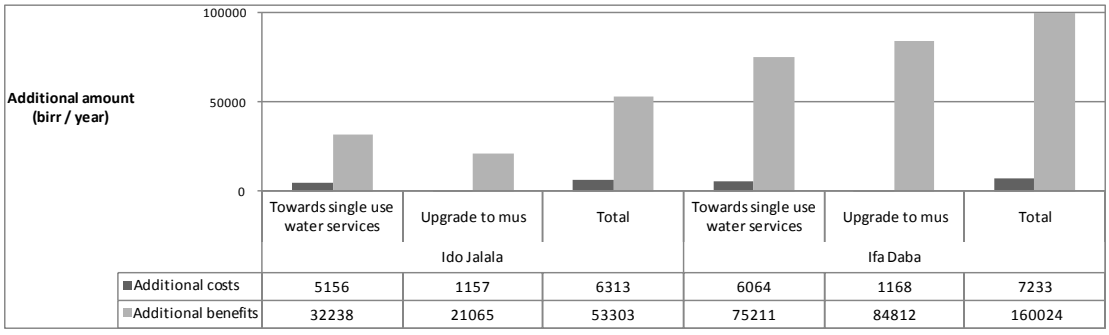
When the annual benefits are compared with the annual costs, as shown in figure 8, it becomes very clear that in the studied cases the benefits of water use easily outweigh the costs related to providing water services, whether these services cater for single use or for multiple uses.

The graph in figure 9 illustrated the additional annual costs and benefits for each of the steps towards multiple use water services. It shows that the additional benefits of going from single use water services to multiple use water services and smaller than the additional benefits of going from no formal water services to single use water services. However, the additional costs in this step are also smaller.



	Ido Jalala			Ifa Daba		
Total annual costs	249	5406	6563	249	6314	7482
Total benefits	105325	137564	158629	110843	186054	270866

Figure 8. Total annual costs and benefits



	Ido Jalala			Ifa Daba		
Additional costs	5156	1157	6313	6064	1168	7233
Additional benefits	32238	21065	53303	75211	84812	160024

Figure 9. Total additional annual costs and benefits

The table below gives an overview of the Benefit/Cost ratios and the rations of the additional benefits / additional costs.

Table 1. Benefits/ Cost and Additional Benefit/Cost ratios

	Ido Jalala			Ifa Daba		
		Domestic water supply services	Multiple use services		Irrigation services	Multiple use services
B/C		25	24		29	36
	Towards water supply services	Upgrade to mus	Total	Towards irrigation services	Upgrade to mus	Total
Additional B/C	6	18	8	12	73	22

In the Ido Jalala case, the benefits outweigh the costs slightly more when domestic water supply services are provided than when multiple use water services are provided, as shown by the slightly higher B/C ration.

In the Ifa Daba case, the B/C ratio for multiple use services is higher than the B/C ratio for irrigation services, which suggests that adding a domestic water component to an irrigation system is a very good investment. It could be argued that the reason for this is that the system is a developed spring system, which

means that very little extra CapIn and Opex have to be made to supply water of suitable quality for domestic purposes, which brings health and time saving benefits.

In both cases, the additional B/C ratio is higher for the upgrade to mus, than for the step towards single use water services. This shows that indeed high additional benefits can be obtained with relatively small additional costs when a single use system is upgraded to cater for multiple uses.

Conclusions and recommendations

The study has shown that introducing single use water services can have impact on the different uses of water, not only the type of use that the services cater for. Especially in the case of limited availability of water resources, it is essential that implementers and policy makers understand the multiple demands of communities and commit themselves to meeting these demands as well as possible by providing multiple use water services, in a sustainable and equitable way. Integrated planning and management, taking into account water demands for different uses, and how these may develop over time, is key in providing sustainable multiple use services. Enabling multiple uses of water by providing multiple use water services results in high benefits, as shown by this study.

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Note/s

All amounts in this paper are given in Birr^{year2000} (based on the GDP deflator of the World Economic Outlook Database (IMF 2007)). 1 US$ ^{year2000} = 8.15 Birr^{year2000}

[1] RiPPLE: Research Inspired Policy and Practice Learning in Ethiopia and the Nile Region (www.rippleethiopia.org)

[2] HCS: Hararghe Catholic Secretariat

Keywords

Costs, benefits, Ethiopia, multiple use of water, multiple use system, RiPPLE

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