Research-inspired Policy and Practice Learning in Ethiopia and the Nile region

The costs and benefits of multiple uses of water:

The case of Gorogutu woreda of East Hararghe zone, Oromiya Regional States, eastern Ethiopia

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Research-inspired Policy and Practice Learning in Ethiopia and the Nile region (RiPPLE) is a five-year research programme consortium funded by the UK's Department for International Development (DFID). It aims to advance evidence-based learning on water supply and sanitation (WSS) focusing specifically on issues of planning, financing, delivery and sustainability and the links between sector improvements and pro-poor economic growth.

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List of Acronyms

Capex	Capital maintenance expenditure
CapIn	Capital investment costs in assets
CoCap	Costs of capital
Ha	Hectare
HCS	Hararghe Catholic Secretariat
Hh	Household
IMF	International Monetary Fund
IRC	International Water and Sanitation Centre
IWRM	Integrated Water Resource Management
Katare	1/4 hectare strip of chat farm land
Koti	1/8 hectare
LPA	Learning and Practice Alliance
Lpcd	Litre per capita per day
l/s	Litres per second
MUS	Multiple Use of Water Services
m.a.s.l./masl	Metres above sea level
NGO	Non-Governmental Organisation
OFWAT	Water Services Regulation Authority of the water and sewerage industry in England and Wales
O&M	Operation & Maintenance
Opex	Operating and minor maintenance expenditure
RiPPLE	Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region
SupCo	Support costs
Timad	1/8 hectare
WASH	Water, Sanitation and Hygiene

Executive Summary

People require water for a wide range of activities essential to their livelihoods. These include both domestic as well as productive uses, which bring multiple benefits. However, multiple uses and benefits are often not addressed in an integrated way. Failing to recognise multiple uses will lead to failure to capitalise on the multiple benefits in terms of poverty reduction, and can even have a negative impact on sustainability.

Cognisant of this fact, this case study takes a closer look at whether the benefits of multiple use services outweigh the costs that they bring along, and what the relationship is between costs and benefits of multiple use as compared with costs and benefits of single use. For this purpose, three cases were selected for an in-depth costs benefit analysis. In the Ido Jalala case, water characteristics, water use, costs and benefits were analysed going from a traditional (unimproved) situation to a multiple use situation from the "domestic water supply side" (first developing an improved domestic system which is then upgraded for irrigation). In the Ifa Daba case, water characteristics, water use, costs and benefits were analysed going from a traditional situation to a multiple use situation from the "irrigation side" (first developing an improved irrigation system which is then upgraded for domestic use). The Biftu Diramu case analysed the water characteristics, water use, costs and benefits going directly from a traditional situation to a multiple use water situation.

The analysis of costs does not only focus on traditionally identified costs like construction and operation and maintenance, but also takes into account the community contribution to these costs and the support costs, borne by the implementing NGOs and the local government. The identified and quantified benefits from multiple water use include health benefits, time saving benefits and benefits from irrigation. Costs and benefits were analysed at both the household level and the system level and 'best' and 'worst' case scenarios were also considered at each level of analysis.

The results of the case study show that even in the worst case scenario the benefits easily outweigh the costs at household level, as well as at system level. It furthermore shows that additional benefits of 'upgrading' from single use to multiple use outweigh the additional costs. Although the benefit / cost ratio of both domestic water supply services and irrigation services proved to be very high, the benefit / cost ratio for domestic water supply was found to be higher than that for irrigation. Although the benefit / cost ratio of improved irrigation is very high, the ratio of additional benefits and costs of going from traditional irrigation to improved irrigation is less positive. This could be due to the fact that the improvements in the irrigation systems are not optimal and do not always provide water in the most efficient and thus profitable way.

1 Introduction

When and wherever possible, people in rural areas will use water for both domestic activities, like drinking, cooking, washing and cleaning, as well as for productive activities such as backyard gardening, irrigation, livestock keeping, processing of agricultural products and small-scale industrial activities, like beer brewing and brick making. These multiple uses of water bring multiple benefits. Domestic water use will mainly lead to an improved health situation with respect to water, sanitation and hygiene related disease, while productive use of water can result in direct economic benefits (income generation) and improved diet leading to increased food security (Moriarty et al 2004).

Box 1.1: Defining Multiple use water services (MUS)

Multiple uses and multiple benefits are often not addressed in an integrated way. Rather, different (sub-) sectors focus on different benefits, with the water supply and sanitation sector focusing on health benefits and the irrigation sub-sector focusing on food security and economic benefits from irrigated agriculture. The failure to recognise multiple uses, i.e. focusing on sub-sectoral water use only, will lead to a failure to capitalise on the multiple benefits. Furthermore, not taking into account the multiple needs people have for water can have a negative impact on sustainability of water supply systems. If systems are designed for single use but used for multiple uses, the resulting extra pressure on services might cause premature system failure and breakdown. Not taking into account multiple uses of water can also negatively impact the willingness of the users to operate and maintain the system, since it does not cater for the multiple water needs that they have.

Interest in multiple uses of water is on the rise in Ethiopia. In recent years, several implementing organisations, mainly NGOs, have been implementing and upgrading systems that do not only cater for domestic water use or irrigation, but that integrate these different uses. During the first East Hararghe Learning and Practice Alliance (LPA) meeting under the RiPPLE project, which took place in March 2007 in Dire Dawa, the LPA members agreed this is an interesting development, but that there is a need for more insight into the linkages between water and growth, and especially the costs and the benefits of such multiple use systems and services.

The literature relevant to understanding linkages between water and growth generally focuses on two separate areas: health and time savings impacts associated with access to improved domestic water supply and sanitation facilities; and improvements in agricultural productivity linked to access to water for irrigation. In both areas there is an extensive body of literature highlighting the benefits of investments in improved services. However, these debates have generally remained quite separate.

The economic costs and benefits of multiple use of water, taking into account both domestic water use as well as productive water use, remain poorly understood (Meinzen-Dick 1997; Van Koppen et al, 2006). Detailed studies on livelihood impacts associated with WASH sector improvement are relatively scarce. There are few studies that look beyond health and time benefits to incorporate the role of water services in small-scale production at the household level and the potential of such productive uses to improve food security and reduce poverty and vulnerability (Slaymaker et al, 2007). To date, very little research has been done on how the additional costs and benefits of multiple uses as compared with single use relate to each other in reality and the analysis that has been done is mostly based on projections and estimates (Slaymaker et al, 2007). The RiPPLE Project feels there is a need for solid assessment of the reality of links between water services and benefits for the poor.

Under the growth theme within the RiPPLE project, it was therefore decided to carry out a case study to assess the costs and benefits of going from single to multiple use water services. The objective of this case study is to provide a better insight into the costs and benefits of improved water services, by analysing the costs and benefits of moving towards multiple use water services in three cases in Gorogutu woreda in East Hararghe zone, Oromiya Regional State, in eastern Ethiopia. The hypothesis of the case study is that with relatively small additional costs, water quantity, quality, reliability and accessibility of single use water services can be improved to such an extent that water can be used for additional uses, which will generate additional benefits that exceed the additional costs.

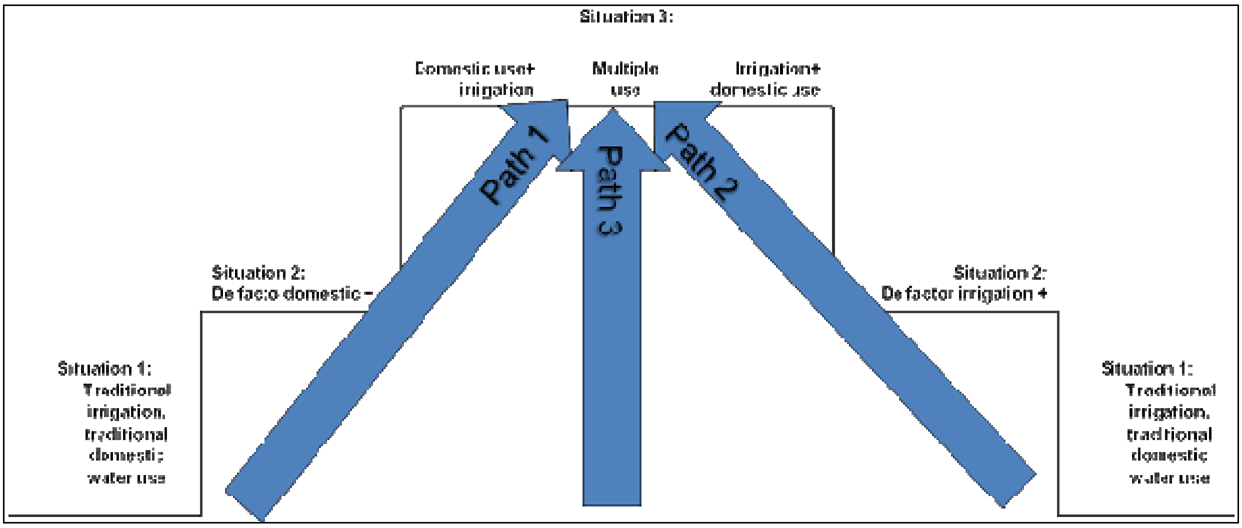
This report will first give an overview of the methodology used. This will be followed by a description of the case study areas in Chapter 3. Chapter 4 will describe the changes in water system, water characteristics and water use which have taken place. Chapter 5 then focuses on the costs related to these changes, while Chapter 6 concentrates on the benefits. Costs and benefits will be compared in Chapter 7. Finally, Chapter 8 will present the concussions and recommendations.

2 Overview of case study methodology[1]

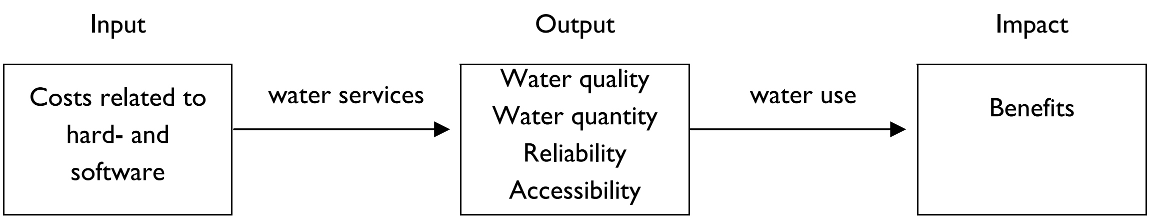
For this case study, three different paths of going from unimproved water services to multiple use water services were considered for analysis:

- Path 1: Traditional (unimproved) situation » de facto domestic plus » Domestic plus per design, through an upgrade of the water supply system
- Path 2: Traditional (unimproved) situation » de facto irrigation plus » Irrigation plus per design, through an upgrade of the irrigation system.
- Path 3: Traditional (unimproved) situation » multiple use

Figure 2.1: Three paths of going from the initial situation to MUS



Each step implies the need for changes in infrastructure and organisational and institutional arrangements (including possible conflict resolution arrangements because of increased pressure on scarce water resources), which carry along certain costs. Direct outputs of the changes in infrastructure and management will be changes in water quantity, water quality, reliability and accessibility. These changes in water characteristics can stimulate changes in water use, which can in turn cause changes in benefits from the use of the water. The benefits can be considered the impact of the changes in water services.



1 Methodological issues are further discussed in subsequent sections

This case study will look at the costs of water services, the water use and the resulting benefits in three cases, each taking a different path towards multiple use services, as described above.

The data collection for this case study was done by a research team consisting of representatives from an implementing organisation (HCS), the zonal and Woreda level government agencies, the RiPPLE consortium partner IRC International Water and Sanitation Centre and RiPPLE project staff (see annex 1).

The case study research began with a workshop, where the methodology and data collection process was jointly developed and refined. The data collection process itself took place from November 2007 to January 2008[2].

Data collection was conducted at several levels:

- Household level[3]
- System level[4]
- Service level (zonal and Woreda level)[5]

To collect data at household level, a wealth ranking and community mapping exercise was first undertaken. This helped to introduce the case study to the community and to give the researchers a first impression of the situation at the case study sites. The wealth ranking exercise differentiated households according to wealth status. Based on the wealth ranks, a total of 9 households (3 from each wealth ranking group) were selected per community to participate in a household survey and household recordkeeping exercise. The study intended to collect in-depth information from a small number of households, rather than more representative, but less in-depth, data from a much larger sample of households. In this way the MUS case study complements the household survey, which was conducted under the RiPPLE project in the end of 2007, in which a total of 1500 households were surveyed. This comprised 75 households in each of 20 kebeles[6], including the three kebeles in which this study was conducted.

To collect data at system level, project documents were reviewed and project staff members were interviewed on the design and construction process as well as the money, time and other resources spent on the process. As far as possible, accounts and books of the local water committee(s) were reviewed and committee members were interviewed to determine the operation and maintenance costs at system level. The system caretakers were requested to keep track of time, money and other resources spent on the operation and maintenance over a certain period of time.

Focus group discussions were held at the three case study sites. Separate focus group discussions were conducted with men and women on the perceived changes in water characteristics and the benefits of the improved water services. To be able to compare the perceived water characteristics, a rating table with micro scenarios describing the water characteristics was used. A mixed focus group discussion was held on the community contributions to the construction and operation and

2 All years in this report are expressed according to the Gregorian Calendar

3 The household level concerns individual households.

4 The system level is determined by the infrastructure in place from the water source down to the water points, taking into account all the different users and uses served by the system.

5 Service level is a wider circle which goes beyond the system itself to include external support structures, e.g. from zonal and Woreda level, upon which sustainable service provision depends.

6 Kebeles are the administrative level below the woreda, equivalent to communities.

maintenance of the systems. Water quality, quantity, reliability, accessibility and use were determined through observation, measurement (e.g. discharge and water quality measurements) and estimation.

At service level, the support staff of the systems (Woreda and zonal level) were interviewed. Furthermore, recurrent budgets and expenditure related to water supply and irrigation in the Woreda were assessed. Data from health clinics on illness, and from the Woreda level Agricultural Office on agricultural prices and inputs, was collected and analysed.

Costs and benefits were analysed per system per year, per capita per year, and per unit water. In order to be able to compare the different costs and benefits over different years, all amounts have been converted into Birr$^{\text{year 2000}}$, based on the GDP deflator of the World Economic Outlook Database (IMF Fund 2007).

3 The case study areas

Within the RiPPLE project, two Woredas have been selected in each of the three project regions (Oromiya, Benishangul-Gumuz, SNNPR) as focus Woredas for the project. In the Oromiya region, Babile and Gorogutu Woreda, both in the East Hararghe zone, have been selected as focus Woredas. Gorogutu Woreda is located about 115 km from Harar. The Woreda has a total area of 531 km^2 and an altitude that ranges between 1200 and 2657m. In the year 2005/2006, the population was estimated to be 136,119 people (Socio Economic Profile, East Hararghe). The agro ecology of about half of the Woreda (51%) is categorised as semi-tropical[7], which is cool and sub-humid climate. About 37% is characterised as semi-arid[8] and about 11% as temperate or highland[9]. There are two rainy seasons: the main rain season named Kiremt (Mehere) occurs from June to September and the minor one named Belg occurs from February to March.

In Gorogutu Woreda, three case study sites were selected, each representing one of the three paths towards multiple use water services as discussed above (see figure 1). A system in Ido Jalala kebele was selected as an example of a system which follows path 1. It had initially only been implemented for domestic use, but has been upgraded to include water use for irrigation and livestock, at the request of the users. In the Ifa Daba kebele, a system was selected to represent a system that has taken path 2 in its development. It was initially intended for irrigation, but was being used for domestic purposes as well. A stand post that facilitates water collection for domestic uses has recently been installed. A third system was selected in Biftu Diramu kebele. This system was designed and constructed to supply water for domestic use, irrigation and livestock from the start and thus represents a system taking the 3rd path.

3.1 Ido Jalala

Ido Jalala PA is found about 105 kilometres South-West of Dire Dawa, at an altitude of about 1250m. The geology of the area is mainly granite with fractured granite formations and the topography is relatively hilly. The village settlement is scattered and households are mainly dependent on farming and cattle rearing. In this kebele an elementary school is the only public service. Before the intervention, the total population of the village was estimated to be 725, with 125 households and an average household size of 5 people. The population at the end of the 20 year design period was projected to be 1127.

However, during the fieldwork period only 70 households using the system were identified, since many households do not want to pay the water fee and continue to use the unprotected springs in the area. The community identified 11% of the user households as 'better-off' households, 34% as 'medium' households and 53% as 'poor' households, based on criteria set by the community (see Table 3.1). According to the household interviews, the average number of people per households had increased from 4.9 persons per household some 5 years ago (before the intervention) to 7.6 people per household now.

7 Oromifa: Baddaa Daree; Amharic: Woyna Dega

8 Oromifa: Gamojjii; Amharic: Kola

9 Oromifa: Baddaa; Amharic: Dega

Table 3.1: Wealth ranking criteria as set by Ido Jalala community

Better off	Medium	Poor
3 and above oxen	Only 2 oxen	1 and below ox
2 and above cows for milk	1 Cow	0-1 cows
2 and above donkey	1 Donkey	No donkey at all
10 and above goats	5-9 goats	0-4 goats
3 and above cultural bee hives	1-2 bee hives	No bee hives
4 and above Timad[8] of land	2 and 3 Timad[10] of land	1-2 Timad[8] of land
1 and above Timad of irrigable land	1/2 Timad of irrigable land	No irrigable land
1000 Birr and above of chat sale	500-1000 Birr of chat sale	0-400 Birr of chat sale

3.2 Ifa Daba

Ifa Daba kebele is located at 125km South-West from Dire Dawa. It is accessible by an all weather asphalt road of 119km and 6km of rural gravel roads. Topography of the area is mountainous and rugged. The catchment area has steep slopes, ranging from 2.5 to 5.5 %. The soil type is clay mixed with small boulders and at some places there is highly fractured basalt mixed with large grained clay that is deep, permeable and well drained. Agriculture is the primary means of income generation and a sign of wealth among the communities. Before the intervention, the primary sources of income of the farmers were rain-fed agriculture (mainly rain-fed cereal crops) and livestock production. The total population of the village using the irrigation system was estimated to be 46 households and a total of 230 individuals.

During the fieldwork period, the number of users turned out to be 121 households. The number increased because more households became interested in the improved system, and is now far beyond the estimated 46 households for the design phase. Of these households, the community identified 27% of the households as 'better-off', 33% as 'medium' and 40% as 'poor', based on the criteria listed in Table 3.2. Before the intervention the average number of people per household was 4.6. This has nowadays increased to 5.8 persons per household.

Table 3.2: Wealth ranking criteria as set by Ifa Daba community

Better off	Medium	Poor
2 and above oxen	1 Donkey	No oxen or donkeys
1 and above cows	No cows	No cows
7 and above sheep	2-7 sheep	1 and below Sheep
1or 2 and above bee hives(Modern)	No bee hives(Modern)	No bee hives(Modern)
4 and above Timad of land	2-3 Timad of land	1 and below Timad of land
2 and above Timad irrigated land	1 Timad irrigated land	½ and below Timad irrigated land
20 and above strip of chat farm	10-20 Strip of chat farm	5 and below strip of chat farm
50 and above foot of eucalyptus trees	15 foot of eucalyptus trees	12 and below foot of eucalyptus trees

[10] 1 Timad = 0,125 ha (1/8 ha)

3.3 Biftu Diramu

The village of Aba Daga is situated in the Biftu Diramu kebele in Gorogutu Woreda about 127km south west from Dire Dawa town and about 21km from Karamile town, via 17km of asphalt road and 4km of dry weather road. The geology of the area is mainly granite with fractured granite formations. The hydrogeology of the area is favourable for spring development. The general topography of the site is rugged terrain with an undulating landscape dissected by many gullies. The village settlement is scattered. For their livelihoods, the inhabitants mainly depend on farming and cattle rearing. Before the intervention, the population of the village was estimated to be 98 households and 490 individuals.

Through the wealth ranking exercise 96 user households were identified, which is close to the estimate of 98 households used in the design of the system. Some 14% of the households were ranked by the community as 'better-off', 26% as 'medium', and 60% as 'poor'. The ranking criteria used by the community can be found in Table 3.3. The average number of persons per household before the intervention was 5, while after the intervention this was 6.4.

Table 3.3: Wealth ranking criteria as set by Biftu Diramu community

Better off	**Medium**	**Poor**
2 Oxen and above	1 Ox	No ox
2 Cows for milk and above	1 Cow for milk	No cow
2 Donkey and above	1Donkey	No donkey
5 Goats and above	2-4 Goats	1Goat and below
5 Sheep and above	2-4 Sheep	1 Sheep and below
8 Timad of land and above	4 Timad of land	2 Timad of land and below
20 Katare [11] and above	10 Katare of chat farm	No Chat farm
2 Corrugated houses and above	1 Corrugated house	Hut

[11] Katare = strip of chat farm. One Katare is equivalent to 1/4 hectare

4 Moving towards multiple use water services: Changes in water systems, water characteristics and water use

This chapter will describe the changes in the water systems due to the interventions that have taken place in the three case study areas and the resulting changes in water characteristics.

4.1 Changes in the water system

4.1.1 Ido Jalala

The Mede Hades spring, emanating from the granite formation with a discharge of 0.427 l/s, was initially used for drinking purpose and animal watering by the people of Ido Jalala kebele. In 2005, the spring was capped by the Ethiopian NGO HCS and a domestic water supply system was constructed. With a projected population growth of 2.23%, based on a population size of 725 people, a design lifespan of 20 years and an average water consumption of 16 lpcd, the domestic water demand of the system was estimated to be 18032 litres per day (or 0.21 l/s). The water supply scheme was designed to have a spring capping box backed with filter media, selected river gravel and runoff protection structure. From the spring capping box, the water is transported to a 16 m^3 reservoir from where the water was supposed to flow by gravity to a water point with four faucets, a washing basin and a cattle trough, though the last of these has not been constructed yet.

People were using the run-off water from the domestic system and the water from other nearby springs for traditional irrigation. This stimulated the community to request HCS to assist them in developing an improved irrigation system. First steps towards this were undertaken right after the construction of the domestic water supply system, with the construction of an irrigation reservoir. However, 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.

4.1.2 Ifa Daba

Before the implementation of the irrigation system, community members used to drink from an unprotected spring. Livestock were watered at the same place. The discharge of the spring is about 1.44 l/s. This spring was used for traditional irrigation as well, though only on a small scale. An irrigation system was constructed in 2004 for irrigation purposes only by HCS. The spring was capped and a night storage reservoir with a capacity of 62 m^3 was constructed. From the night storage reservoir, water flows into a division structure, from where the water is distributed over three small lined canals, consisting of pre-cast concrete semi circular pipes.

Since the implementation of the irrigation infrastructure, the community has been using the system for drinking water as well, which makes it a de facto irrigation+ system. In 2007, a stand post directly connected to the capped spring was added to the system, to facilitate fetching water for domestic use. Furthermore, a cattle trough and washing basin were added to the system. However, the stand post was initially placed in a swampy area, which prevented the users from collecting their water there. Instead, the practice of collecting the water from the irrigation reservoir continued. To facilitate water collection, the stand post was reallocated to a more favourable position at the beginning of 2008.

4.1.3 Biftu Diramu

The community at the Biftu Diramu site used to collect water from an unprotected spring which is located 3km from the main settlement. This is the nearest spring to the village, and was being used for drinking water and for watering livestock before the intervention. The discharge of the spring is approximately 0.3 l/s. Before the intervention, most of the water was lost in the sand because the spring was not protected. In 2002 the spring was developed by HCS with the construction of a spring box backed with filter media, selected river gravel and runoff protection structure. Furthermore a circular water collection reservoir of 10 m^3 was installed and connected with a pipe to a water stand-post with four faucets, a cattle trough and a washing basin. The system also included a small irrigation scheme component, making use of the overflow water from the storage reservoir. Since the overall flow of the spring water (25.9 m^3/day) is greater than the estimated future daily demand of the communities, based on a population growth rate of 2.23% (12.2 m^3/day) there will always be a surplus flow from the reservoir (13.7 m^3/day) which is conveyed by pipe to the small traditional irrigation scheme.

4.1.4 Limitations of the selected case study areas

One of the challenges the research team had to face was the selection of case communities which had gone through the transition from a traditional to an improved single use situation and to a multiple use situation, by different paths (irrigation path, domestic water supply path, and directly to multiple use) as illustrated in figure 1. However, not all of the three systems select were found to be functioning optimally (yet). In Ido Jalala, the irrigation upgrade to the domestic water supply system had not been finalised and was therefore not working optimally. The upgrade to the irrigation system in Ifa Daba was ongoing while data was being collected, so the benefits could not really be captured.

Although Biftu Diramu was supposed to represent a system that has been implemented as a multiple use system, combining domestic and productive uses, the system was not yet developed to its full potential. In particular, irrigation remains underdeveloped and the benefits from irrigation have actually decreased with the development of the system.

In order to follow the case study methodology, and to be able to compare across the 3 cases, it was decided to keep characteristics of the system other than their purpose (domestic water supply, irrigation, multiple use), as constant as possible. This is the reason why three similar systems by the same implementer were selected: in this case gravity spring systems implemented by HCS. It is important to note that spring systems are characterised by low implementation and especially low operation and maintenance costs. In order to get a broader idea of how costs and benefits relate to each other in other types of multiple use system, further studies would be required taking other types of systems into account.

4.2 Changes in water characteristics

To be able to compare the users' perceptions of changes in water (services) characteristics, ranking tables were developed. Different micro scenarios were developed to describe the ranking on a scale from 0 to 100. These micro scenarios can be found in Annex 3. Based on these, the users ranked water quality, accessibility and reliability in the different situations in the development of the water system as indicated in the table below.

Table 4.1: Ranking of water characteristics

	Ido Jalala			Ifa Daba			Biftu Diramu	
	Situation 1: traditional situation	Situation 2: De facto domestic plus	Situation 3: domestic +irrigation per design	Situation 1: traditional situation	Situation 2: De facto irrigation plus	Situation 3: irrigation + domestic use per design	Situation 1: traditional situation	Situation 3: multiple use
Water quality	25	70	70	25	50	80	25	75
Accessibility for domestic use	25	75	75	25	75	95	25	60
Accessibility for livestock	25	25	75	25	50	90	25	90
Accessibility for irrigation	35	25	75	25	75	75	35	20
Reliability	75	90	90	75	90	90	75	70

According to the users of Ido Jalala, the quality of the water has improved due to the protection of the water source. Before the intervention, the earthen pond was full of mud, used by both the community members and the cattle. The colour of the water was unattractive and there were small observable worms inside. The water quality has visually improved. However, in the wet season the water quality tends to decline as flood water gets into the system, because the spring box is unfinished and the spring water comes into contact with some overland floods. Because of this, the water quality was ranked slightly lower than the water quality of the other systems.

In Ifa Daba, the water quality had already improved dramatically with the capping of the spring and the implementation of the irrigation system. Further improvement was seen with the addition of the water-point for domestic water collection.

Some water users from Biftu Diramu argued that the quality of the water had not improved a lot with the intervention. In the initial situation, the discharge of the water was so great that there was no stagnant water in the pond which could bear disease. However others argued that the water quality did significantly improve, as it has become free from dirt, its taste has improved, and it has become free from worms and leeches. In addition the complete absence of waterborne and water-related diseases can be seen as an indication of improved water quality.

In Ido Jalala, the accessibility of the water source has improved greatly with the intervention, as reflected in the table above. Before, only one woman at a time was able to fetch water at a slow speed. Nowadays, three women can easily fetch at the same time. The discharge at the tap is 0.083 l/s, which means it currently takes a bit more than 3.5 minutes to fill an 18 litre jerrycan. The system is being used for irrigation as well, though the infrastructure designed for irrigation is only partly constructed and not in full use.

The accessibility of the water supply for domestic use in Ifa Daba improved a lot with the implementation of the irrigation system. The irrigation system enabled women to fetch water from the pipe supplying water to the reservoir (see photo 1), which was a big improvement on the initial situation in which only one woman could fetch water from the spring at a time, needing a lot of time to fill the container while the others had to wait for their turn according to their arrival time. It improved even further with the implementation of the water-point, from which 3 women can fetch water at the same time, each taking a bit less than 2 minutes to fill an 18 litre jerrycan.

In Biftu Diramu, before the intervention water fetching was very time consuming, since only one person could fetch water at a time from the unprotected spring. It had to be done with great care in order not to disturb the water and keep the quality. Nowadays, four people can simultaneously fetch water from the four taps at the water-point that has been installed. However, most community members complain that the water-point was located around the spring spot instead of closer to their village, which means it is still time consuming for people to fetch water, especially for those who do not have a donkey to carry the containers. Therefore, the accessibility for domestic use was ranked lower than in the other two cases.


Woman fetching water from the irrigation reservoir in Ifa Daba

Since all three systems have been based on perennial springs, with a more or less constant discharge throughout the year, the reliability was considered to be good (between 75 and 90 points) for all development situations in the three case study areas.

4.3 Changes in water use

Data on water use was collected in two ways. First, a household survey was administered to selected households, with questions about their water use for drinking, cooking, personal hygiene, washing utensils before and after the intervention. Secondly, the selected households were asked to keep household records of their water consumption. The amounts of water used for domestic use obtained through this second method were found to be lower than the ones obtained through the interviews. It was assumed that the amounts mentioned in the interviews were overestimated and the data from the household record keeping was considered as most reliable. However, there is no household record keeping data from the situation before the intervention. For this, the study had to rely on data from the household surveys, which was adjusted assuming the same rate of overestimation as in the current situation. Based on this, an indication of the average water use in the traditional situation could be given, as shown in the table below.

4.3.1 Water use for domestic use

Table 4.2 presents the estimated water use for domestic purposes. Annex 4 gives a more elaborate overview of the water use, differentiating between wealth ranking classes. The table shows that the consumption per household increases with the change from the initial situation to a multiple use situation. In the case of Ido Jalala, the domestic water use per household after the intervention is 181% of the household water use before the intervention. In Ifa Daba the household domestic water use after the intervention increased to 112% of the water use before the intervention, while in Biftu

Diramu the water use after intervention is 129% of the initial water use per household. However, as shown in the table, this does not automatically mean an increase in per capita water use, since household size may have changed over the same period. When comparing the initial water use situation with the after situation the increase in household members is taken into account. This explains why the total water consumption per household has increased, but individual water use decreased in the case of Ido Jalala.

Table 4.2: Actual daily water use, based on household record keeping

	Ido Jalala		**Ifa Daba**		**Biftu Diramu**	
	Situation 1: traditional situation	Situation 3: domestic +irrigation per design	Situation 1: traditional situation	Situation 3: irrigation + domestic use per design	Situation 1: traditional situation	Situation 3: multiple use
# persons per household	4.9	7.6	4.6	5.8	5.0	6.4
Total water use (m^3/year)	519	940	1321	1480	1121	1447
Water use per household (l /hh/day)	20.3	36.8	29.9	33.5	32.0	41.3
Increase in water use per household		181%		112%		129%
Water use per capita (lpcd)	6.6	5	7.1	7.5	7.5	8.1
Water use in situation 3 as percentage of water use in situation 1 (%)		76%		106%		108%

The domestic water use is far below the 16 lpcd that was taken as the design consumption by the implementer and the 15 lpcd set by the Universal Access Plan as the standard for improved water supply.

4.3.2 *Water use for livestock*

The water used for livestock in the before and after intervention situation in the three case study areas has been based on the number of livestock kept in both situations. Data on the number of livestock was obtained through household questionnaires and observations.

The graphs below give an overview of the total number of livestock in the situation before (situation 1) and after (situation 3) intervention in the three cases.

Figure 4.1: Number of livestock in Ido Jalala

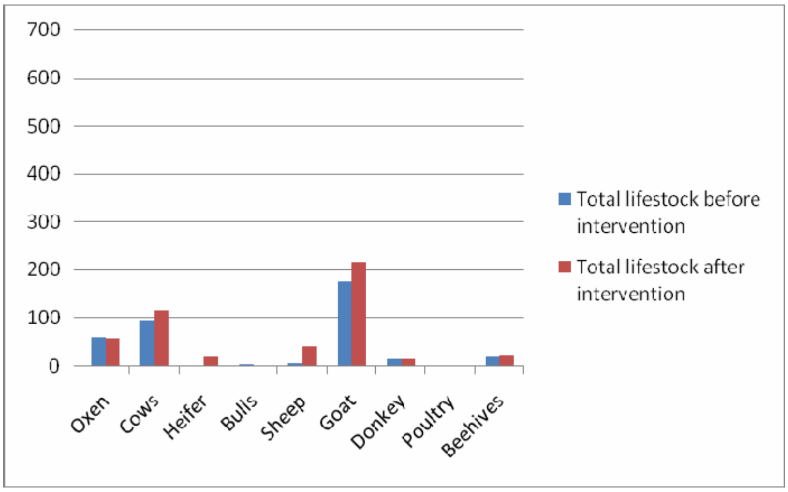


Figure 4.2: Number of livestock in Ifa Daba

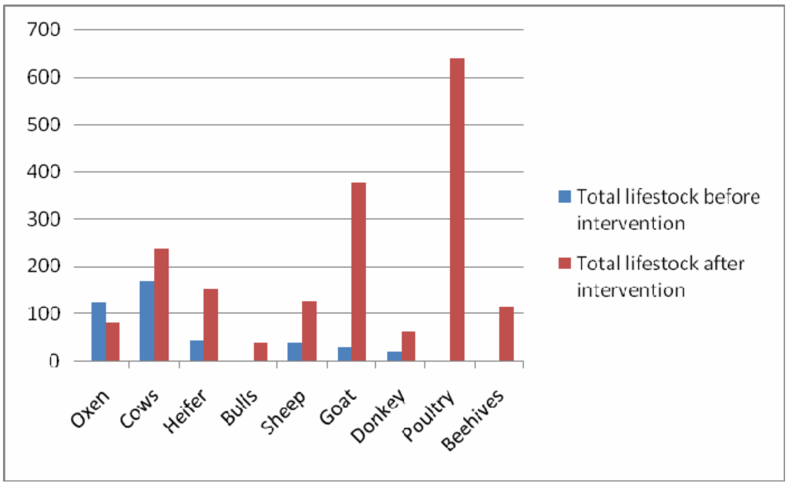
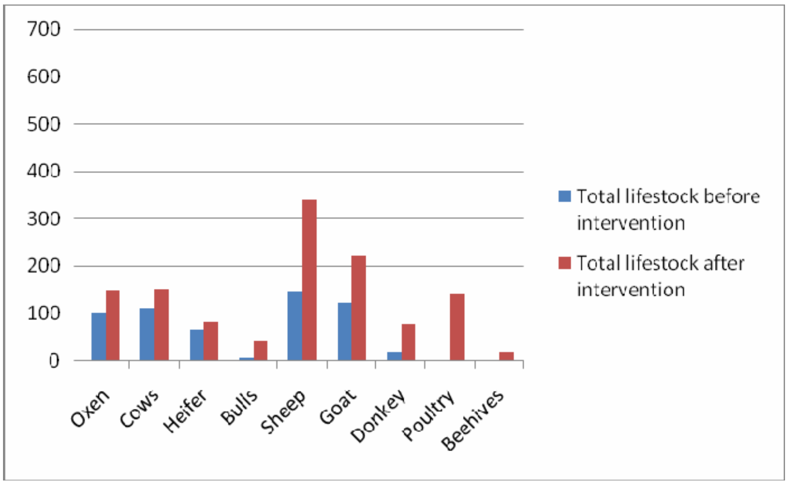


Figure 4.3: Number of livestock in Biftu Diramu



The graphs show there is a general trend of increase in number of livestock per household. The graphs furthermore show a diversification of the livestock holding pattern in the situation after the intervention. It could be argued that since more water is available near the homestead it is more lucrative to keep more animals (especially small stock) or that there might be a link between improved irrigation and thus more benefits from irrigation (e.g. increased availability of fodder or increased income from irrigation crops) which enables the purchase of animals. However it is difficult to conclusively attribute this change in livestock holding pattern to the improved water availability and reliability.

In line with the increase in number of livestock, the water consumption by livestock has increased as shown in the table below.

Table 4.3: Livestock water consumption

	Ido Jalala		**Ifa Daba**		**Biftu Diramu**	
	Situation 1: traditional situation	Situation 3: After intervention	Situation 1: traditional situation	Situation 3: After intervention	Situation 1: traditional situation	Situation 3: After intervention
Total water use from the system(m^3/year)	2234	2516	3597	5723	3121	5702
Water use per household (l /hh/day)	87	98.49	81	130	89	163
Water use per human capita (lpcd)	17.8	13.0	17.7	22.4	17.8	25.3

4.3.3 Irrigation

In Ido Jalala, the intervention has so far focused on improvements in the domestic water supply system. This has not led to changes in the irrigated cropping pattern. The only remaining irrigated crop is chat. The irrigated land for the irrigating households is supposed to be 1 Timad or 1 Qindi. This is the equivalent of 1 oxen day, which equals about 1/8 ha (0.0625 ha). The total irrigated area before the intervention was 2.5 ha, irrigated by a total of 40 users. After the intervention, the irrigated area has been brought back to 1.56 ha, serving 25 users, because more water was allocated to be used for domestic use as the system for irrigation has not been fully completed

In Ifa Daba, the intervention was initially focused on irrigation, to which a domestic water supply component was added at a later stage. According to the records, the area that was traditionally irrigated in the initial situation covered a total area of 5 ha, with 40 users cultivating 0.125 ha each. In the improved irrigation situation, the number of users has increased to 53, irrigating a total area of 6.625ha (also 0.125 ha each). In the initial situation, chat was the main cultivated crop, while after the intervention a large proportion of the chat was replaced by other crops, mainly vegetables.

In Biftu Diramu, the irrigated area was expected to go down from 3 ha (24 users, each irrigating 0.125ha) to 0.75 ha (12 users, each irrigating 0.0625ha) with the implementation of the combined system, since part of the water was allocated for domestic use. In the initial situation, onion, tomatoes and pepper were cultivated, besides chat. In the situation after the intervention, the main irrigated crops are chat, coffee, potatoes and sugarcane.

4.3.4 Overview of changes in water use

Figure 4.4 and 4.5 present an overview of the use of water in the different situations (1, 2 and 3) for each study area. In addition a small amount of water from domestic use and for livestock will run off and will be (partly) used for irrigation.

Figure 4.4: Average annual water use

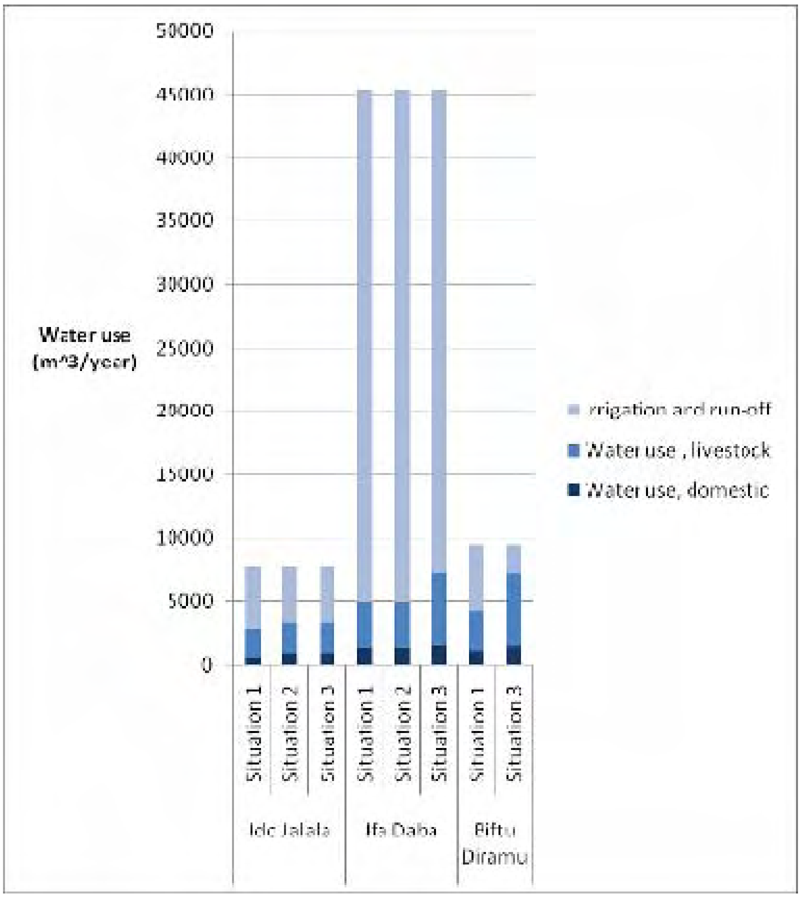
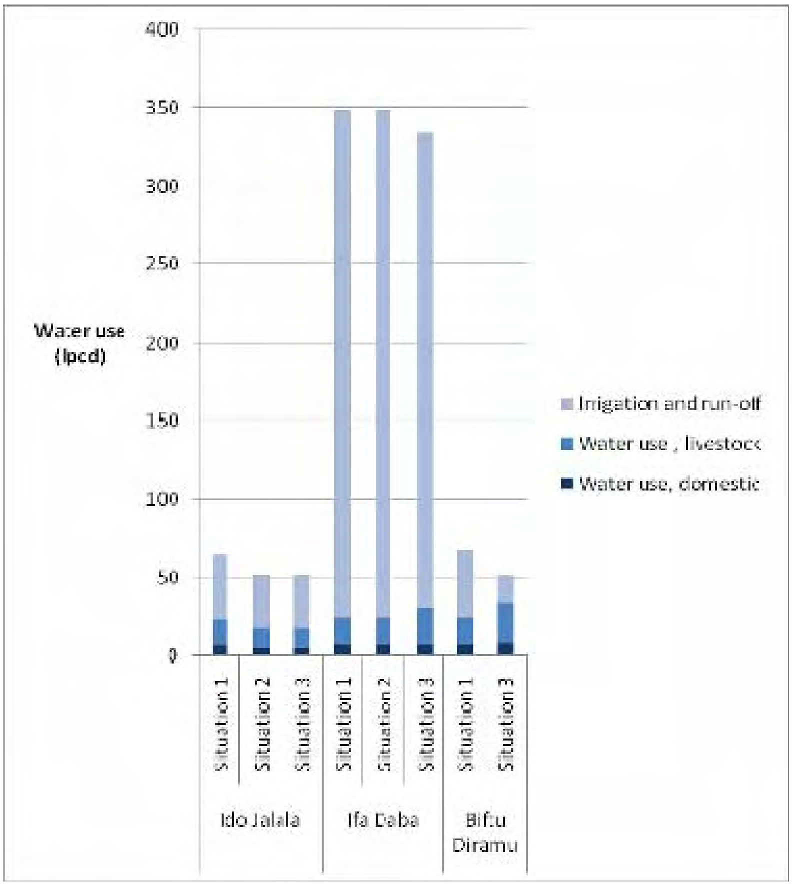


Figure 4.5: Average daily water use per capita



5 Costs

In this chapter the costs of the changes in hard- and software related to the interventions described in chapter four will be analysed.

5.1 Cost classification

The following costs are related to the provision of water services[12]:

- Capital investment costs in assets (CapIn)
- Operating and minor maintenance expenditure (Opex)
- Capital maintenance expenditure (Capex)
- Costs of capital (CoCap)
- Support costs (SupCo)

Capital investment costs in assets (CapIn) include all costs involved in the design and construction of a water system. Operating and minor maintenance expenditure (Opex) concerns all costs related to operation and maintenance (including small repairs) to keep the system going. Replacement and rehabilitation costs are expressed in the Capital maintenance expenditure costs (Capex). The costs of capital (CoCap) include costs of interest repayment on loans, inflation, exchange rate variations, bank fees etc. Most costs of capital are only relevant when big loans are involved in the implementation and/or operation and maintenance of the system. Finally, support costs (SupCo) are the costs that go beyond the direct costs associated with a specific water supply system. These costs can include institutional capacity building and skills training at local and national government, developing and maintaining IWRM plans, development and maintaining monitoring and information systems, setting up a private sector and/or supply chain, awareness raising and promotion of innovative technologies, advocacy and other activities.

Costs can be analysed at household or at service level. At household level, only the household contribution to the different costs will be considered. In general, this means the household contribution, in cash and kind, including labour, materials, land, to the CapIn (contribution to design and implementation) and the Opex (household contribution to O&M costs, for example through water fees, household contribution to O&M through other mechanisms, like small repairs on the account of the household, etc). At service level, all costs of the design, construction, operation and maintenance of a certain system and support to that system and beyond are considered. Furthermore, there can be costs related to the negative impacts of the water services, which should ideally be included. These could include costs related to the deflation of water resources, costs of water conflict, etc.

[12] Based on OFWAT terminology, adapted by IRC

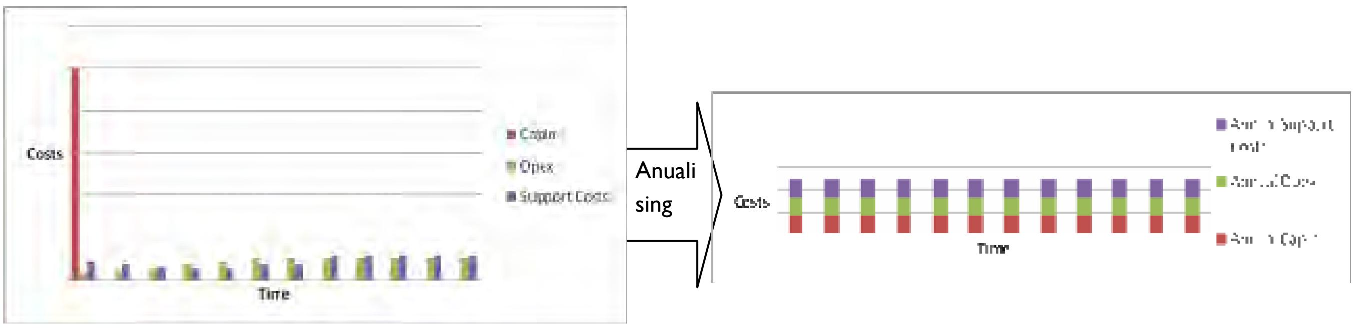
Table 5.1: Water service costs at different levels

Type of cost / Level	Capital investment costs in assets (CapIn)	Operating and minor maintenance expenditure (Opex)	Support costs (SupCo)	Impact costs
Household level	Household contribution to the capital costs (in cash and kind, including labour, materials, land)	Household payment of water fees. Household contribution to O&M through other mechanisms (in cash and kind)		
Service level	Total costs of design and construction of the system, in cash and kind	Total costs of O&M	Direct and indirect support costs	Costs of deflating water resources; costs of water conflicts, etc

For this case study, the Capex and CoCap will not be taken into account in the cost analysis. Because of the low capital intensity of the interventions, we assume the CoCap is negligible. The Capex will not be taken into account because of lack of data on these costs. By not taking into account the Capex, it is implied that after the end of the lifespan of the system, the full CapIn costs will have to be covered.

The costs of water services will vary over the lifespan of the system, as shown in the graph below. In order to compare the costs with the benefits, the costs will have to be annualised. The total costs over the lifespan of the system will therefore be divided over the lifespan of the system.

Figure 5.1: Annualising costs



5.2 Capital investment costs

The capital investment costs consist of the costs carried by the implementer, HCS in this case study, and the contribution of the community. According to HCS policy, the community contribution can be given in labour and materials and should be at least 20% of the capital investment costs borne by HCS.

In situation 1 of the three cases (traditional irrigation and domestic use), investment costs have not been made yet. In situation 2 (de facto single use plus), investment costs are only related to a single use: in the case of Ido Jalala investment costs relate to domestic water supply and in the case of Ifa

Daba investment costs relate to irrigation. In situation 3, investment costs have been made to ensure multiple uses. An overview of the capital investment costs in the different situations is given below. A total overview of the CapIn costs can be found in annex 5.

Table 5.2: Total CapIn

	Ido Jalala			**Ifa Daba**			**Biftu Diramu**
	Situation 2: System designed for domestic use	additional costs of step 2	Situation 3: System designed for domestic use + irrigation	Situation 2: System designed for irrigation	additional costs of step 2	Situation 3: system designed for irrigation + domestic use	Situation 3: System designed for multiple use
Total investment costs HCS (Birr year 2000)	87,613	18,713	106,327	97,849	19,459	117,308	43,217
Total community contribution (Birr year 2000)	4,896	673	5,569	10,763	543	11,306	11,430
Grand Total CapIn (Birr year 2000)	92,509	19,387	111,896	108,613	20,002	128,615	54,647
Grand Total CapIn (Birr year 2000/m^3)	0.60		0.72	0.12		0.14	0.29

The community contribution to the initial Ido Jalala system was 6% and to the upgrade it was 4%. In the case of Ifa Daba, the community contribution to the initial irrigation system was about 11%, while it was only 3% for the upgrading costs. This shows that in the cases of Ido Jalala and Ifa Daba the community contribution was far lower than the intended 20%. The community contribution to the CapIn Costs of Biftu Diramu was around 23% of the total costs. However, when looking at the absolute costs (total community contribution in the table above), the difference between the community contribution in Ifa Daba and Biftu Diramu is smaller, which suggests that a fixed amount rather than a fixed percentage of community contribution to the total costs is being used.

The Biftu Diramu system was installed some years before the other systems. The costs of this system, both in total and per capita, are considerably lower than the costs of the other two systems. It is quite possible that at that time different decisions were made about the quality (and hence costs) of the materials used, the design itself etc. These choices could result in a difference in lifespan of the system, but this could not be determined within this case study. This might be an interesting area for further research.

The table below gives an overview of the costs per capita per year for the three cases. The design lifespan of 20 years was used to calculate these figures.

Table 5.3: CapIn per capita (in relation to the total community)

	Ido Jalala			**Ifa Daba**			**Biftu Diramu**
	Situation 2: System designed for domestic use	additional costs of step 2	Situation 3: System designed for domestic use + irrigation	Situation 2: System designed for irrigation	additional costs of step 2	Situation 3: system designed for irrigation + domestic use	Situation 3: System designed for multiple use
Total investment costs HCS (Birr year 2000/ cap / year)	8.28	1.77	10.05	7.00	1.39	8.39	3.52
Total community contribution (Birr year 2000/ cap / year)	0.46	1.27	0.53	0.77	0.04	0.81	0.93
Grand Total annualised CapIn (Birr year 2000/ capita / year)	8.75	1.83	10.58	7.77	1.43	9.20	4.45

In the Ifa Daba case, only 53 of the 121 households benefited directly from the implemented irrigation system. If the costs for situation 2 were therefore divided over only the number of people who directly benefit from the irrigation system, the grand total annualised CapIn would be 17.73 Birr year 2000/ cap / year. In the case of Ido Jalala, the additional costs of going from situation 2 to situation 3 are related to irrigation. The additional costs divided by the irrigation beneficiaries would give additional costs of 5.13 Birr year 2000/ cap / year.

It could be argued that in reality the lifespan of systems can be expected to be far lower than the design lifespan. This would mean that the CapIn costs would be spread over a shorter period of time, which would imply that the annualised CapIn costs would be higher than the design annual CapIn costs. The actual lifespan of the systems depends on many factors, for example the quality of the constructed system and the materials used, the local capacity for system maintenance, and the willingness of users to contribute to the maintenance costs. Estimating the actual lifespan of the system and the impact of multiple use of water on the lifespan would be extremely interesting and useful, but unfortunately was beyond the scope of this case study. Here we will consider a best case scenario, in which the lifespan of the systems is 20 years and the annual CapIn is as indicated in table 9, and a worst case scenario, in which the lifespan of the systems in 10 years, and the annual CapIn will therefore be double the costs mentioned in table 9.

5.3 Operation and maintenance costs

The operation and minor maintenance costs (Opex) are supposed to be covered to a large extent by the community itself. Water fees are generally collected to cover these daily operation and maintenance costs. The real costs of operation and maintenance are not the same as the collected amount from the water fees. When the collected water fees are greater than the O&M costs, the collected money can be saved to pay for major repairs and rehabilitation of the system at a later date. However for major repairs and rehabilitation, the communities are still likely to request the implementer, or the Woreda or zonal level government to assist them with technical expertise and materials.

The annual operation and maintenance costs will differ over time. When a system has just been installed, the costs are likely to be lower than when the system is approaching the end of its lifespan (as was illustrated in figure 2). For this case study, we therefore use community contribution to the operation and maintenance through the water fees as a proxy for costs at household level. At service level, an estimation is made of the average annual O&M costs over the lifespan of the system.

5.3.1 Service level

Since the selected case studies were implemented relatively recently, it has been difficult to get a good indication of the total operation and maintenance costs over the lifespan of the system. We will therefore estimate the operation and maintenance as 10% of the annual CapIn costs (5% operation and maintenance costs + 5% source protection (as per Hutton and Haller 2004). This gives the Opex costs as presented in the table below.

Table 5.4: Opex costs at system level

	Ido Jalala		Ifa Daba		Biftu Diramu
	Situation 2: De facto domestic plus	Situation 3: domestic +irrigation per design	Situation 2: De facto irrigation plus	Situation 3: irrigation + domestic use per design	Situation 3: multiple use
Total O&M costs (Birr $^{Year\ 2000}$ / year)	463	559	543	643	273
Total O&M costs (Birr $^{Year\ 2000}$/capita / year)	0.87	1.06	0.78	0.92	0.44

Table 5.4 shows that in Ifa Daba the O&M costs increase with the upgrade to irrigation plus domestic per design (situation 3), but since the number of users has increased, the Opex per capita has actually decreased. This suggests that a community contribution of 1.1 Birr $^{Year\ 2000}$ (about 1.6 Birr $^{Year\ 2007}$) per capita per year would be sufficient to operate and maintain the Ido Jalala system and that 1 Birr $^{Year\ 2000}$ (about 1.6 Birr $^{Year\ 2007}$) per capita per year would be sufficient for the operation and maintenance of the Ifa Daba system in situation 3. A community contribution of 0.5 Birr $^{Year\ 2000}$ (about 0.7 Birr $^{Year\ 2007}$) per capita per year would be sufficient to cover operation and minor maintenance of the system in Biftu Diramu.

Water committee

5.3.2 Household level

In all three cases, water committees have been established, which have responsibility for setting the water fee, collecting the fees and using the money for operation and small maintenance. The water committee in Ido Jalala consists of ten members, including two women (cashier and monitor). Fee collection has only recently started (October 2007). At that time, the fee was set at 1.5 Birr$^{Year\ 2007}$ (1.04 Birr$^{Year\ 2000}$ per month, which gives 12.48 Birr$^{Year\ 2000}$ per year) per household per month (as per the decision of the majority. Although 70 households make use of the system, only 24 households have been paying the water fee, which has resulted in revenues of 432 Birr $^{Year\ 2007}$ in 2007 (299 Birr $^{Year\ 2000}$). Defaulters state that the water quality is not optimal due to lack of treatment and therefore they are not willing to pay. In most cases, defaulters are nonetheless allowed to collect water.

The original unimproved irrigation system in Ifa Daba was managed by a traditional management committee constituting of three elders and one 'Malaka'(the person who operates the irrigation system). With the implementation of the new irrigation system this management structure has changed. It now involves nine individuals with different roles (including one chairman, one secretary, one cashier, one treasurer and two care takers). After the establishment of the modern water committee, the necessary training was provided by the implementing organisation (HCS). So far, the water committee has not been successful in setting a water fee and collecting revenues.

The water committee in Biftu Diramu consists of ten members, including two caretakers and the kebele chairman. Households are paying 1 Birr$^{Year\ 2007}$ per month (0.69 Birr$^{Year\ 2000}$ per household per month, which gives 8.32 Birr$^{Year\ 2000}$ per household year). The water committee does not have a bank account because 1000 Birr is required to open a group savings account and so far only 600 Birr has been collected. No receipts for the expenses and revenues are available and there has been discontinuity in fee collection because of a lack of strong follow up by the water committee.

In none of the cases to-date have separate water tariffs have been set for different water uses. There is no separate tariff for people using the water for irrigation. 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 only small increases in operational costs. In the case of other 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 would have to be covered as well as the extra operating cost for the pump operator and the depreciation costs of the pump and generator needed.

5.4 (Post Construction) Support costs

Although the costs of post construction support services are generally not considered in cost analyses, an attempt is made here to give more insight into these costs.

The communities receive post-construction support from Woreda and zonal government officers and, especially in the first 3 years after the construction of the system, from HCS. This post-construction support consists of a variety of activities, including supervision of the system's operation and maintenance after phase out, resolution of conflicts, refresher training for system users and caretakers, and extension work. Besides providing post-construction support, Woreda and zonal officers are involved in promotion activities in unserved areas and in supporting development and construction of new systems. The Woreda water officer spends about 40% of his time on supporting existing systems. The rest of the time he focuses on developing new systems and assisting with the construction. The irrigation officer on the other hand, spends about 70% of his time providing post construction support. The zonal officers are estimated to spend about 20% of their time on post construction support.

Since it was difficult to determine actual support costs for the different situations in the three cases, the support costs per system were estimated based on the recurrent budgets of government agencies that support community-managed water supply and irrigation systems, the relative time that support agents spent on providing post construction support to specific systems, and the number of these systems in the area.

The table below gives an overview of the recurrent costs of the relevant Woreda and irrigation offices and bureaus. The recurrent costs consist of salaries and logistics that allow the Woreda and zonal officers to do their job.

Table 5.5: Recurrent costs of government offices

	Budget 2006	**Expenditure 2006**	**Expenditure 2006 per inhabitant of Goro-gutu**
Recurrent costs Woreda irrigation office (Birr $^{\text{Year 2000}}$/ year)	52770	34969	0.26
Recurrent costs Woreda water office (Birr $^{\text{Year 2000}}$/ year)	34969	34969	0.26
Recurrent costs Zonal irrigation bureau (Birr $^{\text{Year 2000}}$/ year)	1174863	1089939	0.46
Recurrent costs Zonal Water bureau (Birr $^{\text{Year 2000}}$/ year)	405294	344700	0.14
Total			**1.11**

Based on this, the post-construction costs of different systems can be estimated, using the officers' estimates of the relative time spent on post-construction support to different systems.

Table 5.6: Post construction support costs in 2006

	Expenditure (Birr $^{\text{Year 2000}}$/year/system)
Traditional domestic water supply	68
Gravity domestic system	137
Traditional irrigation	181
Gravity Irrigation system	272
Traditional domestic water supply + traditional irrigation	249
Gravity domestic system + traditional irrigation	318
Gravity irrigation system + traditional domestic water supply	340
Gravity domestic + gravity irrigation system	408

The table above gives an overview of the estimated support costs per system. These figures are based on Woreda and zonal recurrent expenditure in the year 2006, as mentioned above. Based on the relative time spent per type of system, and the number of systems in the Gorogutu woreda, the recurrent costs were divided among different systems and an estimate unit support cost per system was determined as indicated in the table above.

As shown in the table above, the support costs of improved domestic water use + irrigation (MUS) are calculated as the sum of the estimated support costs to a gravity domestic system and gravity irrigation system. In case of integrated MUS services however, it could be argued that better coordination between the different sub-sectors would enable a more efficient use of human and financial resources, and thus leading to decreased support costs, avoiding duplication and stimulating synergies. The table below gives an overview of the support costs for the three cases.

For this estimation, we have assumed that the type of system is the only factor that determines the amount of time the support agent spends providing post construction support. Furthermore, we assume that there is a linear relationship between time spending and costs. In reality however, there is unlikely to be such a linear relationship in reality, as some factors, e.g. expenditure on fuel, are not directly related to time spending. In addition, the time allocated to a certain system by support agents will depend not only on the type of system, but also on the distance to the system, the state of the system, the occurrence of conflict, and other factors. The figures presented below should therefore be regarded as rough indications of the support costs.

Table 5.7: Support costs

	Ido Jalala			**Ifa Daba**			**Biftu Diramu**	
	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per design	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Annual support costs (Birr Year 2000/ year)	249	318	408	249	340	408	249	408
Annual support costs (Birr Year 2000/ capita / year)	0.73	0.60	0.77	0.45	0.49	0.58	0.52	0.66

The support costs of HCS were not taken into account, although field workers from HCS visit systems implemented by HCS on a regular basis, especially in the first three years after implementation. The actual support costs might therefore be higher than the costs presented in this case study.

5.5 Impact costs

Negative impact of changes in water services that go beyond system level should ideally be considered and taken into account as well. These negative impacts, for example increased conflict over water resources, or degradation or pollution of water resources, can theoretically be expressed in monetary units. As such, we could consider these costs as impact costs.

However, the research team was not able to clearly identify these types of negative impacts in the case study areas at this moment in time. Although the team recognises the fact that these negative impacts are likely to occur, especially in the long run, it was decided that these are beyond the scope of this particular study.

5.6 Overview of the total costs

5.6.1 System level

The figures below give an overview of the annual costs at system level in the different situations in the case study systems. The graphs show that the total annual costs of the system in the Ifa Daba case are higher than those in the Ido Jalala case. However, since these costs are divided among a larger number of beneficiaries in the Ifa Daba case, the costs per capita are lower. The costs of the Biftu Diramu system are considerably lower. The reason for this is not entirely clear, but is probably related to the fact that this system was implemented at a different time than the other two systems, which could imply that different decisions were taken related to the allowed costs.

Figure 5.2: Annual costs of water services, worst case (lifespan of system: 10 years)

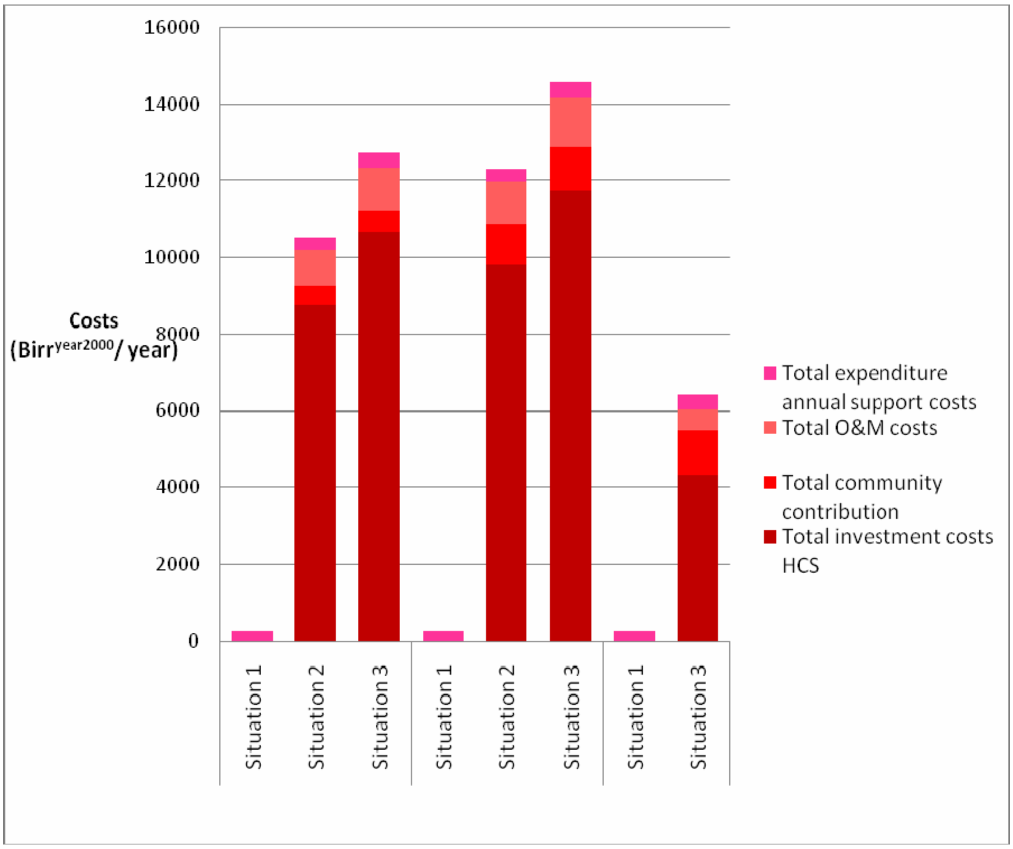


Figure 5.3: Annual costs of water services, best case (lifespan of system: 20 years)

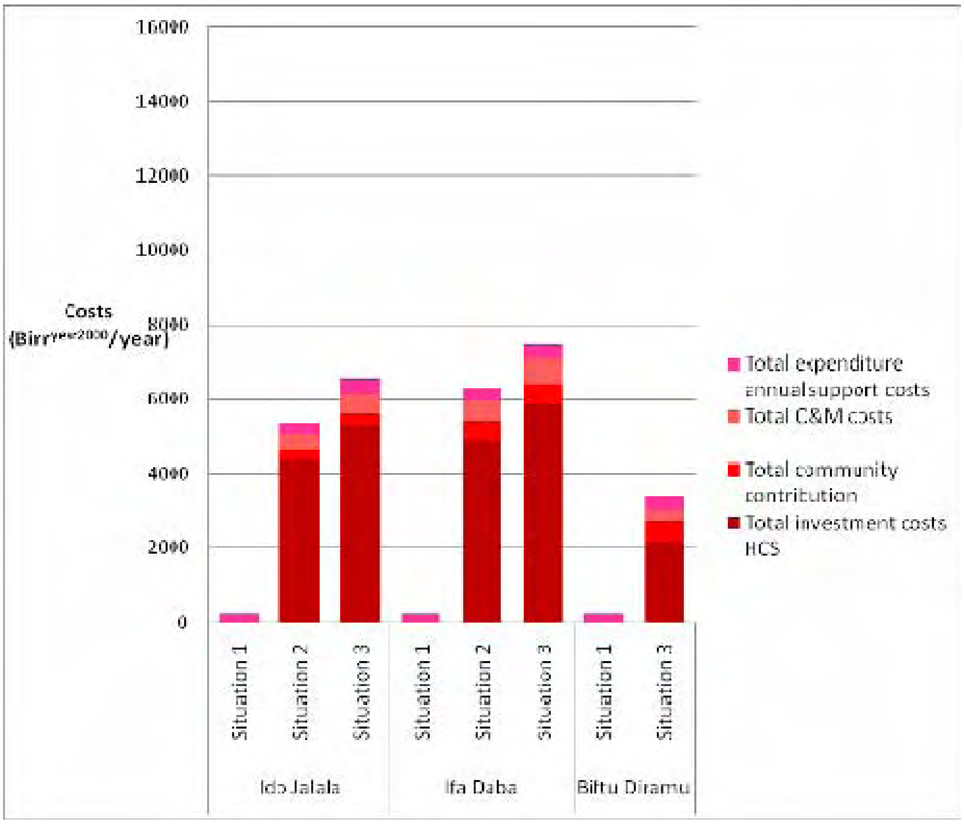


Figure 5.4: Annual costs of water services per capita, worst case (lifespan: 10 years)

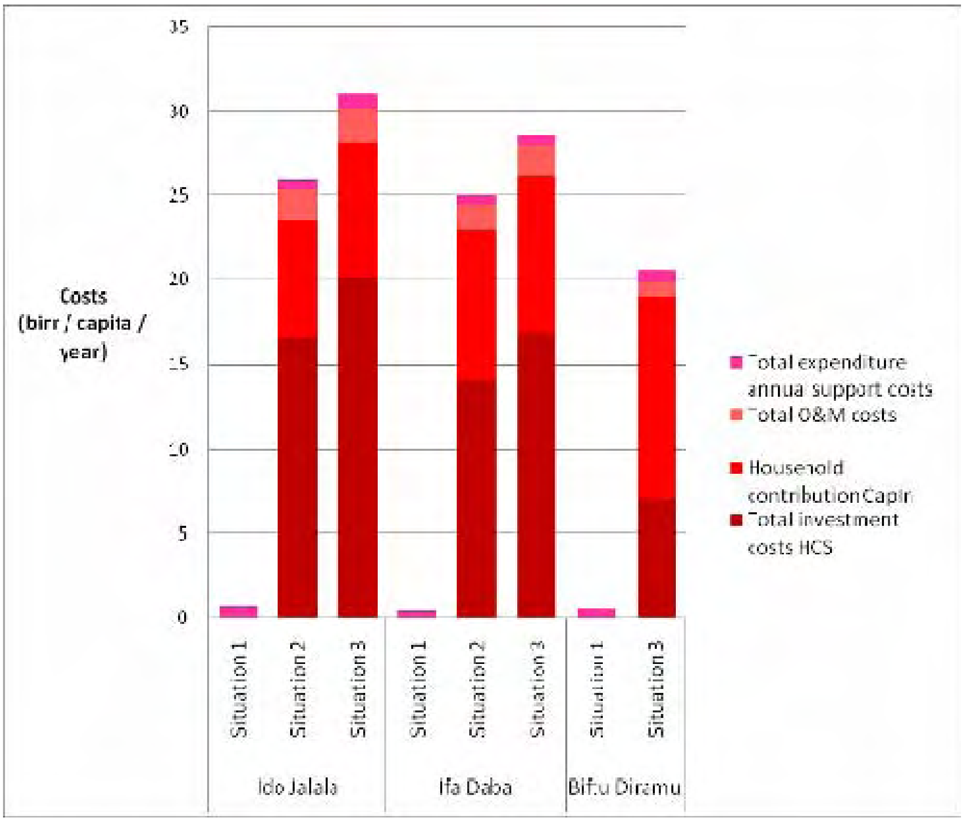
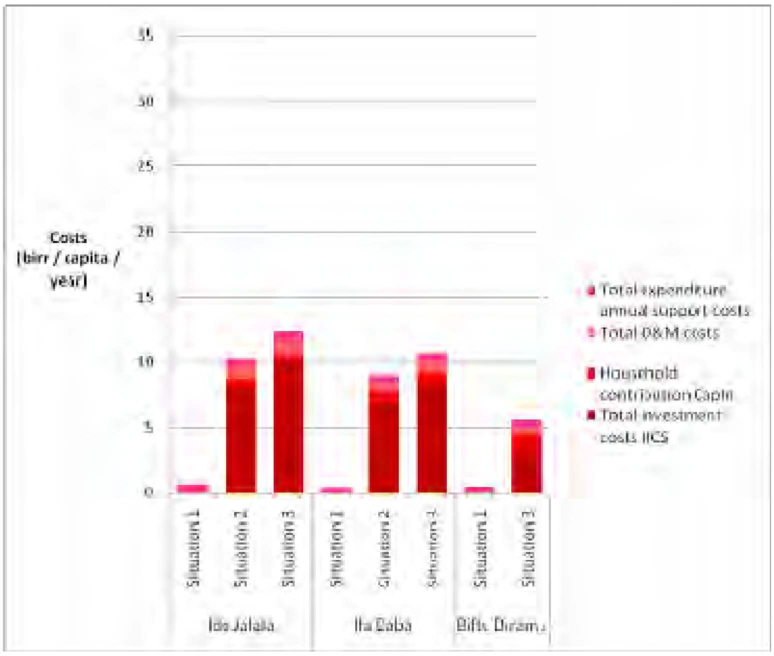


Figure 5.5: Annual costs of water services per capita, best case (lifespan: 20 years)



5.6.2 *Household level*

At household level, costs include the contribution to O&M through water tariffs and the community contribution to the CapIn costs. The graphs in the figures below present an overview of these costs at household level per capita per year in the worst case scenario, assuming a lifespan of 10 years, and in the best case scenario with a system lifespan of 20 years.

Figure 5.6: Annual household level costs per capita, worst case (lifespan: 10 years)

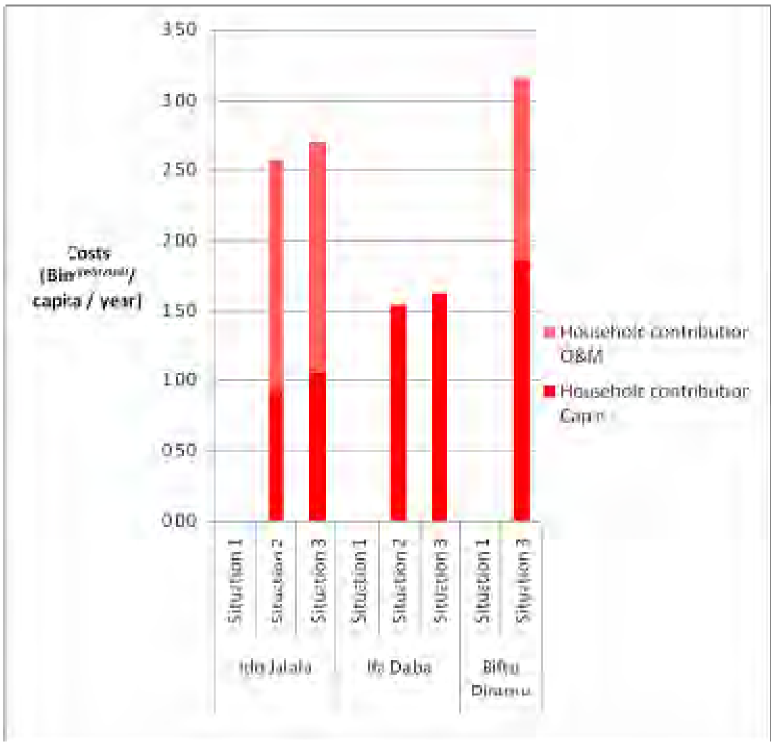
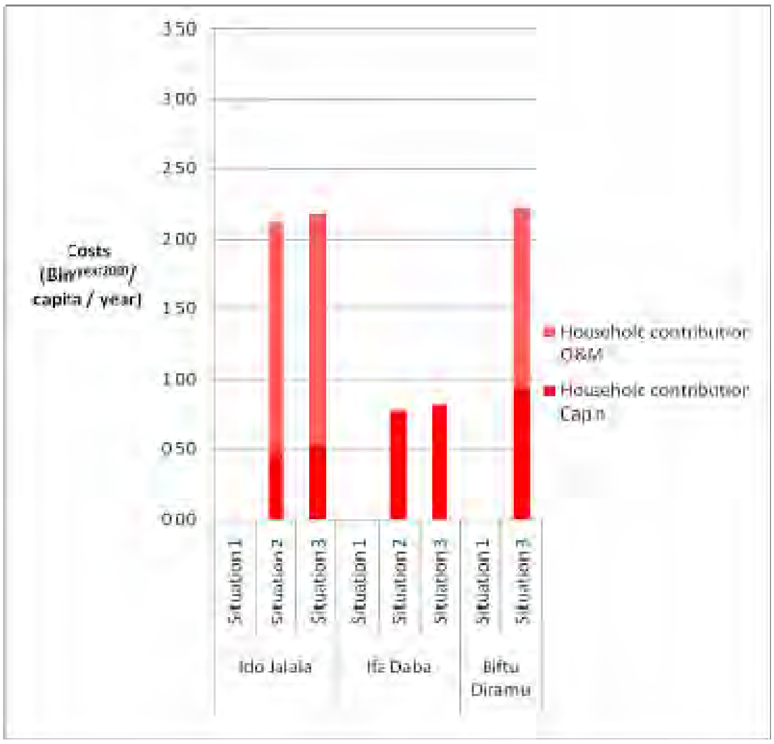


Figure 5.7: Annual household level costs per capita, best case (lifespan 20 years)



6 Benefits

In this chapter, the benefits of the water services in the different situations of the three cases will be presented and analysed.

6.1 Health benefits

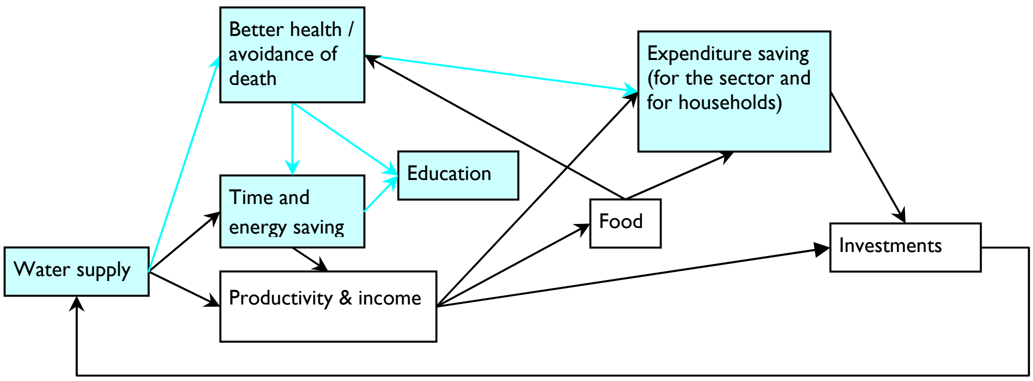
It is estimated that 88% of global cases of diarrhoea – a disease which kills around 2 million people each year – can be attributed to unsatisfactory water, sanitation and hygiene (WHO, 2004; UN / WWAP, 2003). An increase in quantity and quality of water and the use of this water for domestic purposes, including hygiene and sanitation, can lead to an improved health situation. Better health can bring benefits, including:

- Health sector benefit due to avoided illness
- Patient expenses avoided due to avoided illness
- Value of deaths avoided
- Value of productive days gained of those with avoided illness
- Value of child days gained and days of school attendance gained of those with avoided illness

(Hutton and Haller, 2004)

These benefits can result in a decrease in expenditure related to diseases and an increase in time available to be spent on economic activities and education (see figure below).

Figure 6.1: Health benefits related to improved water supply for domestic use



In this case study, not all health related benefits have been taken into account. Health sector treatment costs, avoided deaths and school day attendance benefits were difficult to determine and were therefore not taken into account. The estimation of the health benefits related to improved water supply is here therefore based on:

- Estimated number of days missed due to diarrhoea or dysentery over the course of 1 year before and after the implementation of the improved water supply

- Estimated costs of treatment over the course of 1 year before and after the implementation of the improved water supply

The data on the occurrence of diarrhoea and dysentery before and after the intervention and the related costs was obtained through a household survey. This data was compared with data from the nearest health clinic.

The results are presented in the table below. The table furthermore presents the results of Hutton and Haller (2004)'s analysis for sub-Sahara Africa and an analysis done by Tulu (forthcoming) in Oromiya region, Ethiopia, in order to compare the data obtained in this study with other sources.

Table 6.1: Health benefits related to access to improved water supply

	Ido Jalala	Ifa Daba	Biftu Diramu	Oromiya Region, based on Tulu (forthcoming)[13]	Sub Sahara Africa, based on Hutton and Haller, 2004
Annual health sector treatment costs saved (Birr $^{Year\ 2000}$per person per year[14])					20
Annual patient treatment costs saved (Birr $^{Year\ 2000}$per person per year)	67.01	-11.78	6.57	6	1
Value of avoided deaths (based on predicted future earnings) (Birr $^{Year\ 2000}$per person per year)					23
Value of (adult) productive days gained due to less diarrhoeal illness (Birr $^{Year\ 2000}$per person per year)	14.70	3.91	0	15	1
Annual value of days of school attendance gained + value of child days gained of those with avoided illness (Birr $^{Year\ 2000}$per person per year)					43
Total (Birr $^{Year\ 2000}$per person per year)	81.71	-7.87	6.57	21	89

The table above shows great variation in the estimated health benefits from different sources. The health benefits are very small in the case of Biftu Diramu and even negative in the case of Ifa Daba. It could be argued that in this case people have not yet benefited from the improved domestic water supply. For this analysis, we will assume that the health benefits will only be obtained in the situation with improved water supply (irrigation plus per design) and not in the case of de facto irrigation plus, as was the current case in Ifa Daba.

[13] The following assumptions and data have been used: number of people per household: 8 ; Total health expenditure per household: (2000 price): 105.72 Birr ; Water related health problems According to Oromiya Health Bureau: 45.5% (2000 price) ; The active labour force (age over 10 years): 64% ; Minimum wage in rural Oromiya: is (CSA, 2005).: 7.84/day ; Man days that would have been lost due to sickness of one person: 3 days per person per year ;

[14] 1US$ = 8.21 birr in 2000, source: EIU country report March 2002

There are many limitations of the approach used to determine the health benefits. The data is based on accounts of people, which might not be accurate, either because people do not remember things or because they intentionally give wrong data, in the hope of benefiting from it (e.g. overestimating health costs in the hope that an external organisation refunds the costs). Further, the occurrence of diseases like diarrhoea or dysentery does not only depend on the presence of improved water supply. Sanitation and hygiene practices play a crucial role, but are not taken into account in this analysis.

In this analysis it was therefore decided to look at two different scenarios: In the worst case scenario, the health benefits will be set at 20 Birr Year 2000per person per year (more or less in line with the findings from Tutu), while in the best case scenario, the health benefits will be set at 80 Birr Year 2000 per person per year (more in line with the findings from Ido Jalala and Hutton and Haller (2004).

Table 6.2 gives an indication of the extent of the health benefits.

Table 6.2: Health benefits

	Ido Jalala			Ifa Daba			Biftu Diramu	
	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per design	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Health benefits , worst case scenario (Birr Year 2000per capita per year)	0	20	20	0	0	20	0	20
Health benefits, worst case scenario (Birr Year 2000 per year)	0	10578	10578	0	0	13982	0	12373
Health benefits , best case scenario (Birr Year 2000per capita per year)	0	80	80	0	0	80	0	80
Health benefits, best case scenario (Birr Year 2000 per year)	0	42311	42311	0	0	55929	0	49493

6.2 Irrigation benefits

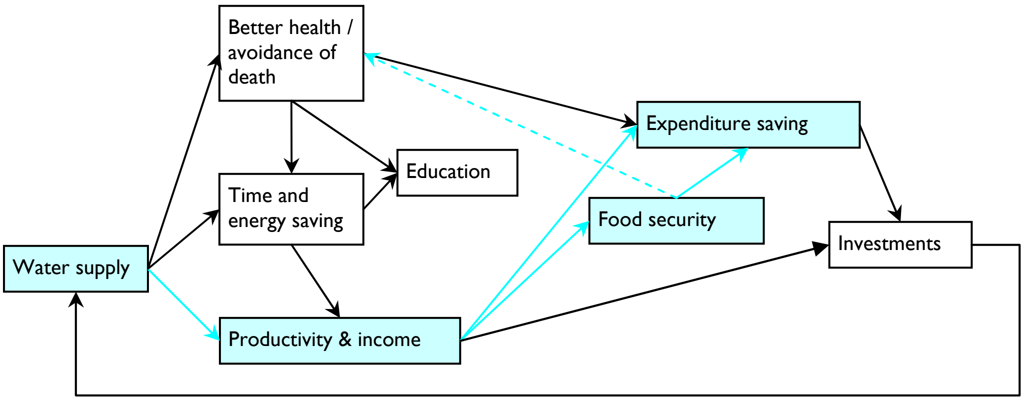
Water is one of the inputs needed for crop production. When water is not available for irrigation, crop production will rely on rain water. Irrigation, traditional or improved, can lead to increased production because it can stimulate:

- change in cropping pattern

- increased crop production per unit land
- expansion of the cropped area

The crops produced can be used for home consumption leading to an improved diet, a more reliable diet and hence improved household food security, as well as bringing income savings since certain food items do not need to be purchased. The produce can also be traded in the market, resulting in increased income. The improved food security situation is likely to lead to improved health and avoidance of illness and deaths (see the figure below), however quantifying this relationship is beyond the scope of this case study.

Figure 6.2: Economic benefits related to improved water supply for productive use



To get an indication of the benefits of traditional and improved irrigation, data was collected on cultivated and irrigated areas, inputs and annual outputs for agricultural production before and after the intervention. Based on this data, the benefits can be calculated as follows:

Net Benefit = irrigated area * ((Increase in production * market price)-increase of inputs)

With: Increase in production = annual productivity per ha $_{\text{irrigated}}$ – annual productivity per ha $_{\text{rain-fed}}$

Increase of inputs = annual costs of inputs per ha $_{\text{irrigated}}$ – annual costs of inputs per ha $_{\text{rain-fed}}$

In all three cases, people have been using water from the spring for traditional irrigation. This has brought them additional benefits over non-irrigated agriculture, especially because it has allowed them to cultivate more crops per year. The average annual production of non-irrigated chat is a lot lower than irrigated chat, as shown in the table below.

Table 6.3: Increase in chat production going from rain-fed to irrigated chat production:

	Ido Jalala	Ifa Daba	Biftu Diramu
Annual non-irrigated chat production (kg/ha)	240	640	520
Annual irrigated chat production (kg/ha)	1280	1200	1200
Increase in production (kg/ha)	1040	560	680

Irrigated chat production in the case study communities is, however, considerably lower than the typical annual irrigated chat production according to agronomic data from the Zonal Agricultural Bureau, which puts the yearly production of chat under irrigated circumstances at 4800 kg/ha.

The table below gives estimations of increase in productivity of a number of crops per ha when going from rain-fed production to irrigated production. These figures are based on the findings from the household survey.

Table 6.4: Increase in crop production going from rain-fed to irrigated crop production

	Tomato	Potato	Pepper	Cabbage
Increase in production *(kg/ha)*	960	3200	500	2000

Costs of the inputs will have to be subtracted from the gross profit. Inputs in the agricultural production process include

- Labour
- Draft power (only human labour in this case study)
- Seeds and seedlings
- Fertiliser/manure
- Herbicides / pesticides
- Water

Draft power is not commonly used in the case study area. Seeds and seedlings are generally obtained for free or at low cost through government or NGO programmes, as are fertiliser, manure, herbicides and pesticides. Human labour is the main input in the labour process and will therefore be the focus of determining the cost of inputs in the agricultural production process.

Based on the available data, the labour input in man-days is estimated to be 16 man-days per year for 1 non-irrigated Koti of chat. For an irrigated Koti (=1/8 ha) of chat, the required labour input increases to 30 man-days per year. One man-day is worth about 10 Birr $^{\text{Year 2000}}$, which means that the additional input of going from rain-fed chat cultivation to irrigated chat cultivation amounts to 1120 Birr $^{\text{Year 2000}}$ per ha[15]. This amount will also be used as an estimation of the labour input for the other crops.

Market prices used in this case study are based on the 2007 price (Source: East Hararghe Agricultural Bureau), corrected to 2000 price using a GDP deflator. The table below gives an overview of the market prices of the most common irrigated crops:

Table 6.5: Market prices

	Tomato	Potato	Pepper	Cabbage	Chat	Coffee	Onion
Price (Birr Year 2000/ kg)	3.47	4.16	41.59	1.73	41.59	17.33	4.16

[15] 14 Mandays*8 Koti*10Birr=1120 Birr/ha

6.2.1 Irrigation benefits at service level

The benefits of irrigated agriculture have been estimated based on the above, as presented in Table 19 below. In situation 1 in Ido Jalala, the benefits of irrigated chat cultivation are estimated to amount to 105,325 Birr. With the decrease in irrigated area under situation 2, the benefits also come down to 65,828 Birr. At the time of the study, the step towards improved irrigation had not been made. however in the case of Ifa Daba, the irrigation benefits increased by 32% as a result of going from traditional to improved irrigation. For this analysis, we will assume that in the case of Ido Jalala a similar increase will take place in the step of going from traditional irrigation (de facto domestic plus) to improved irrigation (domestic plus per design). This would result in benefits that amount to 86,893 Birr.

Table 6.6: Irrigation benefits

	Ido Jalala			Ifa Daba			Biftu Diramu	
With change in cropping pattern	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per design	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Irrigation benefits (Birr Year 2000 per year)	105,325	65,828	86,893	110,843	74,103	74,103_	50,353	10,401
Irrigation benefits at system level (Birr Year 2000 / community member / year)	307	124	164	199	106	106	105	17
Without change in cropping pattern								
Irrigation benefits (Birr Year 2000 per year)	105,325	65,828	86,893	110,843	146,867	146,867	50,353	20,431
Irrigation benefits at system level (Birr Year 2000 / community member / year)	307	124	164	199	210	210	105	33

In Ifa Daba, the net benefits from the chat production amounted to 110,843 Birr in situation 1. In the case of Ifa Daba, the irrigated area has increased with 32% in the step from situation 1 to situation 2, going from traditional to improved irrigation. However, the implementation of the improved irrigation system has gone hand in hand with a change in cropping pattern. In the new situation, potatoes, pepper, cabbage, tomatoes and coffee are grown, in addition to chat. The estimated net benefits from the irrigated cultivation of these crops amounts to 74,103, which would thus mean a decrease in net benefits, as compared with situation 1. If chat had remained the only cultivated crop in situation 2, the net estimated benefits from irrigated chat cultivation would be 146,867.

In the case of Biftu Diramu, the irrigated area reduced drastically and the cropping pattern has changed in the step towards situation 3, bringing the benefits down from 58,193 in situation 1 to 10,401 Birr in situation 3. If the change in cropping pattern had not occurred, the estimated benefits would be 20,431 Birr.

Chat is increasingly being replaced by vegetable cultivation, even though at first sight chat seems more lucrative, in spite of the occasional loss of crop due to night frost. However, during the focus group discussions the women indicated that they are satisfied with the change in cropping pattern from chat to vegetables. They explained that previously they had to go to the market to buy vegetables for the family's consumption, but now vegetables are produced on their own farm, which saves time and contributes to the family's nutrition. However, the time saved through 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, therefore, the benefits of change in cropping pattern are likely to be higher than indicated here.

6.2.2 *Household level irrigation benefits*

The irrigation benefits within the case study community have been presented above. However, since not all households will have access to irrigated land, the benefits at household level will not be in line with the benefits at service level. The table above presents the benefits per irrigating household.

The irrigation benefits for a certain household will depend on whether or not the household has access to irrigated land. In the case of Ido Jalala, the number of household with access to irrigated land decreased in the first step and increased slightly in the second. In the case of Ifa Daba, the number of irrigating households only increased in the first step. In the case of Biftu Diremu, the number of households irrigating decreased.

Table 6.7: Irrigation benefits

	Ido Jalala			**Ifa Daba**			**Biftu Diramu**	
With change in cropping pattern	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per design	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Irrigation benefits **(Birr Year 2000 per irrigating household per year)**	2633	2633	3476	2771	1398	1398	2098	867
Irrigation benefits **(Birr Year 2000 / benefiting capita / year)**	537	349	460	602	242	242	420	135

Without change in cropping pattern	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Irrigation benefits **(Birr Year 2000 per irrigating household per year)**	2633	2633	3476	2771	2771	2771	2098	1703
Irrigation benefits **(Birr Year 2000 / benefiting capita / year)**	537	349	460	602	480	480	420	264

6.3 Benefits from livestock keeping

Improved access to water can have a positive impact on benefits from livestock keeping. These include:

- change in livestock holding pattern
- increased production per head of livestock (e.g. more milk per cow)
- increase in number of heads of livestock that can be kept

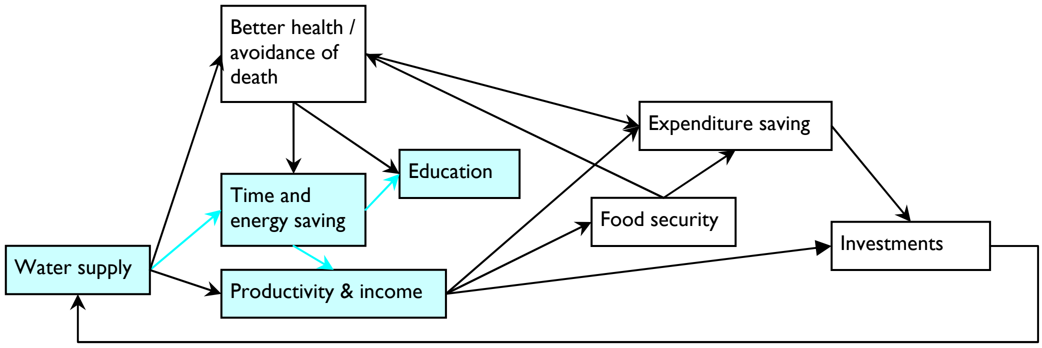
Data was collected on numbers of livestock, the inputs to livestock keeping, the price of the animals and the main products from livestock keeping, for both before and after the intervention. However, the data collected did not give a good indication of the increase in production per animal after the intervention, since the profit per animal did not change. The price of the animals did not go up neither did the milk production. However the collected data do give an indication of changes in livestock holding patterns and the number of animals kept, which was presented in chapter 4.

Putting monetary values to the changes in livestock pattern proved to be very difficult and had to be abandoned. Therefore, the benefits of improved water supply in terms of livestock holding will not be considered in this case study.

6.4 Time saving benefits

Aside from the benefits generated by the use of the water provided, one of the main benefits of improved water supply is the time saving related to the improved access to water. The time saved can increase leisure time, or can be used for economic or educational purposes. This is illustrated in the figure below.

Figure 6.3: Time saving benefits related to improved water supply



In this case study the time saving benefits were estimated by looking at the time spent on water fetching before and after the intervention. The time saved was converted into Birr by multiplying it by the minimum wage for unskilled labour of 10 Birr $^{\text{Year 2000}}$.

In all three 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. So the time saving benefits are not due to a decrease in distance, but rather to the fact that the installation of a tap made fetching water easier and less time consuming.

Table 6.8: Time saving benefits

	Ido Jalala			Ifa Daba			Biftu Diramu	
	Situation 1: traditional situation	Situation 2: de facto domestic +	Situation 3: domestic + per design	Situation 1: traditional situation	Situation 2: de facto irrigation +	Situation 3: irrigation + per design	Situation 1: traditional situation	Situation 3: multiple use
Time saving benefits (Birr $^{\text{Year 2000}}$ per capita per year)	0	123	123	0	65	123	0	65
Time saving benefits (Birr $^{\text{Year 2000}}$ per year)	0	65031	65031	0	45283	85962	0	40477

In Ido Jalala, the time saving benefits of the change from fetching water from a spring, to fetching water from a public stand post, was 123 Birr per capita per year.

In Ifa Daba, time saving benefits for situation 2 were estimated to be 65 Birr per capita per year. This is the time benefit of going from fetching water at the spring to fetching water at the pipe that fills the irrigation reservoir. In the step from situation 1 to situation 2 (traditional situation to de facto irrigation plus), the accessibility of the domestic water supply system has increased. In the step from situation 2 to situation 3 (de facto irrigation plus to irrigation plus per design), the accessibility is likely to improve further, which will result in more time benefits. Since the water tap was only installed recently, the time saving benefits for situation 3 could not be determined directly. We will therefore assume these benefits to be in line with the time saving benefits in the case of Ido Jalala.

In the case of Biftu Diramu, the time benefits were estimated to be 65 Birr. The fact that this is lower than Ido Jalala is probably due to the fact that the distance between the water point and most houses remains large, as discussed in chapter 4.

Time benefits have been converted into money based on the minimum wage for unskilled labour. However, whether or not the time saved is indeed used for productive activities or for education has not been taken into account. The actual time saving benefits could therefore have been overestimated in this study. On the other hand 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'.

6.5 Overview of the total benefits

6.5.1 System level

The graphs below give an overview of the benefits in the three cases in the worst case scenario and the best case scenario. The worst case scenario is the case in which the health benefits and the irrigation benefits are assumed to be minimal (health benefits of 20 Birr $^{\text{Year 2000}}$per capita per year and assuming change in cropping pattern in the Ifa Daba and Biftu Diramu case). The best case scenario will consider the maximal health and irrigation benefits (80 Birr $^{\text{Year 2000}}$per capita per year and irrigation benefits related to no change in cropping pattern).

Figure 6.4: Total annual benefits per system, worst case

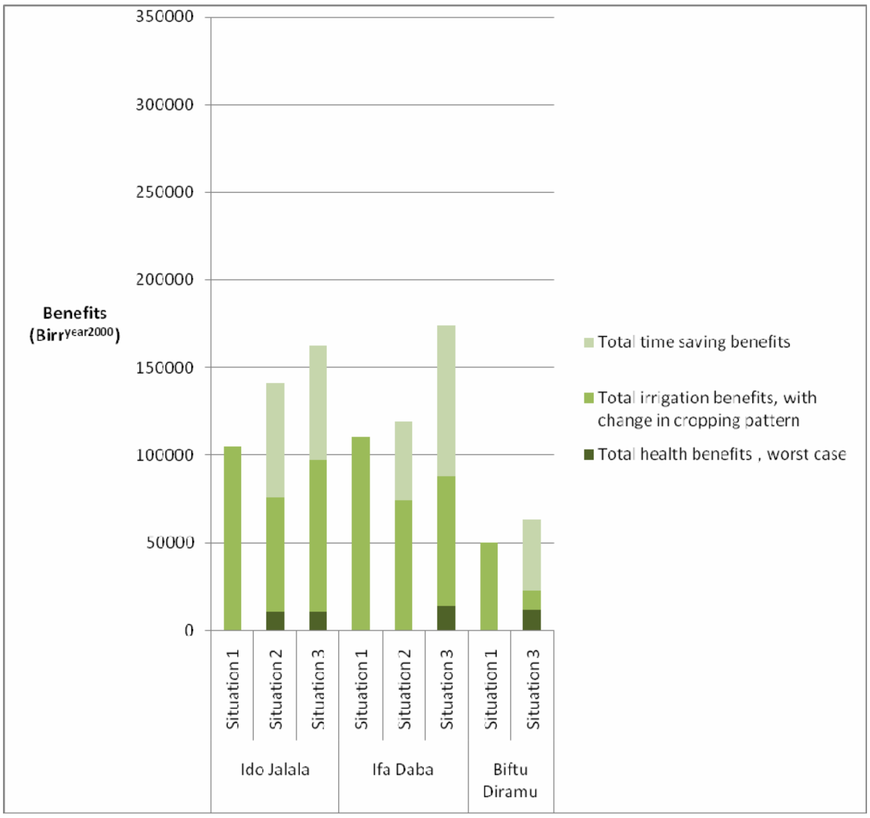
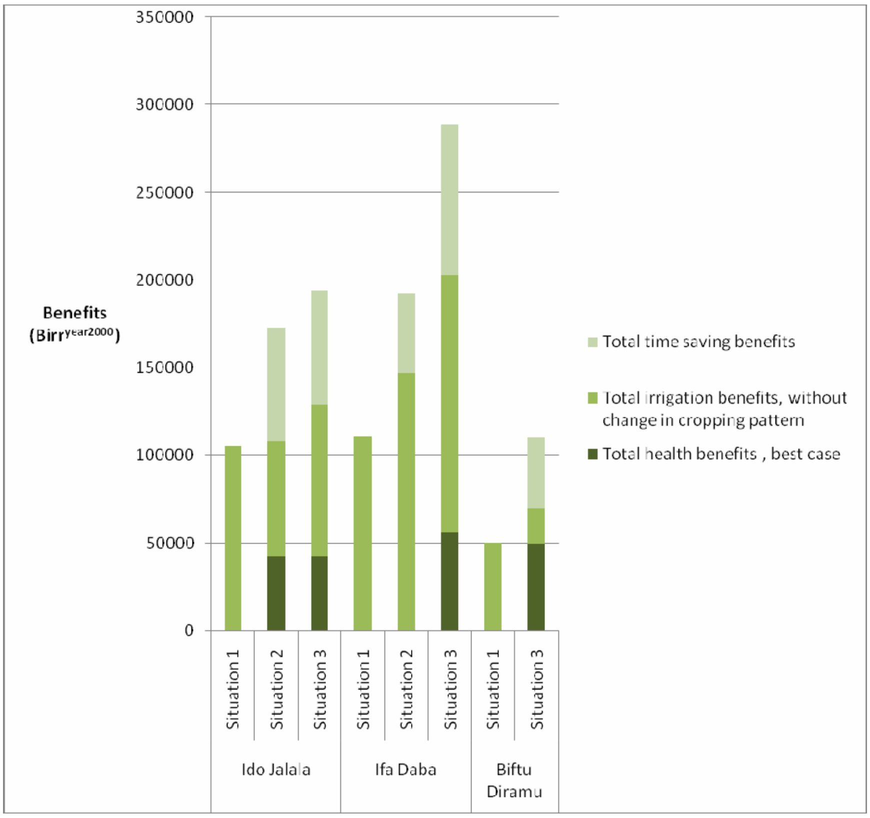


Figure 6.5: Total annual benefits per system, best case



The graphs in figure 6.4 and 6.5 show that in the step from situation 1 (the traditional situation) to situation 2 (the de facto domestic plus situation) in Ido Jalala, the irrigation benefits have decreased. This is in line with the decrease in accessibility for irrigation, as explained in chapter 4. The decrease is however compensated by an increase in health and time saving benefits, related to the increase in accessibility of domestic water and increase in water quality. A similar pattern can be seen in the case of Biftu Diramu.

In the step towards situation 3 (domestic plus per design) in Ido Jalala, the health and time saving benefits stay the same, but the irrigation benefits increase because of the implementation of a more efficient irrigation system.

In the worst case scenario in Ifa Daba, the irrigation benefits also decrease in the step from situation 1 (traditional situation) to situation 2 (improved irrigation + unimproved domestic water supply). This is not directly related to changes in the water characteristics, but rather to a change in cropping pattern. The best case scenario, assuming no change in cropping pattern, shows increasing benefits, in line with the increased accessibility of irrigation water. In the step from situation 2 (improved irrigation + unimproved domestic water supply) to 3 (improved irrigation + improved domestic water supply), the time saving benefits and the health benefits increase, as a result of improved water quality and improved accessibility of the water supply for domestic use.

Although the total benefits may increase, the benefits per capita may simultaneously decrease, as is the case in most steps in the worst case scenario and in the step of going from situation 1 to situation 2 in the best case scenario of Ifa Daba. This is due to population growth. The graphs in the figures below illustrate this.

Figure 6.6: Benefits per capita, worst case

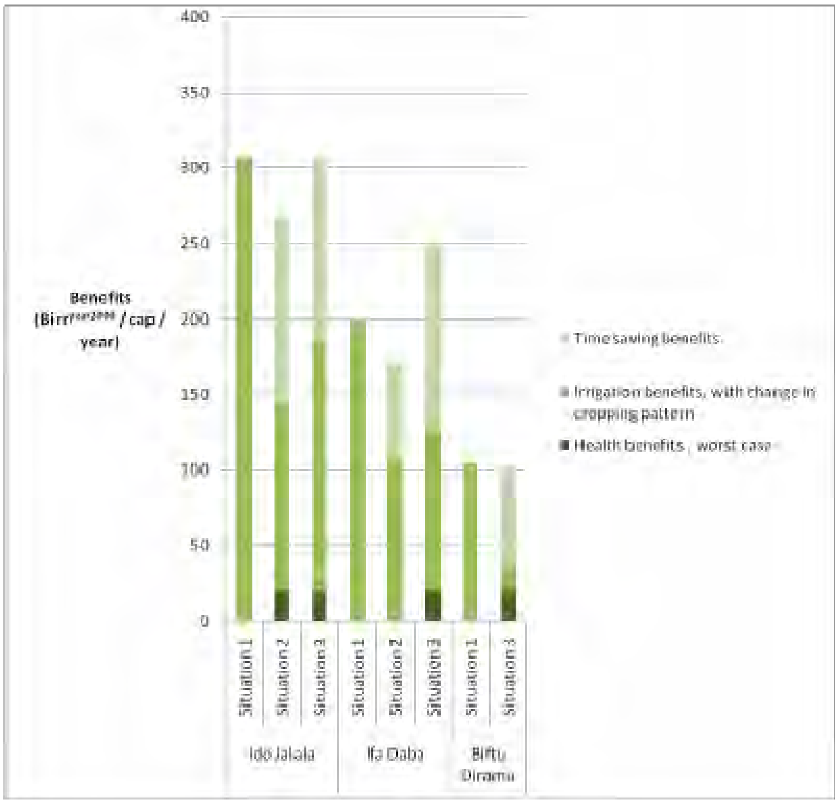
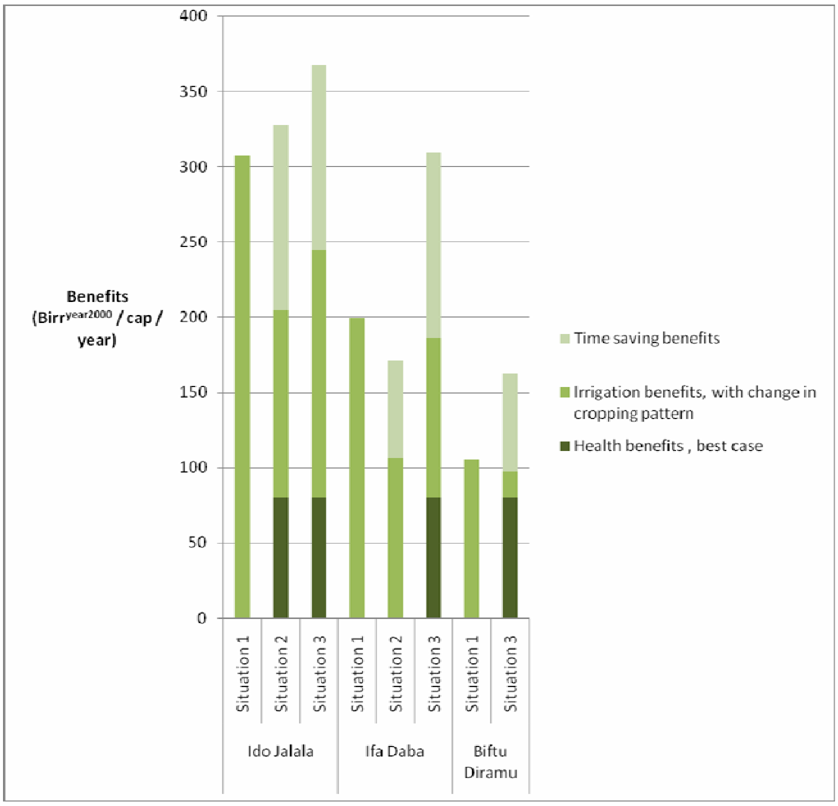


Figure 6.7: Benefits per capita, best case



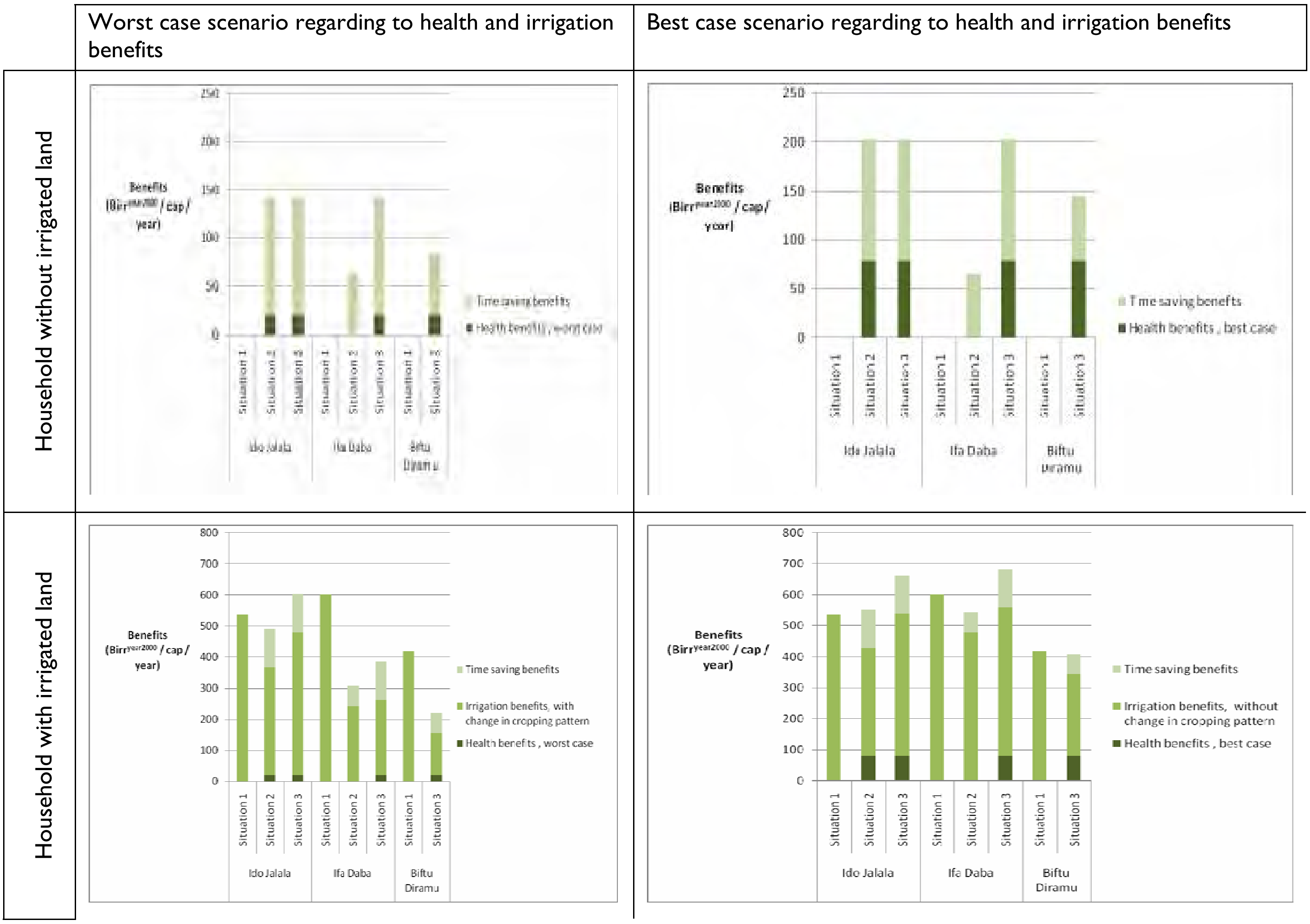
In both the best case scenario and the worst case scenario of Ido Jalala and Ifa Daba, the health and time saving benefits and the benefits per capita outweigh the loss in benefits from irrigation in the step from situation I to situation 3 (so taking into account the upgrade to plus use per design). According to the findings this would not be the case in the worst case scenario in Biftu Diramu, but would happen in a slightly better case scenario. The graphs show that when only step I, of going from situation I to 2, is taken, without including an upgrade that allows for additional use per design, the benefits per capita might decrease.

It should be noted that the benefits as presented in this study might be underestimated, as livestock benefits have not been taken into account and there seemed to be a trend towards an increase in livestock keeping with the implementation of the systems.

6.5.2 Household level

The figure below presents an overview of the benefits at household level, differentiating between households with and without access to irrigated land and between a worst case scenario (minimal health and irrigation benefits) and best case scenario (maximal health and irrigation benefits).

Figure 6.8: Household level benefits under different scenarios



7 Costs and benefits

For each of the three cases, the costs and benefits are compared for each situation. Different scenarios are used to give a good overview of the potential range of cost/benefit ratios.

7.1 Costs and benefits at household level

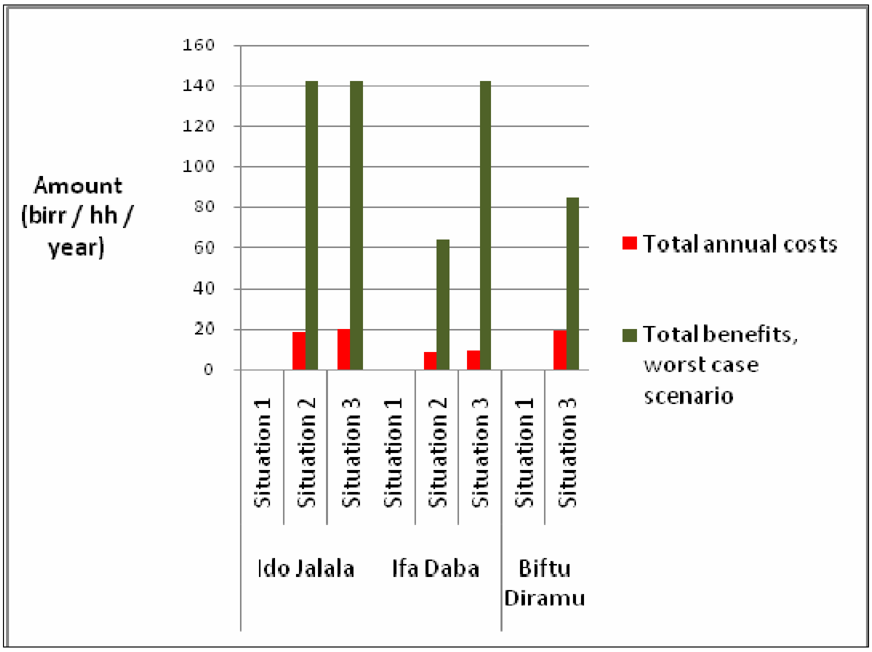
At household level, costs are compared with benefits. Household level costs consist of the household contribution to the costs. Household benefits will depend on the characteristics of the households.

The worst case scenario at household level would be the case in which:

- A household consists of one single person (costs have to be covered by a single person)
- The lifespan of the system is 10 years instead of 20 years (annual CapIn will be higher)
- The household does not have access to irrigated land (the benefits will only include health and time saving benefits)
- The health benefits are 20 birr / person / year

The figures below give an overview of the costs as compared with the benefits for this case.

Figure 7.1: Cost and benefits at household level in the case of a one-person household without access to irrigated land.



Since in the Ido Jalala case the household will not gain additional benefits from the upgrade of the system to domestic plus per design, but will probably have to contribute to it, the benefit /cost ratio is slightly better in situation 2 than in situation 3.

A best case household would be a household of average size, with maximum health benefits and access to irrigated land in all situations. A household with minimum health benefits, but access to irrigation, would be in between. However, when considering a household that does have access to irrigated land, the benefits outweigh the costs to such an extent that it is difficult to visualise the two together in a graph.

The figures below give an indication of the household level benefit / cost ratio for the three cases. The left hand figure assumes a lifespan of 10 years, while the right hand graph assumes a lifespan of 20 years. The graphs show a wide variation in benefit / cost ratios between different household scenarios. The benefit / cost ratio improves in going from situation 2 to 3, because households contribute very little more in situation 3 than in situation 2. They only contribute a small amount more to the CapIn costs, and do not have to pay additional water fees (their contribution to the O&M costs). In case of a motorised system, in which the operational costs are highly dependent on the amount of water used, this might have been different.

Figure 7.2: Household level benefit / cost ratio, assuming a system lifespan of 10 years

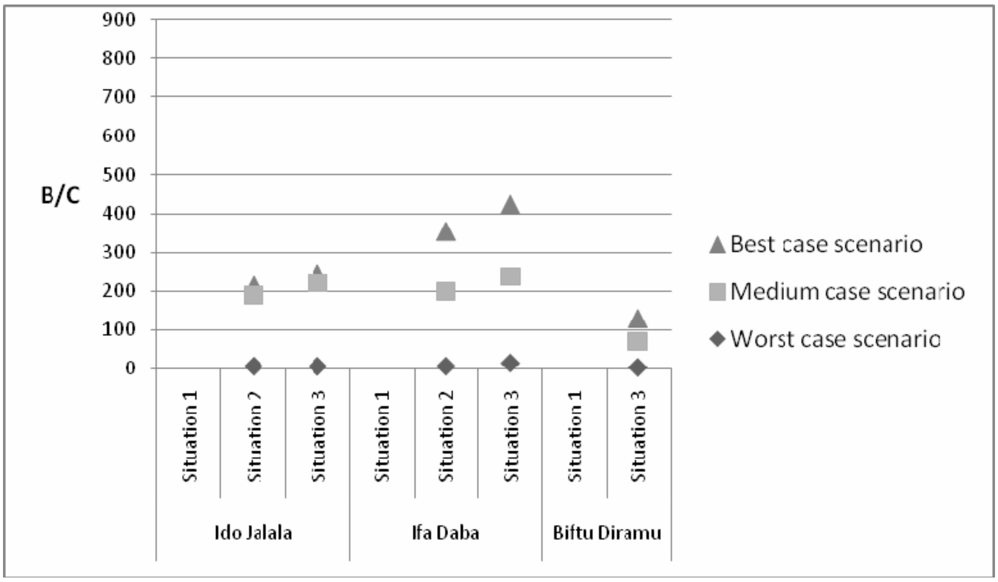
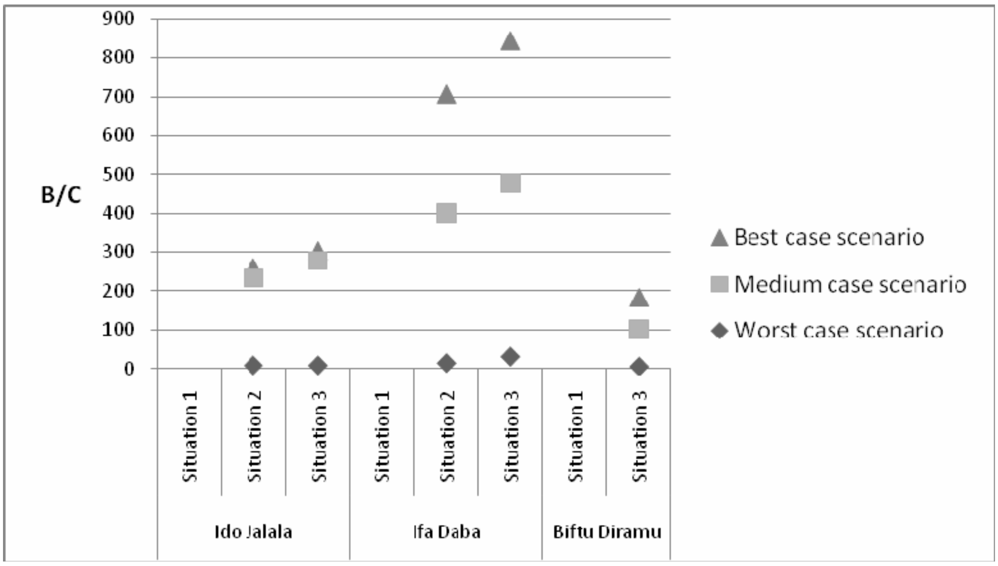


Figure 7.3: Household level benefit / cost ratio, assuming a system lifespan of 20 years



7.2 Costs and benefits at service level

The graphs in the figures below show the total service level annual costs and benefits. Figure 7.4 illustrates the worst case scenario related to the health benefits and the lifespan of the system, while Figure 7.5 illustrates the best case scenario. An overview of graphs for other situations can be found in annex 6.

Figure 7.4: Total costs and benefits, worst case scenario

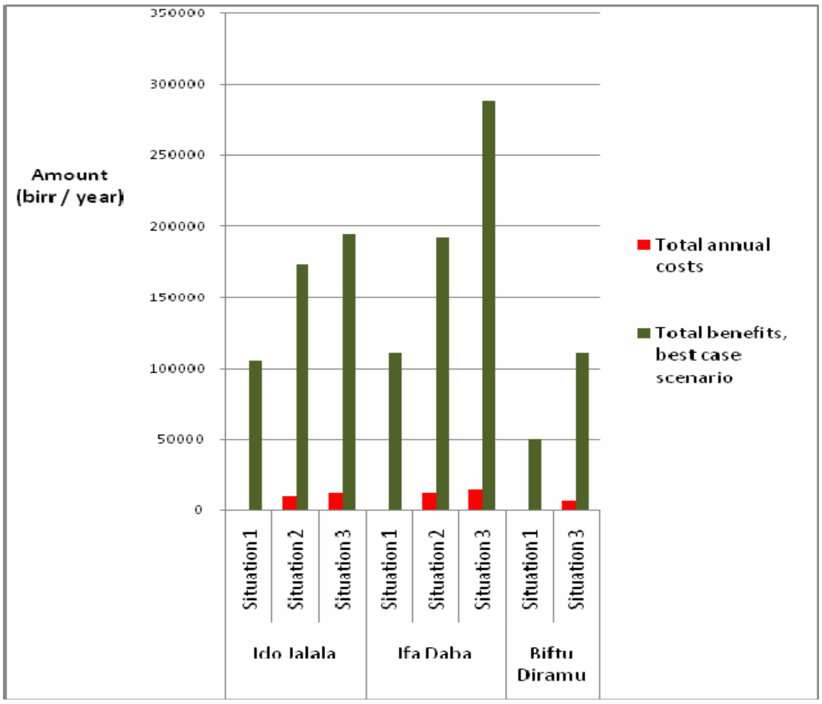
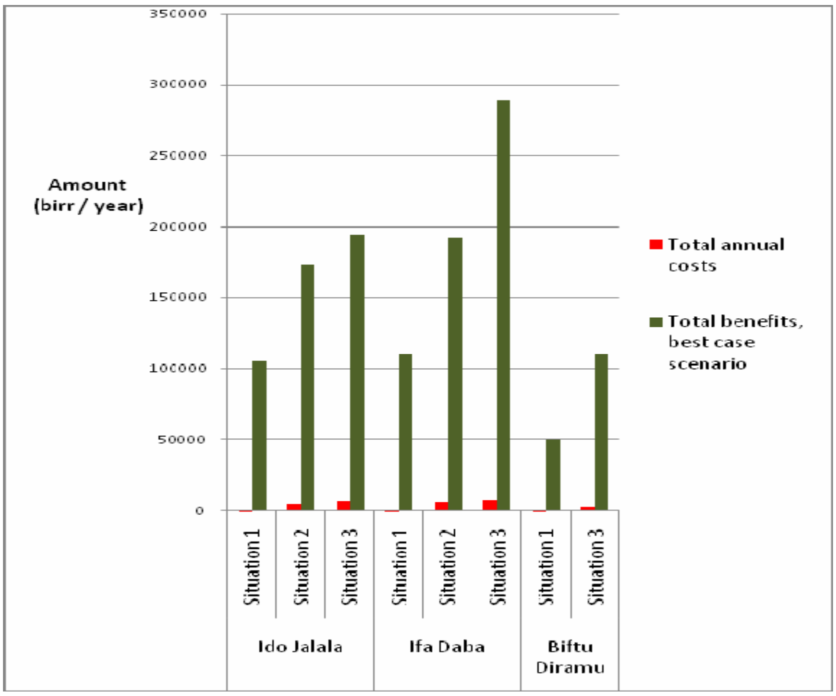


Figure 7.5: Total costs and benefits, best case scenario



These graphs show that in both scenarios the benefits outweigh the costs by a significant margin and that the total benefits increase with the initial implementation of a single use system and de facto multiple use of that system, and again with the move towards allowing for multiple uses through the design of the system. This can also be seen in figures 7.6 and 7.7, which illustrate the range of benefit / cost ratios in the worst and the best case scenario.

Figure 7.6: Benefit / cost ratio at service level, assuming a system lifespan of 10 years

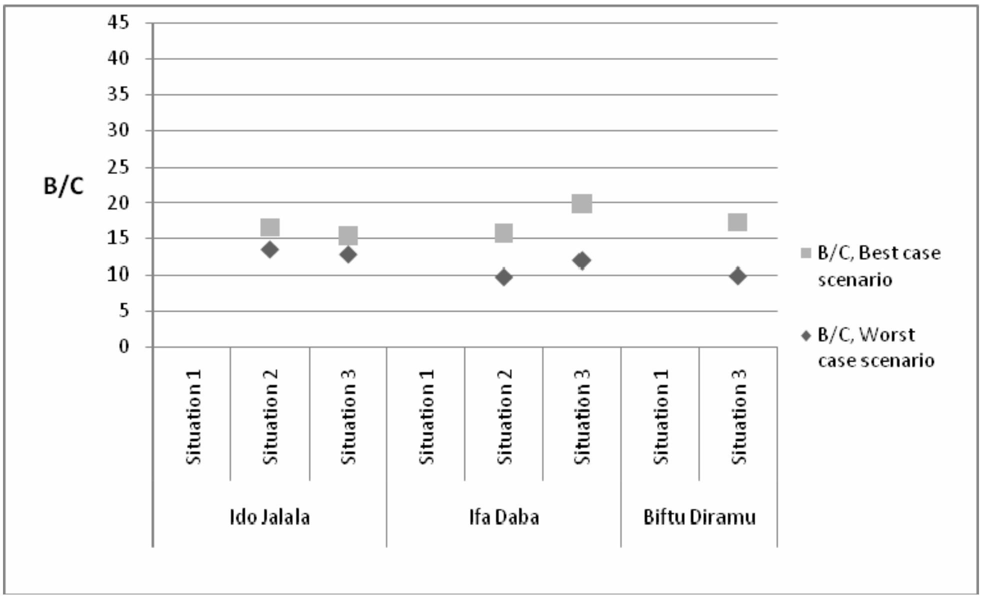
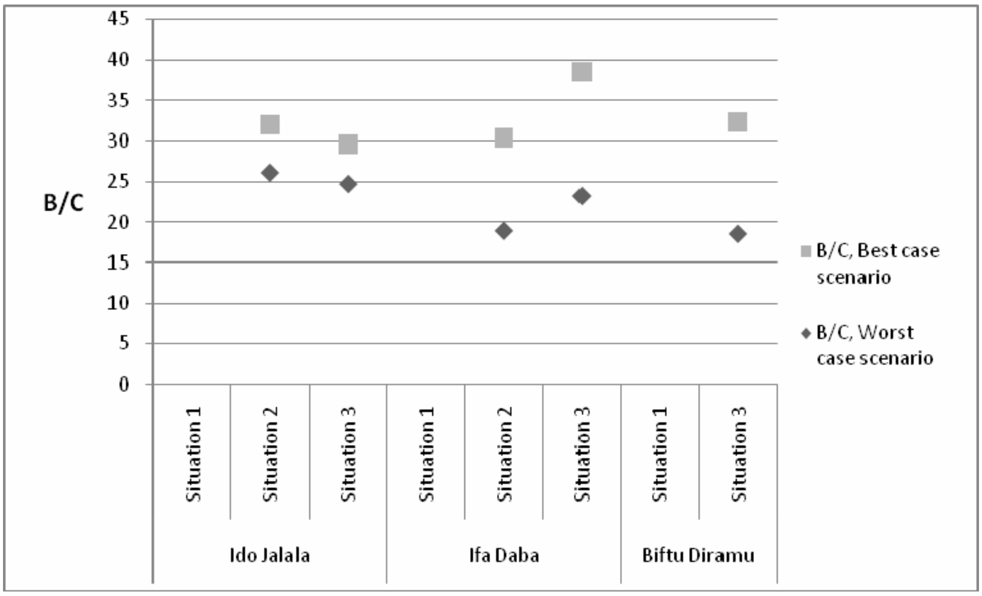


Figure 7.7: Benefit / cost ratio at service level, assuming a system lifespan of 20 years



The fact that the benefit / cost ratio of Ido Jalala is higher in situation 2 than in situation 3, indicates that the benefits outweigh the costs more in the situation of domestic water supply + traditional irrigation, than in the situation of domestic water supply + improved irrigation. In the Ifa Daba case, the benefit / cost ratio is higher in situation 3 than in situation 2.

The graphs below present the additional costs and benefits of the steps from one situation to another, in the worst case scenario (low benefits, short lifespan) and the best case scenario (high benefits, long lifespan). Step 1 is the step from situation 1 to situation 2 (from the traditional situation to the de facto plus situation) and step 2 is the step from situation 2 to situation 3 (from the de facto plus situation to plus per design situation). The graphs indicate that the aditional benefits easily outweigh the additional costs. In the Ido Jalala case, the additional benefits of step 1 are higher than the benefits in step 2. However while the additional costs are 28% and 8% of the additional benefits in step one, in the worst and best case respectively, this is only 11% and 5% for step 2.

In the worst case scenario of the Ifa Daba case, the additional costs of step 1 are higher than the additional benefits (the additional costs are 141% of the additional benefits), while in step 2 the additional benefits far outweigh the additional costs (the additional costs are only 4% of the additional benefits). In the best case scenario, the additional costs are 7 % of the benefits in step 1 and 1% in step 2. The cost benefit ratio of the upgrade of the system from de facto irrigation plus to irrigation plus per design (step 2) is thus better than that of traditional irrigation to improved irrigation (plus) (step 1).

The additional costs in Biftu Diramu range from 48% of the additional benefits under the worst case scenario to 5% under the best case scenario.

Figure 7.8: Total additional costs and benefits, worst case scenario

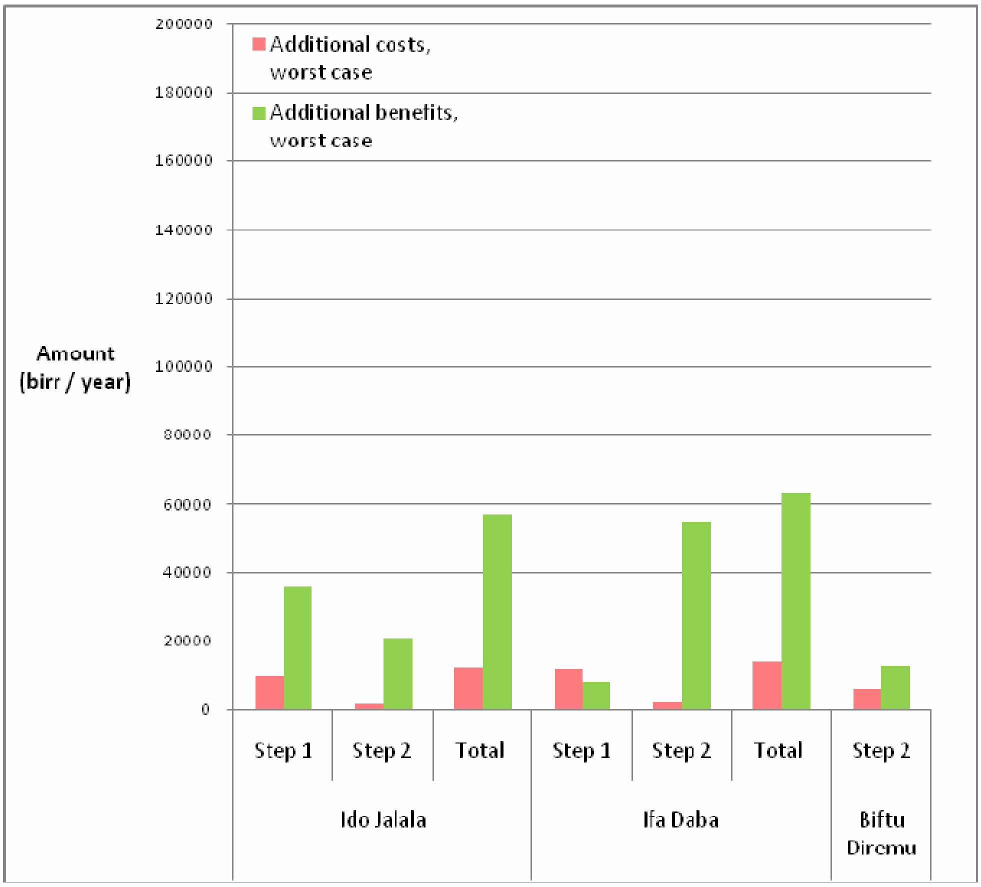
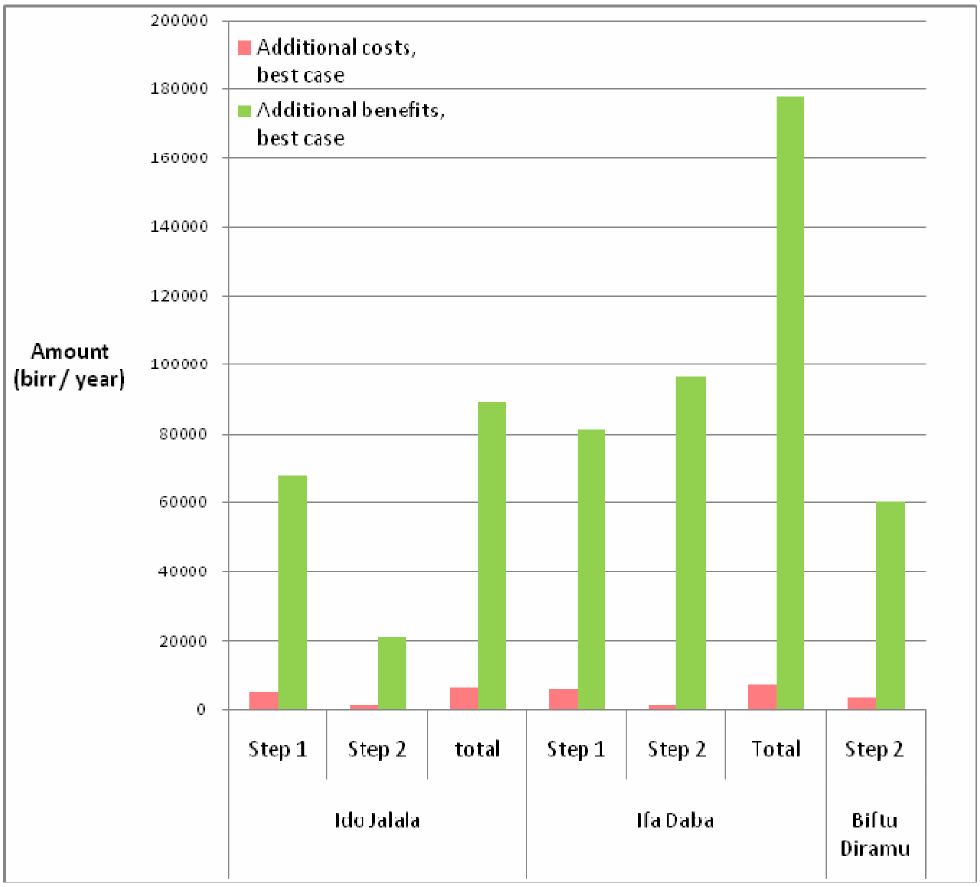


Figure 7.9: Total additional costs and benefits, best case scenario



The tables below give an overview of the costs and the benefits at system level in the best (table 7.1) and the worst case scenarios (table 7.2).

Table 7.1: Best case scenario overview of costs and benefits at system level

Costs and benefits at system level	**Ido Jalala**			**Ifa Daba**			**Biftu Diramu**	
Costs and benefits at system level	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 3*
Total annual costs	249	5,406	6,563	249	6,314	7,482	249	3,414
Total benefits	105,325	173,171	194,236	110,843	192,150	288,757	50,353	110,401
Benefit / cost ratio		32.0	29.6		30.4	38.6		32.3
Benefit-Costs	105,076	167,765	187,673	110,593	185,836	281,275	50,104	106,987
	Ido Jalala				**Ifa Daba**			**Biftu Diramu**
Additional costs and benefits at system level		*Step 1*	*Step 2*	*total*	*Step 1*	*Step 2*	*Total*	*Step 2*
Additional costs		5156	1157	6313	6064	1168	7233	3164
Additional benefits		67845	21065	88910	81307	96607	177914	60048
Additional costs as % of benefits		8%	5%		7%	1%		5%

Table 7.2: Worst case scenario overview of costs and benefits at system level

Costs and benefits at system level	**Ido Jalala**			**Ifa Daba**			**Biftu Diramu**	
Costs and benefits at system level	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 3*
Total annual costs	249	10,494	12,717	249	12,287	14,556	249	6,419
Total benefits	105,325	141,437	162,502	110,843	119,386	174,047	50,353	63,252
Benefit / cost ratio		13.5	12.8		9.7	12.0		9.9
Benefit-Costs	105,076	130,944	149,786	110,593	107,099	159,491	50,104	56,832
	Ido Jalala				**Ifa Daba**			**Biftu Diramu**
Additional costs and benefits at system level		*Step 1*	*Step 2*	*total*	*Step 1*	*Step 2*	*Total*	*Step 2*
Additional costs	na	10,244	2,223	12,467	12,038	2,269	14,306	6,170
Additional benefits	na	36,112	21,065	57,177	8,544	54,660	63,204	12,899
Additional costs as % of benefits		28%	11%		141%	4%		48%

The graphs in figure 7.10 to 7.13 illustrate the relationships between water use, costs and benefits of single use (the inner triangle), de facto plus use (the second layer) and plus use by design (the outer layer). They show that de facto plus use brings high benefits at no additional costs. It could however be argued that water use that exceeds the design capacity will result in system degradation (which means more O&M costs and a shorter lifespan, and thus higher annual CapIn costs), and also possibly in conflicts over water resources. Examining these effects was beyond the scope of this study, but would be an interesting area for further research.

Figure 7.10: Costs, benefits and water use, Ido Jalala, worst case scenario

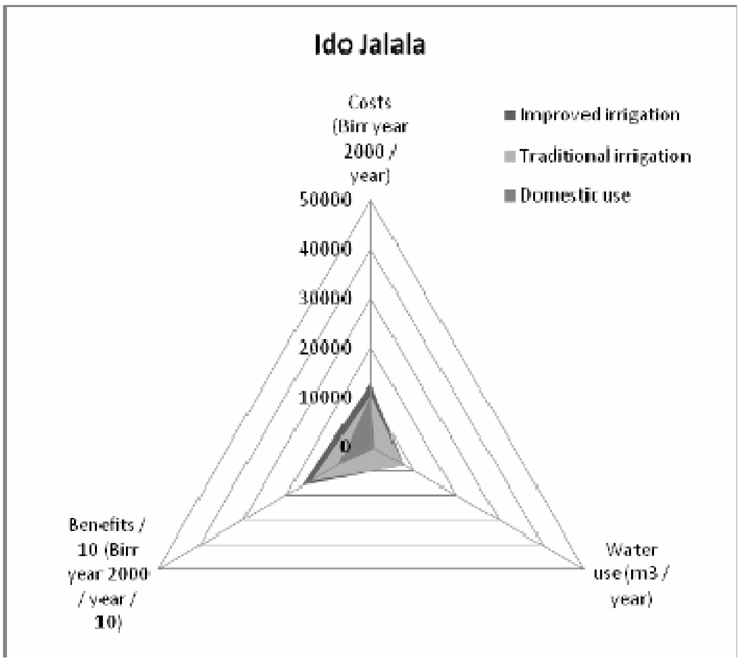


Figure 7.11: Costs, benefits and water use, Ifa Daba, worst case scenario

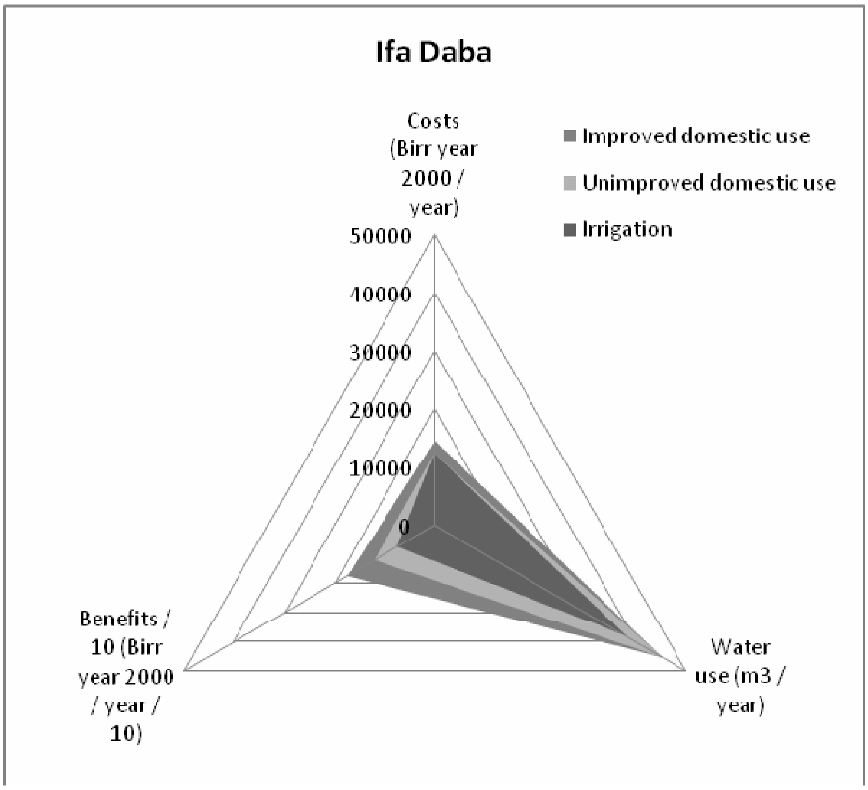


Figure 7.12: Costs, benefits and water use, Ido Jalala, best case scenario

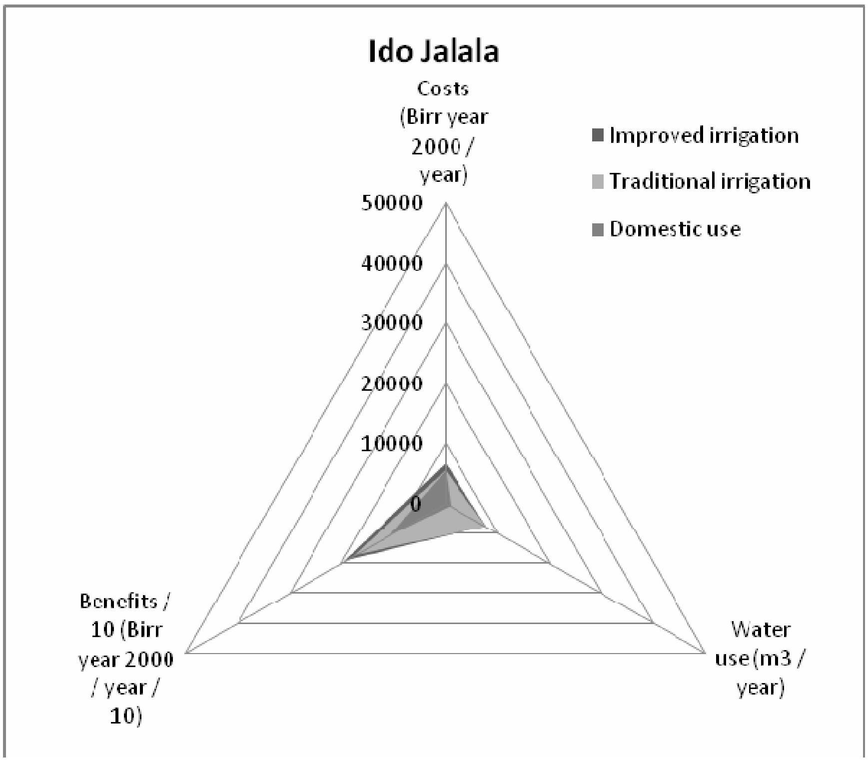
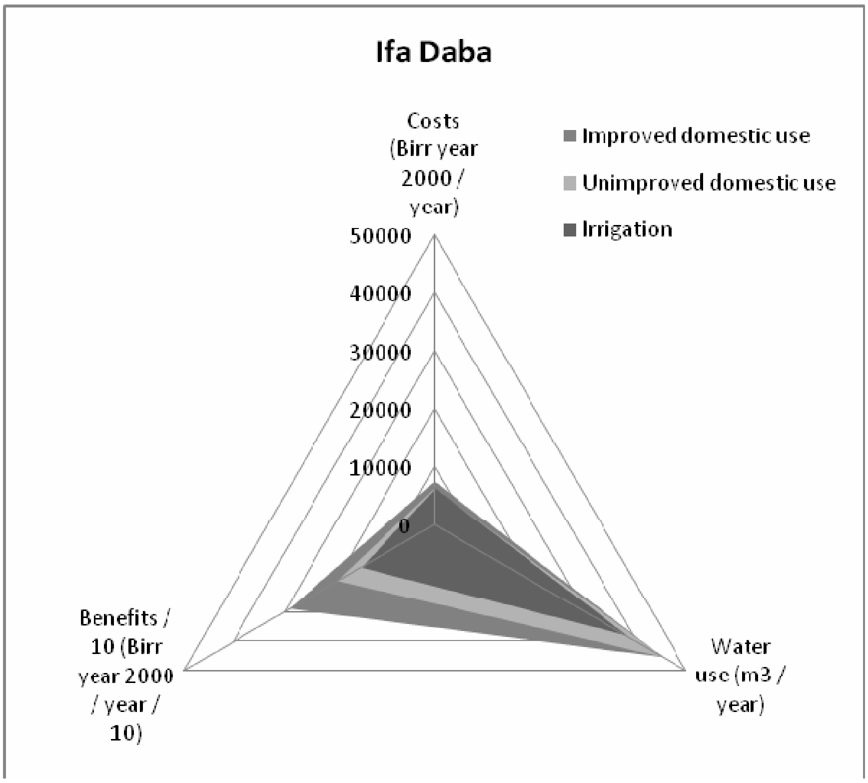


Figure 7.13: Costs, benefits and water use, Ifa Daba, best case scenario



Since the number of beneficiaries differs in the different situations, it is important to also analyse the costs and benefits per capita per year. The graphs in the figures below show the costs and benefits at system level per capita (per community member) for the different situations in the three cases.

Figure 7.14: Total costs and benefits per capita per year, worst case scenario

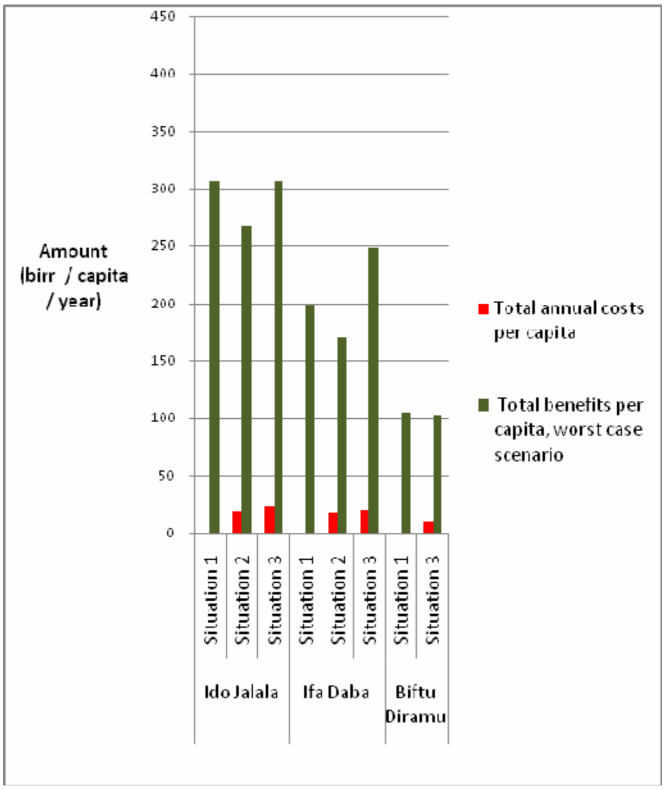
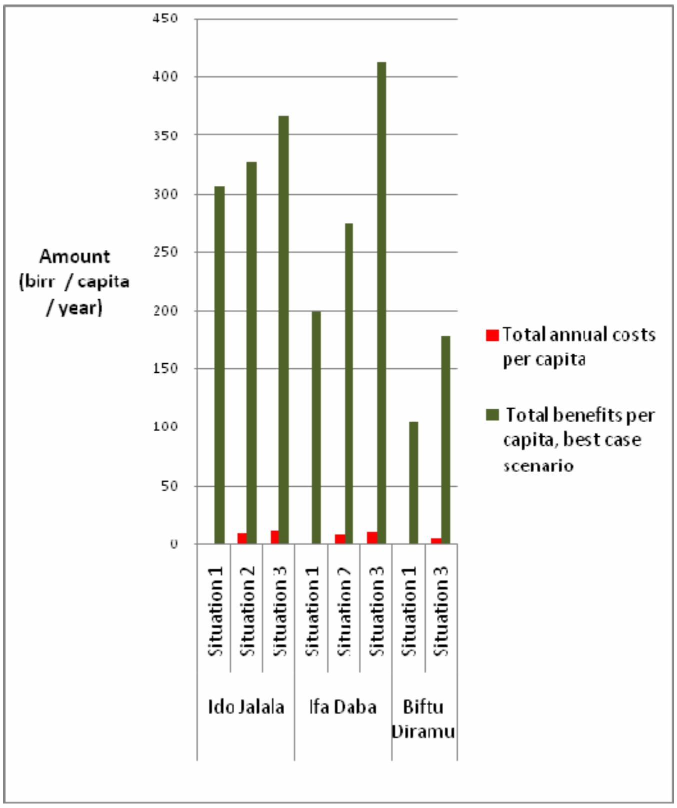


Figure 7.15: Total costs and benefits per capita per year, best case scenario



8 Conclusions and recommendations

8.1 Conclusions

Even in the worst case scenario, the case study has shown that the benefits of multiple use water services easily outweigh the costs at household level, as well as at system level.

The results from the case study suggest that the benefit / cost ratio for domestic water supply interventions is higher than that for irrigation interventions. However, many benefits related to improved domestic water supply (health benefits, time saving) are not always very obvious to the users. Irrigation on the other hand does bring significant and tangible benefits for households with access to irrigated plots.

The case study has shown that benefits from irrigated agriculture, traditional or improved, are very high and an important source of income for rural households. However, it has also shown that not everyone benefits equally, whereas all community members benefit from improvements in domestic water supply, both through improved health as well as through time saving.

Although the benefit / cost ratio of improved irrigation is very high, the ratio of the additional benefits over the additional costs of going from traditional irrigation to improved irrigation is less positive. This could be due to the fact that the improvements in the irrigation systems are not optimal and do not always provide water in the most efficient and thus profitable way.

The Ifa Daba case has shown that adding a domestic water component to a spring irrigation system has a far more favourable benefit / cost ratio than implementing only an irrigation system. It could however be argued that this is especially the case because this is a spring system, which means that very little extra cost is needed to supply water which is of suitable quality for domestic purposes and which can bring health and time saving benefits.

The study has shown that population growth has a large impact on water use, and on costs and benefits per capita. Systems are often over designed to cater for population growth. This may stimulate people to use water for other uses, which can lead to conflict when the population grows. Integrated planning, taking into account water demands for different uses, and how these may develop over time, is key.

8.2 Recommendations

From this case study, recommendations emerged for policy makers and for implementers.

Recommendations for policy makers:

- People will use water for multiple uses, wherever possible. Implementers should be given the opportunity and support needed to respond to these multiple use needs. This will result in multiple benefits, which easily surpass the investments required.
- By making small investments in upgrading of existing single use systems for multiple use, high benefits can be obtained for poor communities.

- Multiple use services demand integrated water resource planning and management, both at the community level, to assure efficient and sustainable water use for multiple purposes, as well at higher levels to prevent depletion of water resources and conflicts.

Recommendations for implementers:

- Implementers need to think about how implementation programmes can maximise benefits. This has to be discussed with the community. A relatively cheap intervention like capping a spring and installing a water point at the spring-site might only result in limited health and time saving benefits, while a somewhat more expensive intervention including the installation of a small piped system to bring water closer to the community might result in far higher benefits.
- The lifespan of different systems should be taken into account when deciding on what kind of system would be most suitable in a certain context. Implementers should be realistic when estimating the lifespan of a system.
- Implementers are recommended to map all uses of water and all sources before starting an intervention. It is important to think about how water use will change with the intervention and to discuss this with different community members. Population growth should be taken into account, and also increase in water demand for other uses (increase in livestock population, increase in market opportunities for irrigated crops, etc). It would be beneficial to discuss different scenarios with the communities and arrive at strategies to address these scenarios.
- Multiple use interventions will affect different households differently. This should be addressed to ensure equity, for example by setting different household contributions to the CapIn and different water fees for different categories of users (people who use the system only for domestic use; people who also use it for livestock; people who also use it for irrigation).
- Potential negative impacts of water interventions should also be explored and taken into account.

The case study also identified a number of areas for further research. These include the following:

- More research on lifespan of systems and the relationship between system lifespan and multiple use of water: Besides data on the design lifespan of certain systems, there is little information on the actual lifespan and the impact of multiple use of water on the lifespan of systems. Initially, the research team considered making an estimate of the actual lifespan, based on a number of characteristics of the system (e.g. willingness to pay, state of maintenance of the system, presence of well trained caretaker, etc). Due to time limitations, it was decided not to pursue this. However, unpacking the issue of system lifespan and how it is affected by multiple use of water, would be a very interesting area for further research.
- Data collection over a longer time period: To obtain more accurate data on changes in water use, the benefits arising and actual operation and maintenance costs, data would have to be collected over a longer time period. It proved very difficult to obtain reliable data on water use quantities. Measuring past water use was obviously not possible, so water use before the intervention had to be estimated based on the available data. Measuring water use by livestock and for irrigation was a challenge as well. It proved very difficult to measure water use for irrigation accurately (see section 4.3). There was very little data available on actual maintenance

costs and the community contribution to them, so in the end the maintenance costs were estimated at a percentage of the CapIn costs (see section 5.3). Data which formed the basis of the calculations on the irrigation benefits are based on household interviews, taken over a short period of time in a specific year. Based on this data, generalisations were made and benefits were estimated for the different situations of the different cases (see section 6.2). Many of these issues could be avoided by collecting data over a longer period.

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Annex 1: Research team composition

Name	Organisation	Responsibility in MUS Research team
Zemede Abebe	HCS	Team/Research Leader
Marieke Adank	IRC	Support the research team
Belayneh Bekele	HCS	Team leader
Samuel Chaka		Researcher
Adissu Delelenge	Woreda Irrigation Office	Agronomist
Jaleta Gebru	Woreda Water Officer	Engineer
Martine Jeths	IRC	Support the research team
Zelalem Lema	Woreda LPA Facilitator RiPPLE	Junior researcher
Demeksa Tamiru	Zonal NGO coordinator of the Finance and Economic Planning office	Researcher

Annex 2: Community maps

Ido Jalela kebele Map by the community

Ifa Daba kebele Map by the community

Biftu Diramu kebele community mapping

Annex 3: Micro scenarios describing water characteristics

Water quality

Description	Score
Very bad: Very turbid / strong colour / very bad taste / very strong odour	20
Bad: Quite turbid / quite strong colour / quite bad taste / quite strong odour	40
Moderate: Bit turbid / bit of colour / some bad taste / some odour	60
Good: hardly turbid / hardly any colour / hardly any bad taste / hardly any odour	80
Very good: Completely transparent / no taste / no odour	100

Accessibility

Description	Score
Very bad: water point completely under water / average distance > 30 min walk / abstraction method: very difficult and cumbersome	20
Bad: area around water point very muddy and slippery / average distance 30-20 min walk / abstraction method: difficult and cumbersome	40
Moderate: half of the area around water point is muddy / average distance 10-20 min walk / abstraction method: only opening tap / long waiting time	60
Good: hardy any mud / Average distance 5-10 walk / abstraction method: only opening tap / some waiting time	80
Very good: water point without mud around it / average distance < 5 min walk / abstraction method: only opening tap / no waiting time	100

Reliability

Description	Score
Very bad: It is very hard for me to predict whether there will be water or not.	20
Bad: It is hard for me to predict whether there will be water or not. My predictions are correct less than half of the time.	40
Moderate: I can sometimes predict whether there will be water or not. My predictions are correct about half of the time.	60
Good: I can almost always predict whether there will be water or not. My predictions are correct more than half of the time.	80
Very good: I can exactly predict whether water will be available.	100

Annex 4: Quantifying domestic water use

The table below shows the amount of water used per capita and per household for domestic use, according to the household surveys. The domestic uses reflected in these amounts are drinking, cooking, personal hygiene and washing utensils.

Table: Daily water use, based on household survey

	Ido Jalala				**Ifa Daba**				**Biftu Diramu**			
	Initial situation		**After intervention**		**Initial situation**		**After intervention**		**Initial situation**		**After intervention**	
	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap
better off	33.3	10.2	45.3	5.7	46.7	10.1	51.3	7.7	41.7	7.1	53.3	7.4
medium	43.3	14.7	35.0	4.8	35.0	9.7	35	5	65.0	12.0	60.0	10.0
worst off	35.0	10.0	89.0	11.8	36.0	13.5	41.7	18.6	30.0	8.9	49.0	11.0
Weighted average	**37.7**	**11.6**	**68.3**	**8.8**	**39.1**	**11.1**	**43.8**	**11.7**	**40.7**	**9.5**	**52.5**	**10.2**

To verify whether these amounts are in line with the actual water use, the selected households were also asked to keep household records of their water consumption. When comparing the measured water use from the household record keeping with the estimated water use from the household survey, it seems that in most cases users, especially the worst-off households, have been overestimating their water use.

The data from the household record keeping is considered more reliable. However, there is no household record keeping data from the situation before the intervention. To get an indication of the average water use in the initial situation, it is assumed that the same rate of overestimation would apply. Based on this, the household use in the initial situation has been determined, as displayed in the table below.

Table: Actual daily water use, based on household record keeping and household survey

	Ido Jalala				**Ifa Daba**				**Biftu Diramu**			
	Initial situation		**After intervention**		**Initial situation**		**After intervention**		**Initial situation**		**After intervention**	
	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap	Per hh	Per cap
better off	35.4	11.3	48.2	6.3	39.4	8.3	43.3	6.3	40.4	6.3	51.7	6.6
medium	46.9	15.9	37.9	5.2	28.8	7.8	28.8	4	46.7	8.6	43.1	7.2
worst off	13.3	3.8	33.8	4.5	26.5	8.1	30.7	11.2	23.3	7.0	38.1	8.7
Weighted average	20.3	6.6	36.8	5	29.9	7.1	33.5	7.5	32.0	7.5	41.3	8.1

Annex 5: CapIn

		Ido Jalala				Ifa Daba				Biftu Diramu	
		Situation I	*Situation 2*	*Additional costs*	*Situation 3*	*Situation I*	*Situation 2*	*Additional costs*	*Situation 3*	*Situation 1*	*Situation 3*
Capital investment costs HCS											
Total investment costs HCS	(birr)	0.00	92780	19817	112597	0	94875	22211	117086	0	35508
Total construction costs HCS	(birr)	0.00	9278	1982	11260	0	9487	2221	11709	0	3551
Total investment costs HCS	(birr)	0	102058	21799	123857	0	104362	24432	128795	0	39059
Total investment costs HCS	(2000 birr)	0	87613	18713	106327	0	97849	19459	117308	0	43217
Total annualised investment costs	2000 birr / year	0	4381	936	5316	0	4892	973	5865	0	2161
Total investment costs HCS	(2000 birr/capita)	0.00	166	35	201	0	140	28	168	0	70
Total investment costs HCS	in 2000 birr / cap / year	0.00	8.28	1.77	10.05	0	7.00	1.39	8.39	0.00	3.52
Community contribution											
Total community input, cash	(birr)	0	0	0	0	0	0	0	0	0	0
Total community input, labour	(birr)	0	2610	390	3000	0	7310	0	7310	0	2380
Total community input, materials	(birr)	0	3093	394	3488	0	4170	682	4852	0	7951
Total community contribution	(birr)	0.00	5703	784	6488	0	11480	682	12162	0	10331
Total community contribution	(2000 birr)	0.00	4896	673	5569	0	10763	543	11306	0	11430

Total annualised community contribution	(2000 birr / year)	0.00	245	34	278	0	538	27	565	0	572
Total community contribution per capita per year	*(2000 birr / cap / year)*	*0.00*	*0.46*	*1.27*	*0.53*	*0.00*	*0.77*	*0.04*	*0.81*	*0.00*	*0.93*
% of community contribution in labour and materials to the CapIn	%	0%	6%	4%	5%	0%	11%	3%	9%	0%	23%
Grand Total CapIn											
Grand Total CapIn	(birr)	0	107761	22583	130344	0	115842	25114	140956	0	49389
Grand Total CapIn	(2000 birr)	0	92509	19387	111896	0	108613	20002	128615	0	54647
Grand Total CapIn	(2000 birr / hh)	0	1322	277	1599	0	898	165	1063	0	569
Grand Total CapIn	(2000 birr / cap)		175	37	212	0	155	29	184	0	89
Grand Total anualised CapIn	(2000 birr / year)	0	4625	969	5595	0	5431	1000	6431	0	2732
Grand Total anualised CapIn	(2000 birr / actual capita / year)		8.75	1.83	10.58	0	7.77	1.43	9.20	0.00	4.45
Grand Total CapIn	(2000 birr/m^3)	0.00	0.60		0.72	0	0.12		0.14	0.00	0.29

Annex 6: Cost overview

Assumed lifespan: 10 years		Ido Jalala			Ifa Daba			Biftu Diramu	
		Situation 1	Situation 2	Situation 3	Situation 1	Situation 2	Situation 3	Situation 1	Situation 3
Capital investment costs									
Total annualised investment costs	2000 birr / year	0	8761	10633	0	9785	11731	0	4322
Total investment costs HCS	in birr / cap / year	0.00	16.57	20.10	0.00	14.00	16.78	0.00	7.03
Household contribution CapIn	(2000 birr /hh / year)	0.00	6.99	7.96	0.00	8.90	9.34	0.00	11.99
Household contribution CapIn	(2000 birr /cap / year)	0.00	0.93	1.05	0.00	1.54	1.62	0.00	1.86
Total community contribution	(2000 birr / year)	0	489.59	556.93	0.00	1076.33	1130.63	0.00	1143.03
Grand Total CapIn	(2000 birr)	0	92509.16	111896.03	0.00	108612.74	128614.82	0.00	54647.38
Grand Total anualised CapIn	(2000 birr / year)	0	9250.92	11189.60	0.00	10861.27	12861.48	0.00	5464.74
Grand Total anualised CapIn	(2000 birr / actual capita / year)	0	17.49	21.16	0.00	15.54	18.40	0.00	8.89
Grand Total CapIn	(2000 birr/m^3)	0.00	1.19	1.44	0.00	0.24	0.28	0.00	0.58
Operation and minor maintenance									
Household contribution	2000 birr/hh/month		1.04	1.04		0.00	0.00		0.69
Household contribution O&M	birr / hh/year		12.48	12.48	0.00	0.00	0.00	0.00	8.32
Household contribution O&M	birr / cap/year	0	1.65	1.65	0.00	0.00	0.00	0.00	1.29
Total O&M costs	(2000 birr / year)		*925*	*1119*	*0*	*1086*	*1286*	*0*	*546*
Total O&M costs	(2000 birr / year	0.00	1.75	2.12	0.00	1.55	1.84	0.00	0.88

	/ capita)								
Total CapIn + Opex									
Total anualised system level costs	(2000 birr / year)	0	10176	12309	0	11947	14148	0	6011
Total anualised system level costs per capita	(2000 birr / year / capita)	0.00	19.24	23.27	0.00	17.09	20.24	0.00	9.72
Total anualised system level costs per unit water	(2000 birr / m^3)	0.00	1.31	1.59	0.00	0.26	0.31	0.00	0.64
Total annualised hh level costs		0.00	19.47	20.43	0.00	8.90	9.34	0.00	20.31
Total annualised hh level costs per capita		0.00	2.58	2.70	0.00	1.54	1.62	0.00	3.15
Support costs									
expenditure annual support costs to system from government	(2000 birr / year)	249.3941105	317.6732372	408.2307291	249.3941105	339.9516023	408.2307291	249.3941105	408.2307291
Total expenditure annual support costs	(2000 birr / year)	249	318	408	249	340	408	249	408
Total expenditure annual support costs	(2000 birr / capital / year)	1	1	1	0	0	1	1	1
Total costs									
Total annual costs	(2000 birr / year)	249	10494	12717	249	12287	14556	249	6419
Total annual costs per capita	(2000 birr / year / capita)	0.73	19.84	24.04	0.45	17.58	20.82	0.52	10.38
Total costs per m^3 produced	(2000 birr / m^3)	0.03	1.35	1.64	0.01	0.27	0.32	0.03	0.68

Assumed lifespan: 20 years	**Ido Jalala**			**Ifa Daba**			**Biftu Diramu**	
	Situation 1	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 3*
Capital investment costs								

Total annualised investment costs	2000 birr / year	0	4381	5316	0	4892	5865	0	2161
Total investment costs HCS	in birr / cap / year	0.00	8.28	10.05	0.00	7.00	8.39	0.00	3.52
Household contribution CapIn	(2000 birr /hh / year)	0.00	3.50	3.98	0.00	4.45	4.67	0.00	5.99
Household contribution CapIn	(2000 birr /cap / year)	0.00	0.46	0.53	0.00	0.77	0.81	0.00	0.93
Total community contribution	(2000 birr / year)	0	244.80	278.46	0.00	538.17	565.32	0.00	571.52
Grand Total CapIn	(2000 birr)	0	92509.16	111896.03	0.00	108612.74	128614.82	0.00	54647.38
Grand Total anualised CapIn	(2000 birr / year)	0	4625.46	5594.80	0.00	5430.64	6430.74	0.00	2732.37
Grand Total anualised CapIn	(2000 birr / actual capita / year)	0	8.75	10.58	0.00	7.77	9.20	0.00	4.45
Grand Total CapIn	(2000 birr/m^3)	0.00	0.60	0.72	0.00	0.12	0.14	0.00	0.29
Operation and minor maintenance									
Household contribution	2000 birr/hh/month		1.04	1.04		0.00	0.00		0.69
Household contribution O&M	birr / hh/year		12.48	12.48	0.00	0.00	0.00	0.00	8.32
Household contribution O&M	birr / cap/year	0	1.65	1.65	0.00	0.00	0.00	0.00	1.29
Total O&M costs	(2000 birr / year)		*463*	*559*	*0*	*543*	*643*	*0*	*273*
Total O&M costs	(2000 birr / year / capita)	0.00	0.87	1.06	0.00	0.78	0.92	0.00	0.44
Total CapIn + Opex									
Total anualised system level costs	(2000 birr / year)	0	5088	6154	0	5974	7074	0	3006
Total anualised system level costs per capita	(2000 birr / year / capita)	0.00	9.62	11.64	0.00	8.54	10.12	0.00	4.86
Total anualised system level costs per unit water	(2000 birr / m^3)	0.00	0.66	0.79	0.00	0.13	0.16	0.00	0.32
Total annualised hh level costs		0.00	15.97	16.45	0.00	4.45	4.67	0.00	14.31
Total annualised hh level costs per capita		0.00	2.11	2.18	0.00	0.77	0.81	0.00	2.22
Support costs									

expenditure annual support costs to system from government	(2000 birr / year)	249	318	408	249	340	408	249	408
Total expenditure annual support costs	(2000 birr / year)	249	318	408	249	340	408	249	408
Total expenditure annual support costs	(2000 birr / capital / year)	1	1	1	0	0	1	1	1
Total costs									
Total annual costs	(2000 birr / year)	249	5406	6563	249	6314	7482	249	3414
Total annual costs per capita	(2000 birr / year / capita)	0.73	10.22	12.41	0.45	9.03	10.70	0.52	5.52
Total costs per m^3 produced	(2000 birr / m^3)	0.03	0.70	0.85	0.01	0.14	0.16	0.03	0.36

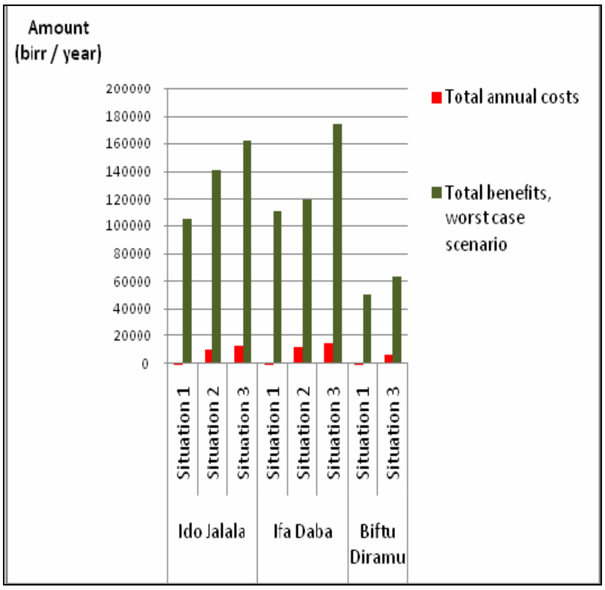
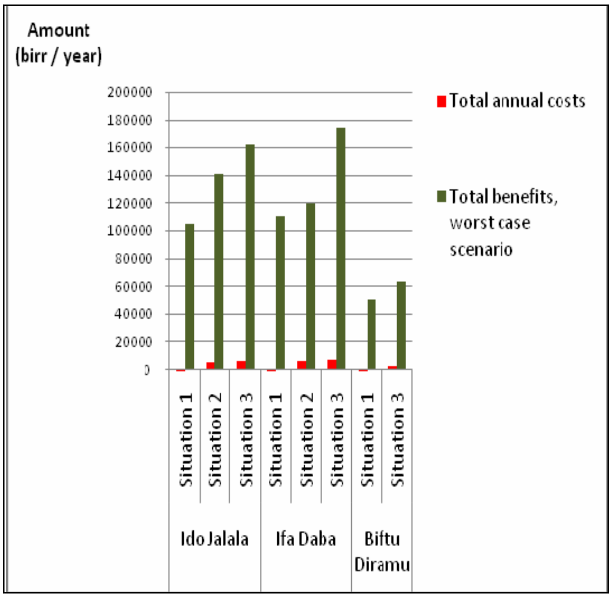
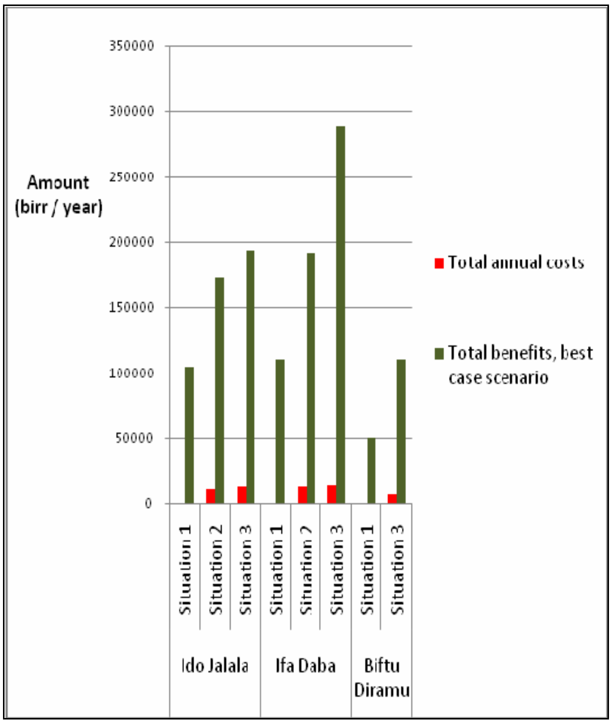
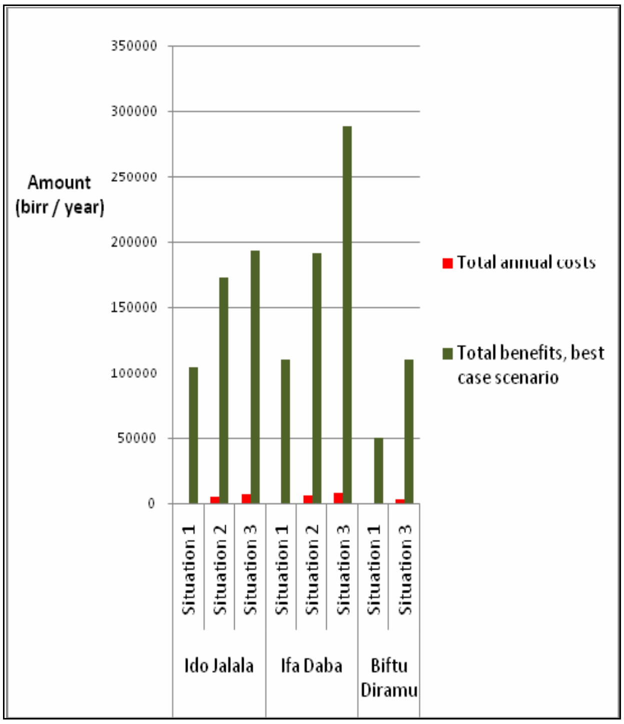
Annex 7: Benefit Overview

		Ido Jalala			**Ifa Daba**			**Biftu Diramu**	
		Situation 1	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 2*	*Situation 3*	*Situation 1*	*Situation 3*
Health benefits , worst case	(2000 birr / capita / year)	0,00	20	20	0,00	0,00	20	0,00	20,00
Total health benefits , worst case	(2000 birr / year)	0	10578	10578	0	0	13982	0	12373
Total health benefits per unit water , worst case	(2000 birr / m^3/year)	0	11,25	11,25	0,00	0,00	9,45	0,00	8,55
Health benefits hh level, worst case	2000 birr / hh/year	0	151	151	0	0	116	0	129
Health benefits , best case	(2000 birr / capita / year)	0,00	80	80	0,00	0,00	80	0,00	80,00
Total health benefits , best case	(2000 birr / year)	0	42311	42311	0	0	55929	0	49493
Total health benefits per unit water ., best case	(2000 birr / m^3/year)	0	45,01	45,01	0,00	0,00	37,79	0,00	34,20
Health benefits hh level, best case	2000 birr / hh/year	0	604	604	0	0	462	0	516
Irrigation related benefits									
Total irrigation benefits, with change in cropping pattern	(2000 birr / year)	105325	65828	86893	110843	74103	74103	50353	10401
Irrigation benefits, with change in cropping pattern	(2000 birr / ben hh / year)	2633	2633	3476	2771	1398	1398	2098	867
Irrigation benefits, with change in cropping pattern	(2000 birr / ben capita / year)	537	349	460	602	242	242	420	135
Irrigation benefits, with change in cropping pattern	(2000 birr / capita / year)	307	124	164	199	106	106	105	17
Irrigation benefits per unit water	(2000 Birr / m^3)	21,05	15,30	20,20	2,74	1,83	1,94	9,65	4,50
Total irrigation benefits, without change in cropping pattern	(2000 birr / year)	105325	65828	86893	110843	146867	146867	50353	20431
Irrigation benefits, without change in cropping pattern	(2000 birr / ben hh / year)	2633	2633	3476	2771	2771	2771	2098	1703

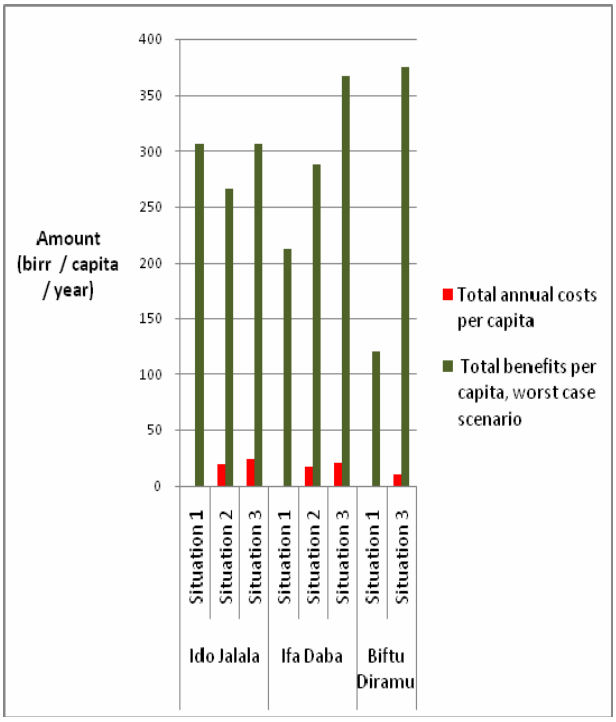
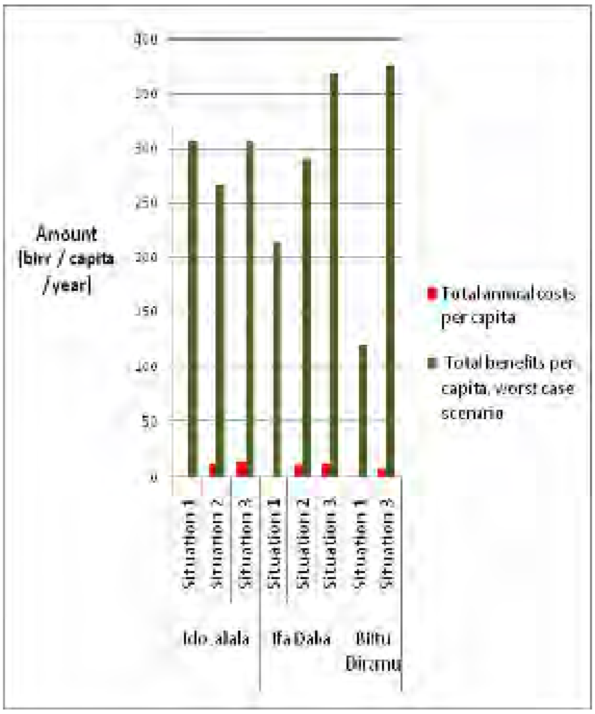
Irrigation benefits	(2000 birr / ben capita / year)	537	349	460	602	480	480	420	264
Irrigation benefits, without change in cropping pattern	(2000 birr / capita / year)	307	124	164	199	210	210	105	33
Irrigation benefits per unit water		21,05	15,30	20,20	2,74	3,63	3,84	9,65	8,84
Time saving									
Time saving benefits	(2000 birr / capita / year)	0	123	123	0	65	123	0	65
Total time saving benefits	(2000 birr / year)	0	65031	65031	0	45283	85962	0	40477
Time saving benefits	2000 Birr / hh / year	0	929	929	0	374	710	0	422
Total benefits									
total benefits , worst case scenario	(2000 birr/system / year)	105325	141437	162502	110843	119386	174047	50353	63252
total benefits , best case scenario	(2000 birr/system / year)	105325	173171	194236	110843	192150	288757	50353	110401
total benefits , worst case scenario	(2000 birr/cap / year)	307	267	307	199	171	249	105	102
total benefits , best case scenario	(2000 birr/cap / year)	307	327	367	199	275	413	105	178
Max hh level benefits	2000 Birr / hh / year	2633	4167	5009	2771	3145	3944	2098	2640
Medium hh level benefits	2000 Birr / hh / year	2633	3713	4556	2771	1772	2224	2098	1417
Min hh level benefits	2000 Birr / hh / year	0,00	1080	1080	0	374	826	0	551

Annex 8: System level costs and benefits in different scenarios

System level costs and benefits per year

	Lifespan of system is assumed 10 years	Lifespan of system is assumed 20 years
Worst case scenario regarding to health benefits		
Best case scenario regarding to health benefits		

System level costs and benefits per capita per year

	Lifespan of system is assumed 10 years	Lifespan of system is assumed 20 years
Worst case scenario regarding to health benefits		
Best case scenario regarding to health benefits