Wageningen University - Department of Social Sciences
MSc. Thesis Environmental Economics and Natural Resource Group

Preconditions for a Payment for Environmental Services establishment at Central Rift Valley, Ethiopia

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Summary

This thesis identifies users of environmental services related to domestic water supply and water for crop and fruit production in the Ethiopian Central Rift Valley (CRV). Additionally, it analyzes the institutional environment and other preconditions for designing and implementing a scheme for Payment for Environmental Services (PES), aimed at protection of the ecosystems providing domestic water supply and water for crop and fruit production.

The total area under irrigation and total number of urban water users in the CRV is quantified. Additionally, based on some assumptions, the total water demand of both user groups has been estimated, in order to provide policy makers with information about water use related to urban water use and irrigation water in the CRV.

The analysis of the institutional environment is done in order to: (i) establish PES concordance with the overall regulatory framework of Ethiopia on water, land, forest and agriculture, (ii) understand which agents hold water property rights and if government institutions can bring support and monitor a PES scheme, based on the level of law implementation (iii) recognize ongoing watershed management plans in which a PES could be embedded in, and (iv) to identify collective action initiatives and development of community institutions aimed at solving environmental problems.

Other preconditions for a PES that are analyzed: (i) the awareness of environmental users in relation to the provision of irrigation and urban drinking water services, to get insight in the willingness to solve potential problems, (ii) the opportunity and transaction costs of setting up a PES scheme, as a theoretical illustration to estimate the costs of conservation and (iii) the identification of a suitable model for PES according to the financial requirements for establishment and functioning of a compensation scheme.

An economic analysis on productivity of small scale irrigation schemes is presented together with an analysis of power relationships regarding water access for irrigation. This analysis enables to understand economic performance of irrigation users, and how water as an open access resource threats the efficient use of irrigation water in the CRV.

The applied methodology consisted of questionnaires requesting qualitative and quantitative information about environment, irrigation and land from governmental organizations at the federal, regional, zone and local level. Besides, interviews were held with groups of irrigation users, for example, with Kebele elders. Non Governmental Organizations (NGO's) were also

interviewed. The interviewed governmental organizations at the federal level were the Ministry of Water Resources (MoWR) and the Ministry of Agriculture and Rural Development (MARD); At the federal level the Oromia Water Resource Bureau (OWRB), the Oromia Environmental Protection Office (OEPO), the Oromia Irrigation Development Agency (OIDA), the Southern Nations, Nationalities, and People's Region (SNNPR), the Water Resource Bureau (WRB) and the Bureau of agriculture SNNPR. The interviewed governmental organizations at the local level were the Woreda Agricultural Development Office (WADO) and more specifically the Irrigation Offices of Tiyo District, Ziway Gugda District, Digelo Tijo, Dugda, Adami Tullu Jido Kombolcha (ATJK) and Munessa District. The interviewed groups of users were a total of 60 members of four irrigation schemes in ATJK, Dugda and Ziway Gugda and 2 elder leaders in ATJK.

Currently, water resources in Ethiopia are open access resources contributing to unrestricted use which may lead to depletion of some of these resources. This is meant to change with the establishment of water fees for water users. However issues as little coordination among decision makers at the federal and regional level regarding the establishment of water fees were observed. For example, MoWR has prepared the River Basin Councils and Organization proclamation (No.534/2007) under which funds required for implementation and operation of River Basin Authorities and Organizations (RBOs) –a multi stake holder platform for the management of Basin- will be provided by respectively the federal government and user's water charges. However, the OWRB proposes, - in the draft version the Oromia Regional State Water Resources Management Regulation - , also a water fee for water users. Hence, two organizations at federal and regional level are developing the same policy instrument.

During the period it was observed that that there are little or economic or non economic incentives to use water efficiently or to protect the CRV watershed. Instead the existent incentives focus on expanding irrigated areas managed by community and private companies (mainly foreign). This together with low reinforcement and compliance with environmental regulations are threats to sustainable development of the region.

The identified community rules about land and water resources relate to the administration, management and maintenance of irrigation schemes as well as to the allocation of water among members of the same irrigation scheme. The only regulation regarding water allocation among users outside irrigation schemes have been developed in water-crisis periods. For example, during the drought of 2003 affecting downstream water users along the Bulbula River, Kebele (the lowest administrative unit in Ethiopia) authorities, the municipality of Bulbula, together with WADO and irrigation schemes upstream along the Bulbula River agreed that irrigation water

abstraction only was allowed at night in order to improve the water flow for downstream domestic users.

The total irrigated area in the CRV is around 12,000 ha, of which 500 ha are closed irrigated production systems and the rest are open irrigation systems. The irrigated areas are sustained by water coming from the following sources, in order of decreasing importance: Lake Ziway (31%), Ketar River (27%), groundwater (25%), Meki River (11%), Bulbula River (4%) and spring water (2%). The total estimated amount of water abstracted in these irrigated areas is 200 M m3/year, of which 96% is used by the open irrigation production systems and 4% by the closed irrigation production systems.

On an urban population of 280,000, about 220,000 (79%) has access to urban water services. The largest urban centres in the study area are: Asella, Meki-Alamtena, Ziway-Adami Tullu and Butajira. Asella in the Arsi Zone extracts water from a spring and the Ashebela River. Kersa, Digalu Kidane, Tijo and Gonde use water from nearby springs. Kulumsa extracts water from a spring and an artificial reservoir, while Ogolcho from a nearby borehole. Ziway and Adami Tullu in the East Shewa extract water from Lake Ziway. Meki and Alam tena extract water from boreholes and a river. The total demand of water from urban water users is estimated at 1.1 M m3/year.

Awareness regarding water scarcity is low among irrigation water users along Lake Ziway and from groundwater sources located in the northern part of this Lake. The perceived causes for those that are aware of water scarcity relate mainly to rainfall variability and much less to (irrigation) water users upstream along the Meki and Ketar. Domestic users downstream along the Bulbula River associate water scarcity to the floriculture greenhouses near Lake Ziway. For other urban water users, water quality is more important than water quantity maybe because of year round water supply.

The estimation of conservation costs related to the establishment a PES as a watershed protection instrument is based on two assumptions. First, it is assumed that the area of upstream forests is positively related with a regular downstream water flow, i.e. more water is available for irrigation in the dry season. Second, it is assumed that the forested areas are privately owned. The area with natural forest in the study area is 31,584 ha, i.e. 3.1% of the total area in the CRV. Assuming that this forest area can be converted into agricultural land, the land rent is used as a proxy for the opportunity costs to keep this area as forest, i.e. 1,600 Birr/ha/year. This means that at least 50 M Birr should be available to compensate land tenants to conserve these forests. However, various transaction costs for implementation of a PES need to be taken into account

and they range from 6 to 45% of the total costs Hence, the total costs in the illustration would range between 53 and 73 M Birr, which corresponds with 0.6 and 1% of the estimated regional gross domestic product of the Rift Valley Lakes Basin in 2005.

To implement a PES, a robust and competent institutional structure is required. Both the development of the River Basin Organizations (RBO) for the Rift Valley Lakes Basin and the Rift Valley Lakes Basin Integrated Resources Development Master Plan Study Project – which is now in the first of three development phases-, offer opportunities to design and implement a PES or any other incentive for sustainable use of land, forest and water resources. Monitoring and enforcement capacity of the regulation and PES agreements can be part of the responsibilities of the RBO, in close coordination with OEPO (i.e. water quality) and OWRB (i.e. water quantity). In order to make this work it is necessary to improve the presence of the OWRB authorities at the local level. However, the establishment of a public system for PES is hampered by high national fiscal deficit - 7.4% of the GDP, which prioritizes investment in other areas than the environment. The high cost of conservation is an obstacle for the development for a public model for a PES. An alternative model for a PES scheme could be a combination of a private and public model. The recommendation for this model is based on the identified regulations for watershed management in the CRV such as the RBOs multi stakeholder platform.

In synthesis, low levels of environmental and water law implementation and monitoring making water in the CRV a common access resource, high conservation opportunity costs, lack of institutionalism and a low level of problem awareness among users of the most important irrigation water sources are findings that suggest that is too early to think of establishing a PES for the CRV. This finding together with the lack of incentive mechanisms for the sustainable land, forest and water management in Ethiopia, calls for the establishment of other incentives. For example, Kassahun (2006) explains how differential land tax incentives can help reduced land degradation. Imposing environmental taxes is another scenario to be studied, so that tax revenues generated would need to be re-invested into the conservation.

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1. Research description

1.1. Introduction

Ethiopia has abundant water resources, all emanating within its territory. Yet, water scarcity is wide-spread and associated with the spatial and temporal distribution of water availability (Edossa et al. 2005). Ethiopia is not a water stressed country with a per capita water availability of 1749 m3/year (Unesco, 2004) but the spatial and temporal variability of water resources limits development, and constrains management and equitable distribution.

Ethiopia is facing major challenges with regard to alleviating poverty. Rain fed smallholder agriculture is the backbone of the national economy providing 44% of the GDP and 85% of the employment. Droughts therefore have a strong impact on economic growth. With a population of 75 million, growing at 3% per year, Ethiopia's economy is dominated by subsistence smallholder agriculture, which accounts for 44% of GDP and 85% of employment (Ministry of economic development and cooperation, 2005).

Excessive land degradation, deforestation and over-irrigation resulted in sedimentation in lakes and increased soil salinity (Legesse and Ayenew, 2006). Between 1990 and 2000, 141,000 ha of forest were lost every year, which equals an average annual deforestation rate of 0.93%. Deforestation may result in soil erosion, land degradation, water and air pollution which may affect the livelihoods of the rural population (Gatzweiler et al., 2007).

Recently, policies of the Ethiopian government strongly support export-oriented irrigated horticulture and private large scale floriculture as a means to increase foreign exchange earnings and employment opportunities. The CRV is a region in Ethiopia where such policies have resulted in large scale investments in floriculture greenhouses and in a strong growth in smallholder irrigation schemes. The associated increase in irrigation water extraction from surface water and groundwater resources puts an increasing claim on scarce water resources in the area (Jansen et al., 2007). However, poverty will remain a major driver for the exploitation of (water) resources by smallholders as long as no alternative livelihood strategies are available that rely less on irrigation water and no regulatory framework is in place to manage water extraction in the CRV (Jansen et al., 2007).

Water resource development[1] is key for economic growth and livelihood improvement in the CRV, which should be supported with sound information on its potential impact and the identification of different users. Moreover, if water resource development is the policy goal, strategies should be developed for communities and stakeholders to conserve and use the environmental services provided by watersheds in a sustainable way.

The situation in the CRV is a typical example of competing claims for land and water resources, i.e. on the one hand for economic growth and on the other hand for environmental sustainability. The challenge will be to combine both objectives to achieve sustainable development for the CRV. One of the requirements to enable and support a process aimed at sustainable development is sound information and knowledge about the issues at stake in the CRV. On basis of such knowledge development options for improved resource use and management can be identified, as well as priorities for research needed to support sustainable development in the CRV. A well-founded knowledge base may help to distinguish myths from facts, and beliefs from realities, which allows to create consensus among different stakeholders and to support well-informed decision-making with respect to resource use and management (Jansen et al., 2006).

Therefore, this thesis investigates demands and users of the environmental services related to domestic water supply and water for crop and fruit production. Additionally, it analyzes the institutional environment and analyzes -under the assumption that certain land uses, specifically forest areas, contribute to regulating environmental services throughout the year- the preconditions for designing and implementing a policy instrument aimed at protection of the ecosystems providing the mentioned environmental services.

1.2. Description of study area

The Ethiopian Central Rift Valley (38°00'-39°30' E and 7°00'-8°30' N) covers about 1 M ha and is part of the Great African Rift Valley. The CRV has an arid to semi-arid climate, although the highlands on the eastern and western escarpments of the valley are sub humid. From the escarpments the lakes on the rift floor are fed by rivers, of which Meki and Ketar Rivers are most important. The four major lakes are Lake Ziway, Lake Langano, Lake Abyata and Lake Shala of

[1] Water resource development means increased water demand and the construction of water infrastructure for irrigation purposes.

which the latter is a sub-catchment of the CRV. Lake Ziway and Lake Langano drain to Lake Abyata, a terminal lake, one by the Bulbula River and Horakelo Rivers. Lake Abyata and Shala together form a National Park that is primarily created for its aquatic bird life. Until now, only a part of the 87.000 ha park is protected and fenced. The park is heavily threatened by the invading human and cattle population (Scholten, 2007).

Land degradation in the highlands of the Ketar watershed already reached moderate to extremely high erosion hazards (Halcrow, 2007). About 40% of the Meki watershed is characterized by an annual soil loss rate of 51–100 t/ha and is under high to very high risks of soil erosion, while some areas in Mareko have an extremely high erosion hazard. In general, the Meki watershed has a high rate of land degradation.

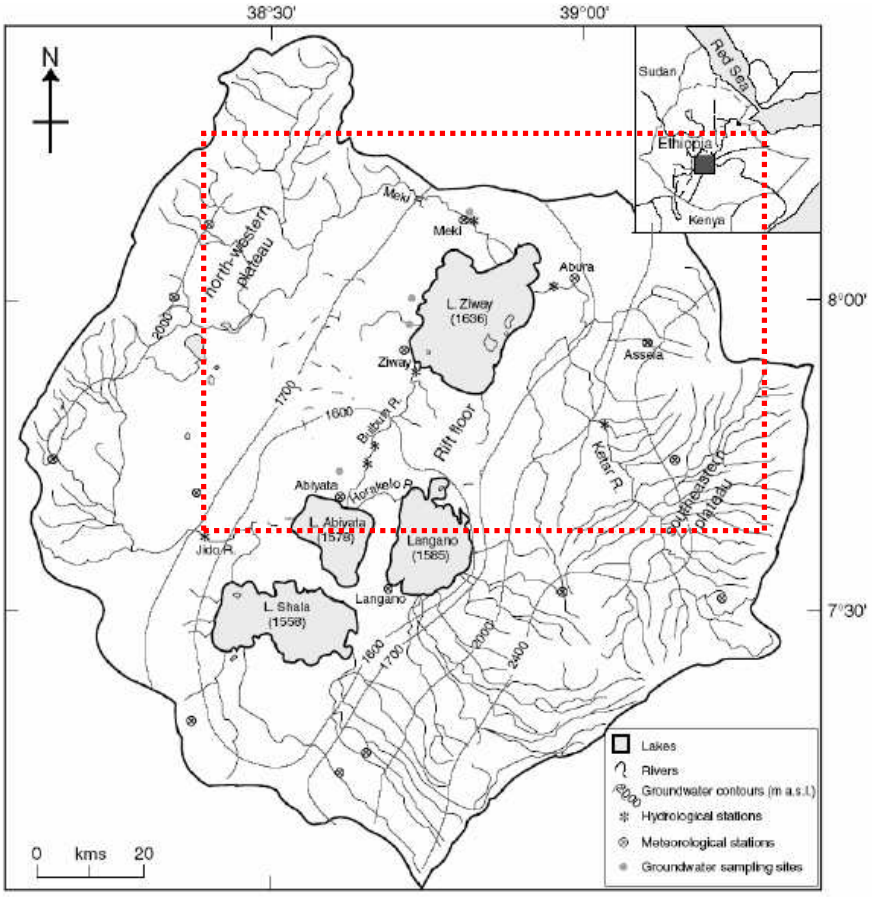

Figure 1. Central Rift Valley and study area (in red)

1.3. Objective and research questions

The objectives of this study are the following:

- To identify the irrigation and urban domestic water users
- To understand how the institutional environment affects the allocation, use and management of water in the region.
- To gain insight into the preconditions required for designing a Payment for Environmental Service scheme (PES), as a watershed protection instrument.

To meet these objectives the following research questions have been addressed:

- Who are the different users of the water resources along the Meki, Ketar, Ziway and Bulbula watersheds?
- What are the main water resources (i.e. river, rain, groundwater, etc.)?
- Who has the property rights over water resources?
- What problems do water users identify related to water?
- What are the coping mechanisms of users during water scarcity (drought)?
- What are the power relationships related to water allocation and use?
- What is the productivity of land, water and labour of small irrigation schemes?
- What are the main policy instruments related to water extraction at the national, federal and Woreda level?
- What are the opportunities and risks that support or constrain the establishment of compensation schemes among stakeholders?

1.4. Literature review

Institutions represent the rules of the game set by the society, as they structure policy, economic and social interaction, while they are a substitute for accurate information because they provide a basis for making sound decisions by ensuring the behaviour of others hence reducing uncertainty (North, 1990; 1991). Ostrom (1986) defines institutions as sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions.

Furthermore, North (1991) distinguishes institutions and organizations. Institutions are perceived as the rules of the game and organizations can be considered as the players through which economic exchange takes place (Louis et al., 2007). So for this study these three definitions which are not excludable to each other will be considered as definitions of institutions and organizations.

Lance and North (1971), Williamson (1999), and Saleth and Dinar (2004) define two levels of institutions, the institutional environment and the institutional arrangements. The institutional environment is defined by a set of fundamental political, social and legal rules that establish the basis of production, exchange and distribution (Saleth et al., 2004) or the broader set of institutions (or 'rules of the game') in which people and organizations develop and implement specific institutional arrangements (Morrison et al., 2005). Institutional arrangements include the governance structure and its evolution within and interaction with the institutional environment (Saleth et al., 2004), or the forms of contract or arrangement that are set up for particular transactions (Morrison et al., 2005).

Governance structure incorporates the economic and political organizations that form part of the institutional arrangements (Williamson, 1994). The specific focus on organizations or institutional arrangements is to highlight their role as "agents of institutional change" (North, 1990). While the rules determine the outcome, the players or actors –as individuals and organizations– can also change the rules depending on their relative share of the outcome or their political bargaining power. As such, institutional arrangements function as mechanisms to effect changes in the institutional environment (Saleth et al., 2004).

The line demarcating the institutional environment and institutional arrangements (or governance structure) is not fixed but varies with the focus and level of analysis. As a result, some segments of institutional arrangements can become part of the institutional environment and vice versa. For instance, when considering institutional water arrangements, the overall economic, political and resource related institutions become part of the institutional environment. Similarly, when the focus is on the institutional arrangements of a particular region or subsector, the institutional arrangements at the national and sectoral levels become part of the institutional environment (Saleth et al., 2004).

1.5. Theoretical framework

Payment schemes for Environmental Services (PES) are flexible mechanisms, which can be adapted to different conditions. They consist of a payment or direct compensation by the users of the service for the maintenance or provision of an environmental service to the providers of the same. PES in watersheds usually relate to water supply, availability and/or quality (FA0, 2004).

A PES scheme, must at least contain the following components (Wunder, 2005): (i) a voluntary transaction where (ii) a well-defined ES (or a land-use likely to secure that service), (iii) is 'bought' by a (minimum one) ES buyer, (iv) from a (minimum one) ES provider, (v) if and only if the ES provider secures ES provision (conditionality).

The PES approach, which compensates those who provide positive externalities contrasts with approaches such as pollution charges, which are based on the ''polluter pays'' principle, i.e. those who create negative externalities should pay for the damage they cause (Pagiola, Arcenas, Platais, 2005).

The main water-related services provided by ecosystems in a typical watershed are (Smith, de Groot, Bergkamp, 2006): provisioning services (regarding food supply and non-food products from water flows), regulating services (related to regulating flows or reducing hazards related to water flows), supporting services (provided to support habitats and ecosystem functioning) and cultural and amenity services (related to recreation and human inspiration).

In more detail, water-related provisioning services in a typical watershed are: Domestic freshwater supply, crop and fruit production, livestock production, fish production, timber and building materials supply, medicines and hydro-electric power. The focus of this study is on domestic freshwater supply in urban areas and freshwater supply for crop and fruit production in private and community based irrigation schemes using water from rivers, lakes and groundwater.

To analyze the existing preconditions for the establishment of a PES scheme in a certain area, Wunder (2007) prioritizes the need to make a basic assessment of site-specific threats, service provision levels and opportunity costs in order to accommodate the PES strategically in the current situation of an area. This kind of analysis can be complemented with a set of required preconditions identified by study cases on the design implementation of such schemes from all over the world.

Wunder (2007) argues that it is often not necessary to do a full economic valuation study of ecosystem services (buyer's benefit) and of the profitability of alternative land use options

(provider's cost). In principle, service providers and buyers agree on the price, just as market prices are determined. Yet, basic calculations can set price ranges, strengthen negotiation positions for either side, or even predetermine whether a PES scheme is economically feasible.

Pagiola (2005) establishes a range of prices for an environmental service, in which the lower limit is the provider's opportunity costs[2] and where the upper limit is the Willingness-To-Pay (WTP) of the service's users. Some studies argue that there is a fundamental difference in the way people make hypothetical decisions relative to the way they make actual decisions (FAO, 2001). A fact that relaxes the position of having to make an economic valuation, as there exists usually a substantial difference between the WTP and the outcome of the actual bargaining process.

Experts on PES (Classen et al., 2005; FAO, 2004; Grieg-Gran, 2005; Smith et al., 2006; Wunder, 2006) identified the following main preconditions: coherence with the overall regulatory framework, need and urgency related to environmental service, support and governance, and identification of suppliers and beneficiaries and analysis of opportunity costs and WTP.

The first one of these preconditions is the existence of the need and urgency related to environmental services. An important aspect of this point is that collective action is more likely to happen if the users are aware of the problem, i.e. water scarcity in dry seasons or poor water quality. Hence, if watershed services are in decline, or there is a threat to future provision of these services (Smith et al., 2006).

Another important issue that can catalyze or hamper a collective action initiative, is the user's perception of the cause for the decline on the environmental service i.e. is water scarcity during the dry season caused due to less rain – a fact that is out of their hands to solve- or is it due to other reasons that fall in their range to solve –competition for water among users, erosion, deforestation, etc.

Smith et al. (2006) argues that a precondition for PES establishment is the existence of a good institutional and political support for using payment scheme instead of direct statutory or regulatory mechanisms for solving the environmental problem.

All watersheds share two key resources, i.e. water and land (Swallow, 2004). Land use affects the provision of environmental services related to water, for example, forests may regulate

[2] One can also add to this, the investment costs for the management of the land (i.e. cost of reforestation, etc) and some of the transactions cost of operating a PES scheme (i.e. financial cost of the environmental service fund, cost of monitoring, etc).

environmental services throughout the year (Gatzweiler et al., 2007). In the case of Ethiopia, the current land tenure system does not offer incentives to providers of environmental services to adopt land conservation measures due to the lack of security on land tenure.

Identifying a suitable model for the establishment of PES is also a precondition. Two models exist (Smith, 2006): (i) private schemes in which private users (i.e. farmers, consumers, etc.) provide payments or rewards in return for maintenance or restoration of a service to providers upstream (Smith, 2006). These private agreements include direct payments from users to providers, so the providers undertake certain activities (i.e. desirable land uses, reforestations, isolations of certain areas, etc) that contribute to improve, maintain or restore the environmental services. Another kind of private agreement is land purchases and leasing to the former owners of the land, in order to guarantee the provision of the environmental service. (ii) Public payment schemes, in which the government decides to pay for watershed services, and which service has the highest priority. The financial sustainability of this kind of model is completely dependent on the government's budget.

Understanding the institutional environment (national and federal regulations, and local rules) and administrative framework in which a PES scheme will operate is a key element, in terms of: (i) knowing who has property rights over the natural resource or environmental service, (ii) evaluating the coherence with the national and regional legislation, as well as, with the customary local rules of the communities, (iii) designing an institutional framework for the chosen scheme, (vi) identifying governmental and community-based organizations that can support the establishment of the PES, (v) identifying management plans in which this instrument can be embedded, (vi) identifying learning lessons from existing or former policy instruments, (vii) identifying the need for administrative coordination regarding watershed management among different administrative jurisdiction, etc.

Finally, in order to understand power relationships a theoretical game is set. Game theory is developed to study decision making in conflict situations regarding different resources. Such a situation exists when two or more decision makers (for the case irrigation sites) who have different private objectives share the same resources. Game theory provides a mathematical process for selecting an optimum strategy in the face of an opponent who has a strategy of his own (Binmore, 1992).

1.6. Research methodology

This case study had a methodology that consisted of a series of questionnaires to different institutions and organizations at federal and local level regarding allocation, use and management of water, as well as for local user-institutions (formal and informal) and organizations. These questionnaires were based on Saleth et al. (2004) and on the preconditions for PES. They were designed for collecting mainly qualitative information on: (i) formal and informal rules on water management and allocation), (ii) land tenure), (iii) agricultural and (iv) environmental laws (i.e. watershed protection policy instruments), (v) decentralization issues and vi) inter-sectoral policies articulation, (vii) conflict resolutions, (viii) future law developments, (ix) collective action initiatives, and (x) awareness of environmental problems.

The interviewed governmental organizations at the federal level were the Ministry of Water Resources (MoWR), the Ministry of Agriculture and Rural Development (MARD). The interviewed governmental organizations at the federal level were the Oromia Water Resource Bureau (OWRB), the Oromia Environmental Protection Office (OEPO), the Oromia Irrigation Development Agency (OIDA), the Southern Nations, Nationalities, and People's Region (SNNPR), the Water Resource Bureau (WRB) and the Bureau of agriculture SNNPR. The interviewed governmental organizations at the local level were the Woreda Agricultural Development Office (WADO) and more specifically the Irrigation Offices of Tiyo, Ziway Gugda, Digelo Tijo, Dugda, Adami Tullu Jido Kombolcha (ATJK) and Munessa.

Community-based institutions are: (i) water user associations (WUAs), (ii) farmers irrigation cooperatives, a group of 60 users were four irrigation schemes in ATJK, Dugda and Ziway Gugda a total of 60 persons and 2 elder leaders in ATJK (For more details on questionnaires the reader is kindly asked to revise the annexes of this study).

The water users were divided into two main groups, i.e. irrigation and urban water users. At the same time, these groups were divided into groups according to the hydrological units and water resources.

Due to the large size of the study area, the perception of water users in the rest of the CRV was based upon interviews with the irrigation department of the Woreda Agricultural Development Offices (WADO) and with NGO's supporting irrigation schemes and key informants.

The sample of urban domestic water users were water supply offices in the Arsi, East Shewa and SNNPR (Section 2.1.5), and NGOs working on water supply in the area.

Additionally, quantitative information was gathered mainly from Woreda Agricultural Development Offices, Water supply offices, NGOs and directives of the irrigation groups on areas of irrigation schemes, location, number of beneficiaries, cultivated products, yields, prices of agricultural products and input costs. The quantitative information for urban water use was about number of beneficiaries per urban centre and total consumption of urban water.

Secondary sources are properly referenced in the document. The reader is also referred to annexes (1, 2 and 3) where he can find contact persons in each organization, as well as the complete questionnaire applied to governmental organizations, users and NGOs.

2. Institutional environment

This chapter presents an overview on both the formal and informal institutional environment from national to the Kebele[3] level. The formal institutional environment is preceded with a brief historical overview of Ethiopian politics during the last century as it helps readers to understand how they have influenced developments with respect to social and collective action, association of farmers, formal and informal natural resources property rights and users' use derived from local knowledge in resources management.

The analysis of the institutional environment is done in order to: (i) establish PES concordance with the overall regulatory framework of Ethiopia on water, land, forest and agriculture, (ii) understand which agents hold water property rights and if government institutions can bring support and monitor a PES scheme, based on the level of law implementation (iii) recognize ongoing watershed management plans in which a PES could be embedded in, and (iv) to identify collective action initiatives and the development of community institutions, in order to understand community's tendencies to cooperate in solving environmental problems.

2.1 Formal Rules

2.1.1 Review on Ethiopian forms of government

During the Ethiopia of Hailie Selaise I (1930- 1974), the agrarian economy of the country had strong feudalist characteristics. There existed two main land tenure systems (Cohen, 1974): communal land holdings in the north and private land holdings in the south. The north was historically the mainstay of the Empire and the south was a conquest area since the last century. Agricultural land was mainly in the hands of a small minority, a large number of the rural population was tenant farmer who paid one-third to one-half of their crop production to the land lord depending on land pressure and land fertility.

Early 1974, Mengistu's revolution overthrew Haile Selassie and replaced the "very backward, archaic and feudalist system" (BBC News, 1998 Mengistu defends 'Red Terror'). From then on Lieutenant Colonel Mengistu Haile Mariam and the Dergue – the shadowy ruling body of the revolutionary regime- imposed socialism as the so long waited "solution" for the Ethiopian

[3] Define as the smallest administrative in unit in Ethiopia.

economy and its people's livelihood. Under this system, the Dergue called for the need full scale "villagization' (Scott, 1998), which meant the resettlement of all 33 million rural Ethiopians. Mengistu justifications for this was, that "The scattered and hapzard habitation and livelihood of Ethiopian peasants cannot build socialism insofar as efforts are dispersed and livelihood is individual, the results are only hand–to-mouth production amounting to fruitless struggle and drudgery, which cannot build a prosperous society". Other reasons for villagization were that concentration of the population in villages would bring services to scattered populations, and that it allowed state-designed social production (through producer cooperatives), mechanization, political education and enhancement of state control. (Kebbede, 1992; In: Scott, 1998).

Mengistu understood the idea of "modern" as the villagization process, and a precondition for socialism. When referring to pastoralist communities, he argued that the image of the nation was "a symbol of backwardness and a valley of ignorance to others, thus, he called on Ethiopians to "rally together to free farming from the ugly forces of nature". Finally he condemned pastoralism per se, praising villagization as a way "to rehabilitate our nomad society" (Kebbede, 1992 in Scott, 1998).

The massive resettlement erased a precious legacy of local agricultural and pastoral knowledge. Resettlements were far more than a change in scenery. It took people from a setting in which they had skills and resources to produce many of their basic needs and hence to be self-sufficient and transferred them to a setting where these skills were of little or no value. Thus, peasant with location-specific natural resource's knowledge turned into an unskilled, ignorant labourer, completely dependent for his survival on the central government (Scott, 1998). Consequently, ethnic groups were mixed and social networks were dismantled, hindering collective management of natural resources.

The military government endorsed the famous Rural Lands Proclamation on March 4, 1975, abolishing the anachronistic tenure system by nationalizing all rural land and redistribute it to the peasants. The proclamation prohibited any title to private tenure. The sale, exchange, mortgaging, leasing and bequeathing of land was also prohibited. The proclamation has also stipulated the formation of Peasant Associations (Kebeles) with a minimum of 800 ha, which became the lowest local administrative level in rural Ethiopia. Peasant Associations were also envisaged to play a greater role in the transformation of peasant agriculture (Getachew, 2006).

Implementation of these policies combined with other policies caused widespread destruction of natural resources and production almost stagnated in the face of a growing population

(Bezuayehu et al., 2002). These developments and the severe drought in the early 1980's are closely associated with the famines to which international aid responded.

Meles' overthrew the Mengistu regime in 1991 which was the end of the "Red Terror". The new regime started a decentralization process, through establishment of the new Constitution which gave regions the quality of autonomous federations within one state (Stiglitz, 2007).

2.1.2 The Ethiopian Federal Constitution

The constitution of 1995 establishes a federal and democratic state structure. Accordingly, the Ethiopian State is called the Federal Democratic Republic of Ethiopia. In this way, Article 47 stipulates the ten Member States of the Federal Democratic Republic of Ethiopia, including Oromia, and the region of Southern Nations, Nationalities and Peoples (SNNP), which are in the study area.

Article 52 describes the powers and functions of the states, the most important ones related to the topic of this study are to: (i) enact and execute the state constitution and other laws; (ii) formulate and execute economic, social and development policies, strategies and plans of the State; and, (iii) administer land and other natural resources in accordance with federal laws.

The right to development is also addressed in Article 43, mentioning: (i) that every Ethiopian has the right to improved living standards and to sustainable development, (ii) the right of consultation with respect to policies and projects affecting their community, (iii) all international agreements should aim for sustainable development, etc.

The right to have a clean and healthy environment is stated in Article 44. All persons who have been displaced or whose livelihoods have been adversely affected as a result of State programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate State assistance (Halcrow et al., 2007).

2.1.3 The federal level

According to the Constitution (Art. 45), the form of government of the Federal Democratic Republic of Ethiopia is parliamentarian. Moreover, according to Article 50, the federal government and the States have legislative, executive and judicial powers.

The supreme power of the Federal Government resides in the Council of Peoples' representatives. Additionally, the supreme power of states resides in the State Parliament.

2.1.4 The regional level

According to Art 50, the states are organized at the state and Woreda level. State Parliament, may, while organizing its administration, include other administrative hierarchies. This is the case of the Kebeles (or Peasant Associations), which can be understood as the lowest administrative level.

The State Parliament is the legislature of the State with regard to matters falling within its powers. It is also in charge of preparing, adopting or amending the Constitution of the State. At the same time the Government of the State is the highest executive organ of the State and the judicial powers of states reside in the courts.

The regional administration has various sector bureaus to develop regional policies and strategies and to implement regional programs, development projects, etc. Various economic sectors are administered by designated bureaus, broadly replicated at the federal ministries. These are comprised of agriculture, health, water resources, planning and economic development, mines and energy, transport and communications, works and urban development, trade and industry, tourism (though not designated as a bureau) and others (Halcrow et al., 2007).

2.1.5 Zone, woreda and kebele levels

The administrative levels below the region are: Zones, special Woredas, Woredas (Figure 1) and Kebeles. The study area comprises two regional states, i.e. Oromia and SNNP. The zones in the study area in the Oromia region are Arsi (Ziway Gugda, Tiyo, Digelo and Tijo, and Munessa

Woredas) and East Shewa (ATJK and Dugda Woredas), and SNNPR with Guraghe (Sodo, Meskana and Mareko Woredas).

A Woreda is the highest local administrative unit. The Woreda government consists of a democratically elected council, a cabinet elected from council members, and sectoral offices which serve as implementing agencies and contact points with local communities. There are cabinet positions for selected sectoral public offices. The sectoral offices are accountable to the cabinet members. More decision-making power has been given to Woredas in recent years, with the aim of: (i) Enhancing people's participation in local development planning and implementation, (ii) strengthening service delivery through capacity building, and (iii) ensuring that development activities are focused on specific priorities and requirements of local communities.

Below the Woreda level, communities are further subdivided into smaller electoral units, known as Kebeles which are subdivided into community groups, to enhance community participation in the planning and implementation of development programs (Halcrow et al., 2007).

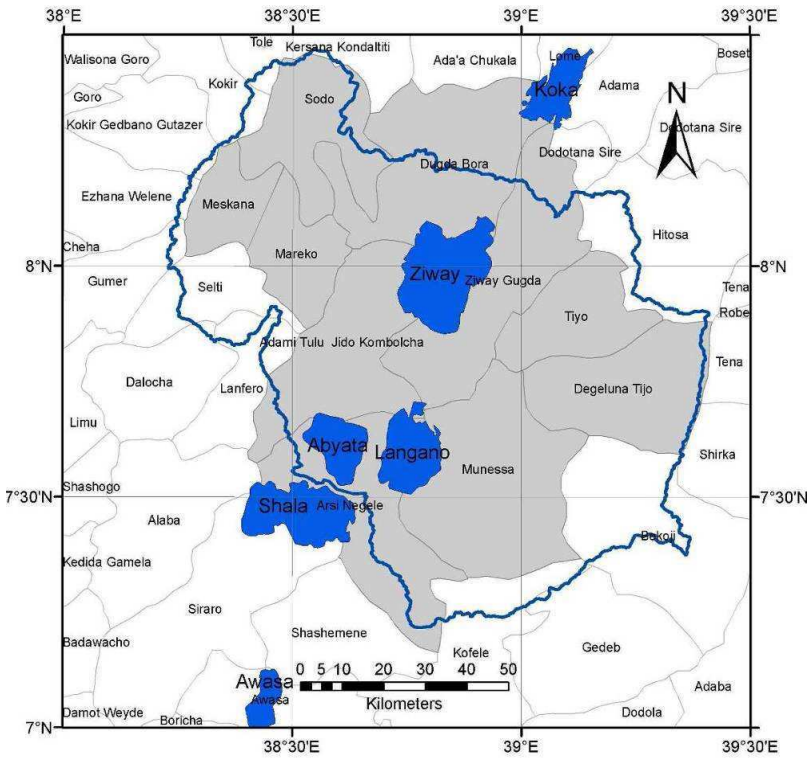

Figure 2. *Map of Woredas in the Central Rift Valley*

2.1.6 Water sector government agencies

The most important governmental water sector agencies are established at the federal and regional levels.

These agencies at the federal level include:

- The Ministry of Water Resources (MoWR) established in 1995, responsible for the development, planning and management of water resources, development of polices, strategies and programs, development and implementation of water laws and regulations, conducting studies and research activities, provision of technical support to regional water bureaus and offices and international agreements.

- The Ministry of Agriculture and Rural Development (MoA), in charge of water management (irrigation extension), including water harvesting for smallholder irrigated and rain fed agriculture (FAO, 2007).

- The Environmental Protection Authority (EPA), responsible for the development of enabling policy and regulatory frameworks and the preparation and implementation of proactive environmental management systems; as well as for enforcement and compliance mechanisms, among others.

The most important regional agencies involved in the water sector include:

- The Oromia Water Resource Bureau (OWRB): with similar responsibilities and duties as the MoWR at the regional level.

- The Oromia Irrigation Development Authority, which has been merged recently to the OWRB.

- The Oromia Environmental Protection Office: with similar responsibilities and duties as the EPA

2.1.7 Agricultural policies

Agricultural Development Led Industrialization (ADLI) is one of the government's core policies for rural development as well as overall economic growth. The policy presumes that extensive agricultural development in the country could serve as an instrument for economic diversification and industrialization. Initially, ADLI was expected to be the key to economic development, but its role in the economy has diminished and it increasingly became the subject of debate among the professional and academic communities. There is criticism on how it is implemented, namely with insufficient emphasis on the improvement of agricultural productivity and the quality of agricultural outputs. Many experts also say that there is a need for a major structural change of the agricultural sector before a policy such as ADLI can work (Halcrow et al., 2007).

The Rural Development Policy: A strong, free market economy is raised in this policy, with the expectation that it will benefit the people, liberate Ethiopia from being dependent on aid, and guarantee rapid economic development. However, this policy is not clearly related to a strategy or activities (i.e. infrastructure, product marketing, etc.) required for reaching its aims. Because of the lack of capital, and the large labour force and sufficient land, rapid growth is expected to be attained through a development strategy which requires less capital and more human power and land. The following elements are emphasized in this policy: human labour extensive utilization approach, agricultural and rural development based on efficient utilization of existing land and compatible development with different agro-ecological zones.

Despite that some parts of this policy are incompatible with modern agriculture and seem to promote to maintain subsistence agriculture, it does not deal with the need to train farmers to improve their production systems. It also explicitly reiterates that all land belongs to the state. This remains a highly controversial subject in Ethiopia because the proposed improvements in agricultural productivity cannot happen without land ownership by the farmers (Halcrow et al., 2007).

Cooperatives Societies (No.147/1998): The institutionalization of cooperative societies comes as an initiative of generating economies of scale and thus improving the production conditions in Ethiopia. According to this proclamation, a cooperative society should be formed by individuals (of at least 10 persons) on a voluntary basis, and who have similar needs for creating savings and mutual assistance among themselves, by pooling their resources, knowledge and property.

There are many kinds of cooperative societies (agricultural, housing, industrial, savings and credit, etc). The most interesting parts of this proclamation are the creation of warranties to credit suppliers enabling cooperatives to access credit.

This proclamation states that every society must have its own by-laws containing among others: requirements necessary for membership of the society, rights and duties of the society, employment of workers and distribution of profits. The rules regarding management of natural resources are established in an informal way, and this may include water scheduling (Section 3.1.2).

Furthermore, the main management bodies of societies are defined in this law: a general assembly, an executive committee and a control committee. Under the executive committee there is a credit committee, an education committee and an arbitration committee. There are block leaders and each of the farmers groups under the control committee.

2.1.8 Environmental, water and land policies

A brief description of the main policy framework regarding environment, land and water is presented in this section. Additionally, a brief description of the implementation process and bottlenecks of each rule is presented based on the interviews conducted.

Environmental impact assessment proclamation (No. 299/2002): Environmental impact assessments (EIA) are used to predict and manage the environmental effects associated with activities as a result of its design, construction and operation. Moreover, the environmental impact assessment serves administrative transparency and accountability, it aims to involve the public and in particular communities, in the planning of and decision making on developments which may affect them and their environment.

It is also mentioned in this proclamation that without authorization from the Environmental Protection Authority or from the relevant regional environmental agency (i.e. Oromia Environmental Protection Office), no person shall commence implementation of any project that requires an environmental impact assessment.

Based on the interviews conducted to the Oromia Environmental Protection Office (OEPO) and on field verifications, the OEPO faces constraints in terms of:(i) implementing the rule, mainly

because a regional version of the proclamation is not yet available, (ii) low monitoring and reinforcing capacity due to lack of budget (i.e. few cars to cover the big region, also the main office of the OEPO is located in Addis Ababa).

In addition, the political priority of generating economic growth influences the licensing process for foreign investment enterprises. For example, some flower companies received an operation license through the Oromia Investment Office without carrying out any EIA.

Environmental pollution control proclamation (No. 300/2002): According to this proclamation, the EPA should define the pollution environmental standards for example of discharge of effluents into water bodies and sewage systems.

This proclamation clearly specifies the function of law enforcement in the EPA and the regional environmental agencies, in terms of taking administrative or legal measures against violations. However, very few environmental violations are prosecuted (Halcrow et al., 2007).

In this broad policy, the irrigation policy is introduced, stating the following objectives: (i) development and enhancement of small scale irrigated agriculture and grazing land for food self-sufficiency at the household level; (ii) development and enhancement of small-, medium- and large - scale irrigated agriculture for food security and food self–sufficiency and markets at national level including export earnings and to satisfy local agro-industrial demands; (iii) promotion of irrigation, planning and implementation on an economically viable, socially equitable, technically efficient, environmentally sound basis as well as development of sustainable, productive and affordable irrigation farms; (iv) promotion of water use efficiency, control of wastage, protection of irrigation structures and appropriate drainage systems, (v) ensuring that -small, medium and large scale- irrigation projects are identified and designed for implementation by the private sector and/or the Government.

This policy has achieved very little at the grass root level due to lack of implementation and monitoring, so water resources are an open-access resource with no excludability and high rivalry competitive consumption.

Forestry proclamation (No. 94/1994) determines the conservation, development, protection and utilization of forest resources. Although the proclamation recognizes three types of ownership of forest land -state forests, regional forests and private forests- and the responsibility of the state and regional governments to designate, demarcate and register state, regional and

protected forests. The lack of human capacity to do this and the lack in transparency of the process results in mistrust and uncertainty about property rights issues (Gatzweiler et al., 2007).

Fragmented jurisdiction, ownership and management, has led to weak accountability and administrative inefficiency. The forest protection measures are sporadic and inconsistent. Complications occur in enforcing legal and administrative measures. Illegal loggers and illegal settlers exploit these weak links to take over forests under different types of ownership (Gessesse, Kleman, 2006).

River basin councils and organization proclamation (No.534/2007) recognizes that economic development will claim more natural resources, especially over water. Establishment of river basins councils and authorities is one of the main instruments to implement integrated water resources management to address and manage these claims. Negotiated policy making opens up the possibility of participatory planning, which is increasingly important particularly for natural resources, as already highlighted in 1992 in Chapter 8 of Agenda 21 (UN, 1992).

The objective of the River Basin High Councils and Authorities is to promote and monitor water resources management in each area using the basin's water resources for the socioeconomic welfare of the people in an equitable and participatory manner, and without compromising the sustainability of the aquatic ecosystems. The Basin High Councils and Authorities are in charge of (i) providing policy guidance and planning to ensure coordination among stakeholders, (ii) preparation of the river basin plan, (iii) proposing to the government the rate of water charges to be paid by water users in the basin, (iv) examining and determining water allocation rules (in periods of water shortage and drought).

The Basin Authority (BA) will be the secretariat of the Basin High Councils and Authority (BHC) and is in charge of (i) proposing policy measures for integrated water resource management, (ii) monitoring the implementation and measure impacts of watershed management projects, (iii) preparing basin's plans, (iv) issuing permits regarding water use and water works in the basin, (v) collecting, compiling, analyzing and disseminating information regarding watershed management, (vi) giving advice and technical support to the BHC for allocation and use of water, and (vii) collecting water charges from users. The funding for the BA should come from the federal government and from the water charges to be collected.

Federal rural land administration proclamation (No. 89/1997) confirms the statement made in the Constitution about land as a common property and it poses strict restrictions on land sale or other means of land exchange. This restriction is conceived by the government primarily as a

preventive measure against possible massive peasant displacement and is a safety-net instrument for the majority of poor peasants (Bezuayehu et al., 2002). However, the tenure security may have an impact on the type and level of land investment and hence on land degradation (Bezuayehu et al., 2002). More specifically, the higher the security of tenure, the more land owners will invest to maintain or improve land quality. The Ethiopian Economic Association et al. (2002) showed that 76% of the surveyed population think that their claim on their existing holding will not last for more than five years. Furthermore, regarding land distributions, another indicator of land tenure insecurity, a significant majority (73%) thinks that there will be land redistribution in the future.

This proclamation also validates the power of regions to administer rural land through the Regional Councils, based on the criteria that all assignment on land holding rights should be done in an equal way either to peasant and nomads. However, according to Bezuayehu et al. (2002) the responses to allocation and land redistribution were different done by every regional government in form and time, resulting in a serious problem of landlessness in Oromia region.

Oromia Regional State Water Resources Management Regulation was still under development at the moment of reporting. Therefore, the information presented here is based on a draft version provided by the OWRB. Under this regulation the right to use water should be acquired by a permit granted by the Licensing Authority. The following water uses do not require a licence: (i) domestic purposes, non commercial livestock watering, (ii) traditional irrigation carried out by hand without involving major construction works on land not exceeding 2 ha; (iii) artisanal mining or traditional water driven flour mills; iv) cattle and other water abstractions, in standard quantities that are still to be established by the OWRB, (v) recreational fishing or fishing for home consumption; and (vi) storing or impounding run-off or water from any source for the purpose of irrigating vegetables, crops, fruits or for watering livestock only for home consumption, not for commercial purposes as well as water for pastoralists.

The licensed water users will be subject to a handling fee and an annual fee for the use of water and for discharge of treated waste water (“polluter pays principle”) into water bodies. Tariffs for drinking water supply would be charged as it has been done up-to-date, based on the cost recovery criteria. The criteria and way of estimating the charge per cubic meter according each type of use is still under development. The reason behind charging for water relates to the funding required to empower the local departments of the OWRB (i.e. irrigation department, etc).

The Licensing Authority will be in charge of regulating water abstraction in certain areas. This will provide, for example, options to control water abstraction from the Bulbula River upstream and therefore minimize negative externalities affecting downstream domestic water users.

The process of granting a water license is subject to an EIA, for example, for extracting water for beneficial use, discharging polluted water and for the construction of water works.

Community participation in decision-making on licensing is addressed in this regulation, through informing the relevant stakeholders/community on the submitted plans for water abstraction or waste discharge. Stakeholders/community will have the opportunity to express any objections (within 30 days) regarding the implementation of the project.

First, the Licensing Authority will consider: (i) negative effects that may result from the use of water, construction of water works and discharge of waste including the impact on the environment, (ii) existing legally recognized water uses; (iii) water that the applicant has already been permitted to use, (vi) alternative sources of water; and (vi) objections and comments, if any, made by any interested or affected persons, (v) the purpose of water use; (vi) timing and maximum amount of water abstraction; (vii) protection area status; (viii) public health interests (ix) the efficiency of water use; and (x) the type of abstracting and measuring instruments and equipment.

Protection of groundwater and surface water sources used for drinking water should be based on so-called 'Water Protection Areas (WPA)'. The strategy towards the constitution of these areas is not through an incentive system but through land disowning use rights of people living in this WPA to be established, with compensation to affected people. Considering the population growth, and the high pressure on land together with the low monitoring and low rule enforcement this seems as a difficult task. Since, under lack of monitoring from local authorities as land can be quickly reoccupied by illegal invaders (Murtinho et al., 2005).

The use restrictions established for this WPA include (i) the construction of pipelines for transporting oil, chemical products, etc.; (ii) the storage of any hazardous substances including, petrol, diesel, chemicals, pesticides, heavy metals, chlorinated hydrocarbons and fertilizers; (iii) the removal or clearance of ground cover of ground water aquifers; (iv) the discharge of waste or effluents; (v) mining, dredging or the reclamation of land; (vi) the alteration of existing land contours, including any grading or construction of roads or cultivation crops; (vii) clearing or harvesting, including the felling of trees or the drainage of wetlands; (viii) planting plants with

negative impact on the water resources; (ix) the construction of housing building, or commercial animal farming, and the like; and (x) the washing and maintenance of vehicles and equipment.

Oromia rural land use administration and use proclamation (No.56/2002): is a transfer of the federal mandate to the regions, and allows the Oromia government to allocate land, based on economic viability as well as to distribute land, taking into account land qualities or attributes, which should ensure some degree of equity and perhaps risk distribution on food production (Bezuayehu et al., 2002).

This proclamation states the right of residents aged eighteen and above, whose livelihood depends on agriculture and wants to also dedicate to agriculture to have the right to get rural land free of payment for a life long right to use land for agricultural purpose as well as to lease and while the right remains in effect, inherited it to his family members.

The proclamation also opens up the possibility for the government, NGOs and private agents to lease land from peasants with the following restrictions: (i) a peasant can lease up to half of the land under his holding, (ii) the duration of the contract is up to three years for those who apply traditional farming (mainly peasants) and fifteen years for the users of modern farming[4] technology.

Specifically, the proclamation determines the minimum farm plot size to be owned by a farmer on an area of 0.5 ha for cereals and 0.25 for perennial crops. For irrigated land, it sets a maximum of 0.5 ha per peasant.

Land distribution can only be done in irrigated land on traditional and modern schemes, exceeding the minimum size per capita, thus reducing the land risk tenure for rain-fed areas. Exchanges between rain fed and irrigable land are possible, but this proclamation does not establish the criteria or ratio for exchange between these two types of lands.

This proclamation also establishes the mandate for land use planning, including restriction of land use activities in protected areas and protection of forests. However, this land restriction has not yet been established.

[4] The term “modern” farming is defined as a technology based on fertilizers, improved seeds, herbicides and pesticides, mechanization, etc.

2.1.9 Review on the formal policy environment

Implementation as the Achilles' heel of the policies regarding water and environment in Ethiopia exposes water resources to open access pressures, with a lack of enforceable property rights allowing unrestricted depletion of the resource.

There is little coordination among decision makers at the federal and regional level regarding the establishment of water fees. For example, MoWR has prepared the River Basin Councils and Organization proclamation (No.534/2007) under which funds required for implementation and operation of River Basin Authorities and Organizations (RBOs) –a multi stake holder platform for the management of Basin- will be provided by respectively the federal government and user's water charges. However, the OWRB proposes, in the draft version the Oromia Regional State Water Resources Management Regulation, a water fee for water users. Hence, two organizations at federal and regional level are developing policy instruments that compete for the same funding sources.

Environmental protection and conservation objectives are missing or at least not explicit in the RBO and in the Oromia water resource management regulations. There are no funds to promote efficient use of water and watersheds protection is disregarded or left to the will of foreign aid. Instead, economic incentives for the private sector and low reinforcement of the few environmental regulations are a threat to sustainable economic development.

Under a scenario of non existent incentives for efficient water use and watershed protection, it is surprising to observe how the quest for economic development is disregarding environmental issues. Favourable economic incentives to private (mainly foreign) companies and farmers, under low reinforcement of and not compliance with environmental regulation, are a threat to needed sustainable economic development in the region.

3 Informal rules

Rules established by users of water resources are the outcome of a long-term interaction process between individuals (Ostrom, 1992). This section attempts to explain these rules based on a series of interviews with leaders and members of irrigation schemes, members of NGO's supporting community irrigation schemes, and elders of Kebeles around Lake Ziway and the Bulbula River in ATJK Kombolcha Woreda.

First, a brief history of irrigation in Ethiopia is presented as well as the livelihood characteristics of the users, to understand the way in which informal irrigation rules have evolved according to the goals of the people using water.

3.1.1 Introduction of pump irrigation

Irrigation was introduced by the Imperial Government of Ethiopia with the commercial irrigated sugar farms in the early 1950s (FAO, 2007) and by the Socialist government in order to boost food production and achieve food self-sufficiency (Kloos, 1991). The strategies were cooperative farms, large-scale rain-fed and irrigated agriculture on state farms (Kloos, 1991). The top-down approach included elements such as increased government control over agricultural production and marketing through the Agricultural Marketing Corporation's quotas[5], fixed crop prices and regulation of international trade and market places, low community participation in the decision-making and insecure land tenure. The latter being one strong disincentive for peasant involvement and production (Cohen, Isaksson, 1988; Franzel et al., 1989 In: Kloos, 1991).

The effect of such policies on the livelihoods of inhabitants of the study area is illustrated in Nippon Koei Co (2004) describing the case of the Komayu Safar Assembly in Bulbula. It describes how, after the severe droughts of 1976-1977 causing a great loss of humans and cattle, a government's commission recognized the opportunity to use the river for irrigation. In 1980, the Assembly of Komayu Safar elderly in Bulbula PA discussed the tragedy caused by the famine. In this meeting, elders suggested that they should seriously consider the advice of the commission, and this resulted in a change of their livelihood strategy from semi-pastoral to sedentary agriculture. This description fits the trend in irrigated area since 1973, showing a rapid increase in the area around Ziway, Ketar, Meki and Bulbula, but especially around Lake Ziway (Jansen et al., 2007). However, the poor economy and low investment by government and private farmers, unsatisfactory community participation in the operation of schemes, together with biophysical conditions constrained further irrigation development.

After the fall of the Derg regime, the draft water legislation finally approved in 1999 intended to regulate all forms of water use. The uncontrolled peasant irrigation development since 1984

[5] A quota system was imposed to extract marketed surplus from the peasants through the co-operatives (Bezuayehu et al. 2002).

was criticized by officials of the major governmental water development agencies. They warned for increased erosion as a result of the clearance of natural vegetation along rivers and lakes. As well as flooding, water logging and salinization as a result of poor drainage and water management and for a decrease in water availability for downstream users (WRDA, 1985 In: Kloos, 1991).

3.1.2 Irrigation rules

The identified rules can be classified into the following categories: administration and operation of the scheme, water property rights and land distribution. Most of the identified rules relate to the internal management of the scheme and none of the interviewed persons mention explicit rules for coordinating upstream and downstream water use. However, rules regarding coordination of water use with third parties on access to drinking water and on pastures close or in irrigated land were identified.

In general, all Water users associations (WUA) have an administration body which is the Board composed of chairman, secretary, treasurer, head of finance, inspector and pump operators. The Board of WUA committee meetings are held on a more or less regular schedule (i.e. every month or twice a year on average). Issues discussed during these meetings are, for example, on the crops to be cultivated, fuel and water distribution, payment for pump guard, fees for members that do not respect water scheduling or do not pay on time, credit availability, application of new members, etc.

Pump operators, guards and block leaders (leaders of each irrigation team) are nominated by the WUA board members, which have a relatively higher educational background than WUA members.

There are different fees for members: (i) an annual saving amount for pump replacement, this amount varies among WUAs because of member's capacity to pay. Some WUA do not charge this fee punctually, which results in conflicts when the pump brakes down and no funds are available for repair. (ii) A fee to cover the salary of the guard and pump operator: Generally, WUAs pay the guard and the pump operator on a monthly basis (sometimes the guard can also be the pump operator). Sometimes the WUA gives the guard/operator a plot of land to avoid the collection of member fees to pay him.

Payments for operation of the pump can be classified according to the type of energy source: diesel and/or electricity. The costs of electricity are lower than for diesel but availability of electricity is less certain. Electricity is charged on a use basis, i.e. pump hours are recorded in the operation log book by the pump operator. Fuel and oil are also charged on a use basis of use, i.e. some WUAs buy large quantities of fuel and every member pays to the pump operator at the moment of pumping. Other WUAs prefer that every member brings its own oil and fuel for the pump operation, in this way there are less disputes on payments by members to the WUA board.

The fee for the electricity payment of the pump is charged on use basis and it is covered by each of the members of the WUA. The number of hours are recorded in the operation log book, for which the pump operator is responsible.

Cleaning of the main irrigation canal is a responsibility of all WUA members and cleaning of the other canals is a task of those farmers with plots along these canals. The most common problem is that these maintenance operations are done at very irregular time intervals.

Water scheduling was identified as the only water distribution rule. This is done first among groups in a general assembly of the WUA, and the detailed scheduling is subsequently elaborated among members of each irrigation group, based on the crop's irrigation requirements.

In periods without water scarcity, rules are related to the usage of the pump rather than to water distribution per se. In water-stressed periods rules relate directly to water distribution, i.e. during water scarcity, priority on water distribution is given to those farmers who have been more involved in the maintenance works of the whole irrigation scheme.

The only rules identified that resemble a distribution on property rights existed between members of one WUA. The use of surface water sources not regulated and there are no restrictions imposed in accessing them, where as, hand-dug ponds and wells are regulated (Tache , Irwin, 2003).

The rules regarding land in pastoral communities relate to the reservation of irrigated land for access of cattle to water courses. It also relates to protected pasture areas; in other cases farmers keep a part of their land for grazing own cattle. In the case of protected communal grazing areas, the Kebele leaders decide on certain reserved areas for grass on communal lands, fees and penalties for trespassers. The collected funds are used to pay the guard and to cover the transport expenses of Kebele members when they have to meet with staff of the Woreda Agricultural Offices, conflict resolution, etc.

3.1.3 Pastoralist's rules

First, the rules, mainly developed by customary pastoralists groups such as the Borana, were studied and compared with those in the study area. The findings confirm that strict rules exist for the management of rangelands.

Migration patterns of pastoralists are based on a system with clear seasonal movements of herd. During the rainy season, young male members move with the big dry herds –the non lactating animals- to independent grazing land, located up to several hundred kilometres from the homestead. Pasture is abundant during the rainy season and the animals can survive on surface water. A few lactating animals supply the food for the herders. In the dry season the big herd moves back to the family's homestead. This allows land to rest until the next rainy season (Van Bodegraven, 2006).

The traditional pastoralist system of rangeland management is under pressure due to the high population pressure and land scarcity. The settlement of former pastoralists has contributed to year round grazing of these areas causing overgrazing and degradation of much of the rangelands.

3.1.4 Informal rules from the local governments agencies

The crisis during the drought of 2002-2003 contributed to other informal contingency rules, specifically for irrigation users and communities around the Bulbula River. In this period the water flow of the Bulbula River was interrupted because of water scarcity. Kebele authorities of down and middle stream parts of the Bulbula river met with the Woreda Agricultural Development Office (WADO) of Adami Tullu to discuss solutions to solve their water scarcity problems. In response to the needs of the community, the WADO posed a restriction on the private and community irrigation schemes in the upstream part of the Bulbula to pump water only during night time. This guaranteed that people requiring water for domestic use in middle and downstream Bulbula would have access to water during daytime. This restriction lasted until the next rainy period when the flow in Bulbula recovered.

4 Identification of environmental service users

The purpose of this chapter is to present information on the users of environmental services related to irrigation and urban domestic water users. For irrigated crop and fruit production service, the main sources of irrigation water are identified, together with hectares under irrigation, type of landholder, number of beneficiaries and overall water use for irrigation.

Information chains from local to national and *vice versa* regarding water resources are archaic and often little operational. Federal and regional levels are the decision-making bodies and the zone and Woreda levels are the implementation agencies of policies. Decision-making regarding the development of the water sector (especially irrigation) is often done based on incomplete and unreliable information. Hence, unrealistic assumptions about the carrying capacity of the environment in relation to the multiple water demands could result in a collapse of the entire socio-ecosystem. None of the irrigation agencies at the decision-making level, i.e. MoWR and OWRB at federal level, had data available on the irrigation sector for the area of study.

4.1 Irrigation

4.1.1 Areas per water source

Water sources for irrigation in the study area can be classified in the following categories: rivers, lakes, springs, and groundwater. There are three major sub-watersheds with irrigated agriculture, i.e. Meki, Ketar and Bulbula.

The Ketar watershed contains information on irrigated area from the rivers: Ketar, Boosha, Gonde, Kulumsa, Bilalo and Doosha in Tijo Woreda; Gusha, Girrisa, Haliila, Dhangalet, Boora, Gurracha and Xeemela in Digelo and Tiyo Woreda, as well as, Ketar, Tajii, Werga, Matana and Kersa in Munessa Woreda. The Meki watershed contains information on the irrigated area from the rivers in Dudga, Meskana and Mareko Woredas. Additionally, the Bulbula watershed contains ATJK info, including the info of the Kebeles belonging to Ziway Gugda in the riparian area of Bulbula River since recently they have been transferred to ATJK's jurisdiction.

Moreover, the category Groundwater contains information for irrigation schemes using water from this source in Dugda and Ziway Gugda woredas, since these were the only woredas which

report use of groundwater due to easy accessibility and good quality. Finally, information on irrigation based on springs is from Tijo Woreda.

Based on this information, the total irrigated area in the CRV is about 12,000 ha, i.e. in the Ketar watershed 3,338 ha, in the Meki watershed 1,315 ha, around Lake Ziway 3,782 ha, along the Bulbula River 468 ha, based on groundwater sources 3,072 ha and on springs 204 ha (Figure 1)

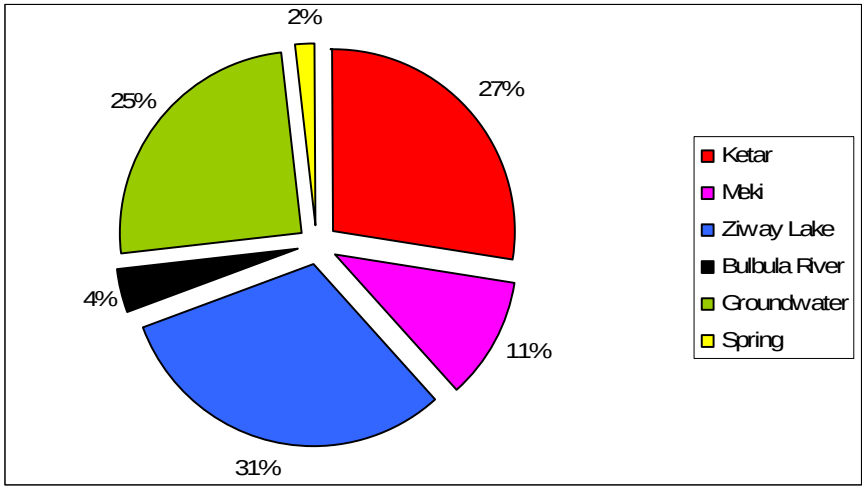

Figure 3. Distribution of irrigated area per water source

The numbers suggest a relatively small irrigated area in Meki, but this has to do with the fact that most of the schemes located in this area rely on groundwater, providing water to 25% of the irrigated area in the CRV.

Ketar watershed

Irrigation water users in the Ketar watershed rely on traditional and modern irrigation systems, respectively 70 and 30%. The formation of cooperatives is a relatively new form of organization in the CRV, but the percentage of land managed in cooperatives (28%) is the highest among the water sources (Figure 2). Water user associations are the predominant form of organization in the Ketar watershed (2,319 ha), private irrigation covers about 3%.

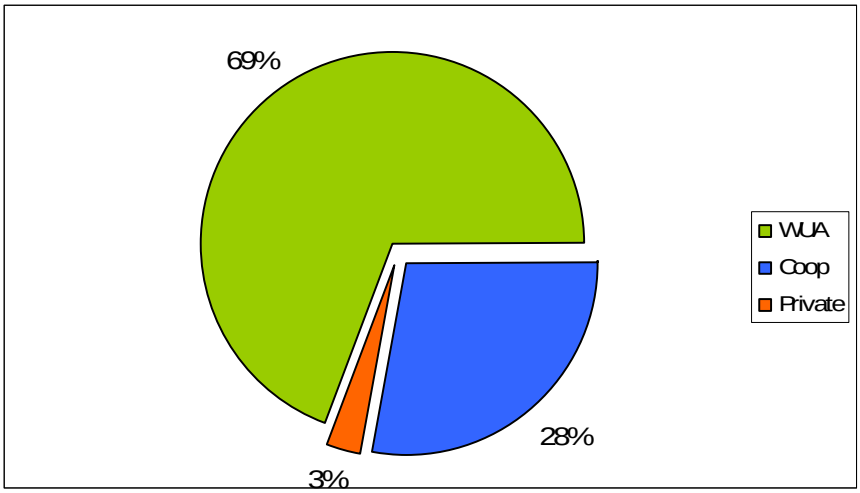

Figure 4. Irrigated area (ha) by user in Ketar watershed

Meki watershed

The areas under traditional and modern irrigation extracting water from the Meki watershed are respectively 59 and 41%. According to the data available, there are no cooperatives or private agents in this watershed; WUAs irrigate the total area of 1,315 ha.

Lake Ziway

Lake Ziway has the largest area under private irrigation (1,999 ha). The irrigated area of WUAs is 1,150 ha and of Cooperatives 633 ha. Modern irrigation is predominant with 71% of the total irrigated area (Figure 3).

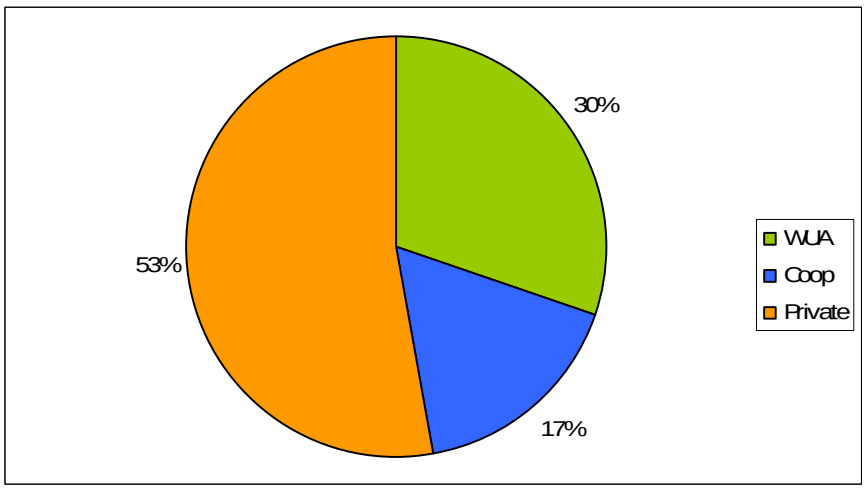

Figure 5. Irrigated area (%) by user in Lake Ziway

Bulbula River

The Bulbula River has the highest share of irrigated land managed by private investors. Community irrigation schemes under Cooperatives and WUAs have a total of 119 ha (Figure 4.). All irrigated land along the Bulbula River is under modern systems.

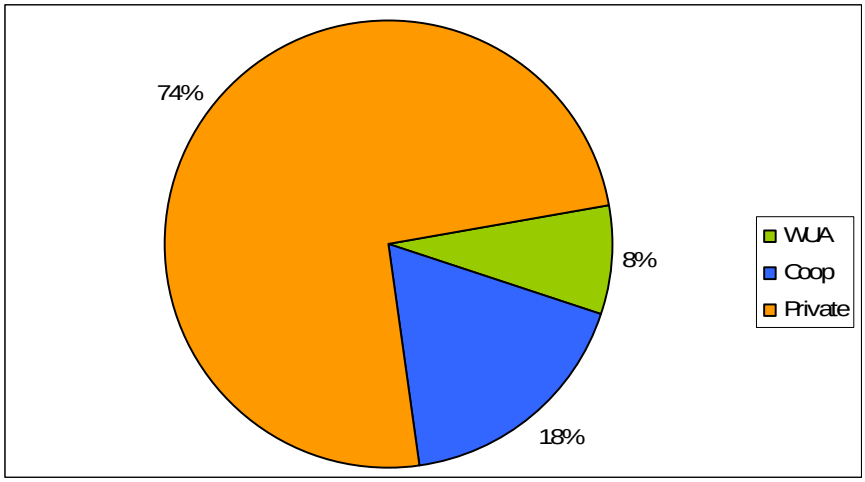

Figure 6. Irrigated area (%) by user in the Bulbula watershed

Groundwater

All groundwater users are located in the Woredas of Dugda and Ziway Gugda and mainly organized in WUAs, i.e. 2,700 ha out of 3,072 ha (Figure 5). Modern and traditional irrigation cover respectively 84 and 16% of the total irrigated area.

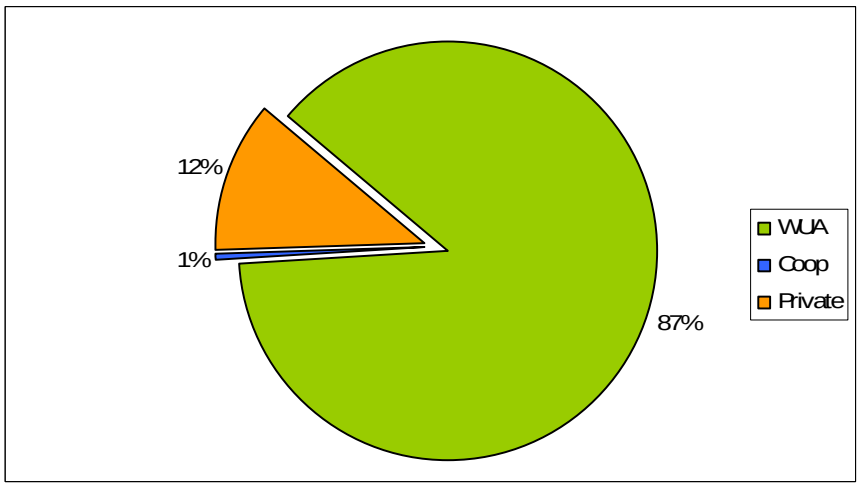

Figure 7. Irrigated area (%) by users depending on groundwater

Springs

The irrigated area based on springs is entirely in Tijo Woreda. WUAs manage 128 ha, while Cooperatives 76 ha. Modern and traditional irrigation systems are respectively 63 and 37% of the total irrigated area.

4.1.2 Irrigation water abstraction

The calculation of the overall water abstraction for irrigation schemes in the CRV is based on Jansen et al. (2007).

Two types of irrigated systems are in the study area, i.e. open and closed. It is assumed that the only closed production system is the flower company in ATJK, the rest of the schemes are open irrigated production systems.

Another assumption is that there are two cropping seasons in open irrigation production systems, the first season starts in the beginning of the rainy season and lasts from early June until September. The second season begins in January when rainfall increases each month until the rainy season (Scholten, 2006). Furthermore, it is assumed that the net rainfall contributes 350 mm of water for crops grown in the first season (wet season).

For open irrigated production systems, the following assumption is made with respect to consumptive water use and losses: crop water requirements (evapotranspiration –ETP) are on average 500 mm per crop (Table 18 In: Jansen et al. (2007)). Hence, total ETP of two crops is 1,000 mm, of which 350 mm is provided by rainfall. Net ETP covered by irrigation water should be 650 mm which is applied with an efficiency of 40%. This means that water extraction for irrigation is 16,250 m^3/ha per year.

In the closed irrigated production systems (500 ha), the gross annual water use in the production of roses is 20,000 m^3/ha (Jansen et al., 2007). Rainfall intercepted by the greenhouse canopies is discharged to Lake Ziway and, therefore, can be subtracted from the gross water use. The assumption here is that the same amount as rainfall provides to open field irrigation systems, i.e. 350 mm per year. Therefore, net annual water use is 16,500 m^3/ha.

Using the annual water use per hectare in open field and closed irrigation system times the total area under each irrigation system, the total annual water abstraction for open irrigated

production systems can be estimated at 192 M (Million) m^3 (i.e. 96% of the total irrigation water abstraction) and for closed irrigation systems at 8 M m^3 (i.e. 4% of total irrigation abstraction, a percentage that seems quite big if one compares areas of open and close field irrigation schemes). Thus, the total water abstraction for irrigation is estimated at about 200 M m^3/year.

4.2 Urban water supply

4.2.1 Water supply coverage in urban centres

Water supply services in Ethiopia are among the lowest in Africa. Urban water supply infrastructure is mostly a field of the government, while NGOs support more the development of rural water supply infrastructure (Rahmato, 1999).

According to MWR (1996; In: Rahmato, 1999), 19% of the rural and 80% of the urban population have access to safe water, which is 26% of the total population. The high urban water supply is mainly due to the inclusion of Addis Ababa in these figures. If Addis Ababa is excluded the average urban water supply coverage drops to 31% according to an unpublished report of Ernst and Young.

In the study area, the percentage of urban population with access to urban water services is 79% out of 279,699 inhabitants, corresponding with the figure of Rahmato (1999). The largest urban centres in the study area are: Asella, Meki-Alamtena, Ziway-Adami Tullu and Butajira (Figure 6).

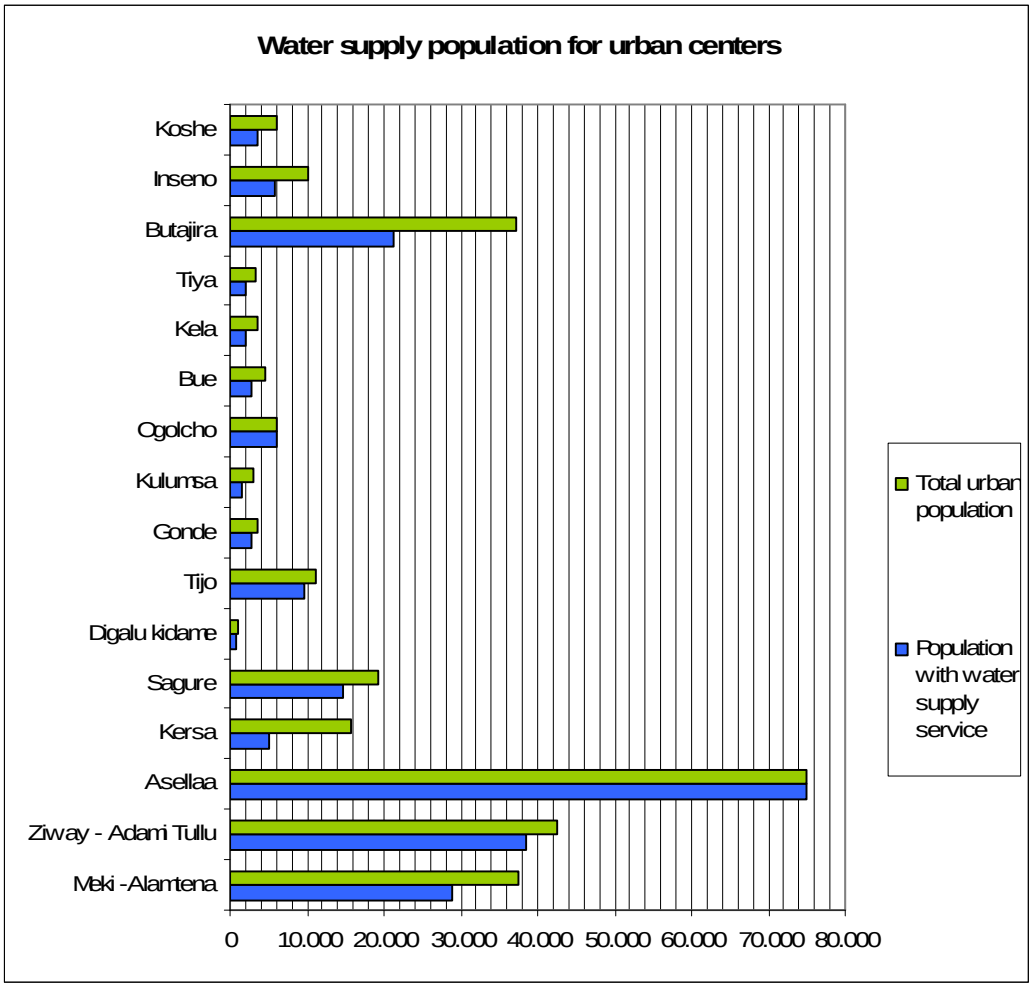

Figure 8. Population with water supply services in urban centers of the study area

Asella in the Arsi Zone extracts water from a spring and the Ashebela River. Kersa, Digalu Kidane, Tijo, Gonde use water from springs near these towns. Kulumsa extracts water from a spring and a dam, while Ogolcho from a nearby borehole. Ziway and Adam Tullu in the East Shewa extract water from Lake Ziway. Meki and Alam tena extract water from boreholes and a river.

4.2.2 Water consumption in urban centres

Based on the figures on population and water coverage, the calculation of total annual water consumption is done in this part. The average domestic water use in Ethiopia of 13.3 l/day (Jansen et al., 2007) –in contrast to the world average of 125 l/day- is used for the towns with no

information on total consumption (See Table 1). For the towns of Asella, Kersa, Sagure, Gonde and Ogolcho, this figure was calculated based on the data provided by the Arsi Water Supply Office.

Table 1. Total domestic water consumption in urban centers.

Urban Centre	Total consumption[6] (m3/year)	Consumption lt/day/person
Meki -Alamtena	140,130	13.3
Ziway- Adami Tullu	186,218	13.3
Asellaa	360,818	13.2
Kersa	28,655	15.4
Sagure	64,848	12
Digalu kidame	3,228	13.3
Tijo	46,409	13.3
Gonde	33,840	32.9
Kulumsa	7,379	13.3
Ogolcho	14,544	6.6
Bue	13,180	13.3
Kela	10,031	13.3
Tiya	9,796	13.3
Butajira	102,832	13.3
Inseno	27,953	13.3
Koshe	16,818	13.3
Total	1,066,680	

The national estimate of water consumed per person per day (13 litres) is similar to estimates made with the data provided by the Arsi Water Supply Office, except for Gonde and Ogolcho. Based on these data, the total urban water supply in the CRV is estimated at about 1 M m3 per year. The distribution of urban water supply in the CRV is shown in Figure 7.

[6] Total water consumption is obtained by multiplying the consumption lt/day/person times the total number of inhabitants times 365.

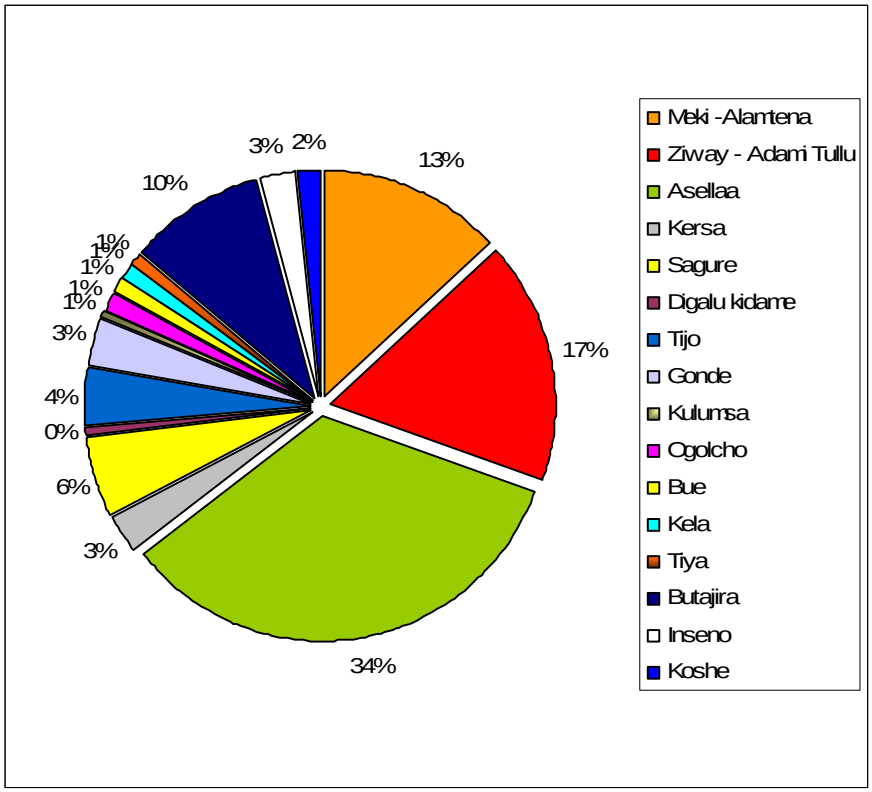

Figure 9. Distribution (%) of water supply over urban centers in the CRV

5 Preconditions for Payment for Environmental Services scheme

This chapter presents the results of the analysis of existing preconditions for a PES scheme in the CRV. Five conditions have been identified which are presented in the following five sections: coherence with regulatory framework, need and urgency related to environmental service, support and governance, identification of suppliers and beneficiaries and an analysis of opportunity costs and WTP.

5.1 Environmental service problem awareness, perceptual causes and coping strategies

The level of awareness for irrigation water users and urban water users vary broadly per location and per water source. Table 2 presents the results of the survey on problem awareness among stakeholders. Also the level of awareness of NGOs and government organizations (GO) working with irrigation and urban water are included. In general, problems (marked with an "X") related to the availability of water for irrigation were expressed by irrigation service users, whereas water quality problems mainly by urban water supply users.

In the Meki watershed, the problem of water scarcity was always mentioned, specifically in the lowlands. According to the users, the erratic rainy season and competition among water users along the Meki River are the main reasons for water scarcity. The problem of sedimentation and siltation was mentioned by members of community irrigation schemes in the North West of Lake Ziway.

In the Ketar watershed, water scarcity was not addressed frequently by the irrigation-related governmental agencies, only for some irrigation schemes closely located to each other, suggesting competition for water (Dugda and Digelo Tijo Woredas).

Table 2. User's awareness of a problem with the environmental service

	Irrigation users			Urban water users
Location	**Users**	**GO**	**NGO**	**GO**
	Water quantity	**Water quantity**	**Water quantity**	**Water quality**
Meki	X	X	X	
Ketar	X	X	X	
Lake Ziway				X
Bulbula River	X	X	X	X
Springs				
Groundwater		X	X	X

The situation in Lake Ziway is somewhat different since the lake acts as a buffer. Although most of the users of irrigation water recognized the seasonal change in the lake's water level, it does not affect their irrigation activities. Most interviewed users associate the decrease mainly with erratic rainy seasons and, to a lesser extent, to many irrigation schemes located in Meki and Ketar. The possible effect of upstream land use in the Meki and Ketar watershed and the salinization risk in Lake Ziway were only mentioned by the NGOs that work around the lake.

Regarding urban water supply, water pollution was mentioned by users in Ziway town, which abstracts water from the lake to supply its urban population. Inputs (fertilizers and biocides) used in various irrigation schemes upstream, along the lake and the nearby greenhouses, increase the risk of water pollution (Jansen et al., 2007).

Along the Bulbula River, water scarcity (mainly in the dry season) is a problem for the rural communities that depend on it for their domestic activities as well as for watering their cattle (Ayenew, 2007). This is a fact that exemplifies how different uses of water compete to an extent that they can become excludable to each other (section 3.1.4).

The development of irrigation close to Lake Ziway is a response to the uncertainty in constant provision of water further away along the Bulbula River. NGOs do not want to invest in pumps that will be useless in the future due to water scarcity. For farmers this is difficult to accept because in their opinion, much fresh water, which can be used to irrigate crops and improve their livelihoods, goes unutilized to the salty Lake Abijata. For people living close to Lake Abijata and the Bulbula River, the problem of water scarcity is associated with the flower and horticulture farms located along the Bulbula River.

For users of groundwater for irrigation, water scarcity was not directly mentioned although some users of irrigations schemes perceived a decreasing water level but this was not affecting their irrigation activities since they can still fulfil their water demand. Water supply offices and some NGOs indicated that groundwater levels have dropped recently but that they still do not pose a real problem for urban water supply. However, proper management is needed to avoid future problems.

Users have developed a range of strategies coping with water scarcity. Farmers on irrigated land tend to have a rain-fed plot for producing staple products for home consumption like maize, teff, haricot bean, and sorghum. Another risk minimizing strategy is to own livestock, as they can be sold in periods of cash shortages, for example, due to crop failure. Domestic water users along the Bulbula River dig holes in the bedding of the river to get water during periods of

drought. The alternative is to walk (1 to 5 hours depending on location) to Lake Ziway or to the fresh water springs north of Lake Langano.

5.2 Support and governance

To implement a PES, a robust and competent institutional structure is required. Both the development of the River Basin Organizations (RBO) for the Rift Valley Lakes Basin and the Rift Valley Lakes Basin Integrated Resources Development Master Plan Study Project – which is now in the first of three development phases-, offer great opportunities to design and implement a PES or any other incentive for sustainable use of land, forest and water resources. Monitoring and enforcement capacity of the regulation and PES agreements can be part of the responsibilities of the RBO, in close coordination with OEPO (i.e. water quality) and OWRB (i.e. water quantity). In order to make this work it is necessary to improve the presence of the OWRB authorities at the local level.

The result of the revision on the water institutional environment showed (section 2) that there are no clear incentives for users with regard to the protection of water or environment. The low level of implementation of water and environment law showed that water is a common access resource and that currently, no institution exists that can support the governance of a PES.

5.3 Environmental service users and providers

The current land tenure system in Ethiopia does not award providers of environmental services for land and forest conservation. Hence farmers are driven to maximize benefits from land exploitation in the short-term resulting in land degradation and thus posing negative externalities on downstream environmental service users. On the other hand, even private property of land may generate negative externalities to downstream users. However, the rate of degradation tends to be lower under secure private or communal property rights than under insecure property rights (Deininger et al., 2004). Additionally, insecure land tenure rights can reduce the willingness of beneficiaries to participate, since usually payments only show returns in the medium to long term. Payments do, however, provide a direct incentive to the service suppliers, since it should at least cover the opportunity costs of reserving land the provision of the environmental services.

Willingness to pay

Although this study was not specifically set up to estimate a Willingness to Pay (WTP) for irrigation environmental services, farmers were asked whether they would be willing to pay a fee for having access to irrigation water. From a total sample of 60 members of four irrigation schemes in ATJK, Dugda and Ziway Gugda, 25% of the farmers argued that water is a gift from nature and, therefore the idea of paying a fee was rejected. The rest argued that they already pay pumping costs and thus indirectly pay for the water. Other fees would decrease their benefits. Highland farmers in the CRV mainly use gravity irrigation while lowland farmers rely on pumps. Therefore, irrigation costs of lowland farmers are higher and thus the WTP could be lower than for highlanders.

Opportunity and transactions costs

Markets for watersheds services are usually local in scope with most transactions occurring at watershed level. These markets usually do not involve trading commodities such as water quantity or quality but rather financing land uses that generate watershed benefits (Pagiola, 2002).

The theoretical exercise of estimating conservation costs related to PES as a watershed protection instrument is based on two important assumptions. First, it is assumed that the area of upstream forests is positively related to a regular downstream water flow, i.e. more water is available for irrigation in the dry season (Gessesse and Kleman, 2007). They identified for the South of CRV how a less stable stream flow throughout the year is related to deforestation and increased use of stream water for irrigation purposes.

Secondly, for the sake of setting up a scenario related to a compensation scheme, it is assumed that the forested areas are in the hands of private agents (see section 2.1.8.). A fact in line with Gessesse, Kleman (2007) in which is shown how expansion of agriculture and in particularly smallholder farming contributes to over 80% of the forest area loss, either by clearings created by the intrusion of small farm plots, grazing lands and villages or expansion of agriculture from the exterior into the forests.

Despite many assumptions, it is useful to explore how a PES scheme could contribute to the conservation of the actual forested area in the CRV. The area with natural forest in the study area is 31,584 ha, i.e. 3.1% of the total area in the CRV (Jansen et al., 2007). Assuming that this forest area can be converted into agricultural land, the land rent is used as a proxy for the opportunity

costs of keeping this area forested (Murtinho et al., 2005). Information from the WADO of Digelo Tijo and Munessa indicates an average land rent of 1,600 Birr/ha/year, i.e. about 50 M Birr should be available to compensate land tenants to conserve these forests (Table 3).

For any market transaction it is necessary to identify an organization who wishes to inform people, designs the compensation scheme, conducts negotiations leading up to a bargain, draws up the contracts, monitors environmental changes and undertakes the inspection needed to make sure that the terms of the contract are observed, etc. (Coase, 1960). The problem is that these operations are often costly. A review of carbon sequestration schemes in various developing countries shows transactions costs varying from 6 to 45% (Cacho et al., 2005; In: Wunder, 2006). Using these values and the total opportunity costs, it is found that transaction costs of setting a compensation scheme, range between 3 and 23 M Birr. Hence, the total costs for this PES scheme would range between 53 and 73 M ha, corresponding with 0.6 and 1 % of the estimated regional gross domestic product of the Rift Valley Lakes Basin in 2005 estimated by Halcrow et al. (2007).

Table 3 Opportunity costs and transactions costs of conserving forested areas (Birr)

Opportunity costs of conserving forested areas	50,534,400
Opportunity costs plus transaction costs (45%)	73,274,880
Opportunity costs plus transaction costs (6%)	53,566,464

5.4 Identification of a suitable model for payment schemes

The development of this kind of private initiatives in the CRV seems highly unlikely to happen, since as shown before, opportunity costs and transactions costs of conservation are just too high for a group of private environmental service users to take.

Additionally, the establishment of a public system is also very unlikely since the Ethiopian state has a high fiscal deficit - 7.4 per cent of GDP in 2007 (AfDB/OECD, 2007), which in turn prioritizes investment in areas different from environment. The high cost of conservation is an obstacle for the development for a public model for a PES.

According to this, none of the suggested models in the literature really fit the Ethiopian reality, for the reasons mentioned before. An alternative model for a PES scheme is suggested here, a

combination of a private and public model. The recommendation for this kind of model is done on basis of the identified developing initiatives for watershed management in the CRV.

An interface between the RBO and the already established community institutions could also lower the transaction costs. As part of monitoring activities, could be partially transferred to users and providers, with the support of the RBO. In general, few data on transaction cost are available to determine if these claims are true, but intuitively they make sense. (Huang, Upadhyaya, 2007)

Presumably, one way transaction costs could be lowered is where payments are distributed to a Kebele rather than individual households, (Huang et al., 2007). Another way of reducing transactions costs is by incorporating environmental NGOs that serve as intermediaries. This will also help to recognize the important labour of these organizations in terms of creating environmental awareness and facilitating resource management in the area.

6. Analysis of power relations

The analysis of power relations is addressed by setting up a game theory exercise, which incorporates spatial location of irrigation schemes and costs of pumping from different water sources. Thus, by analyzing the social net benefits under a cooperative scenario and contrasting these benefits with the summation of private net benefits of each irrigation site under non cooperative scenarios, one can depict the inefficiencies related to water being an open access resource. Also, the analysis presented in this chapter, helps to understand the reasons for setting up a water market in the CRV

The scenario explained below resembles the one at the CRV, where irrigation sites located in Dugda Woreda, north west of Lake Ziway, have the possibility of having available more than one water source. The classification of upstream and downstream refers to the position of each irrigation site with respect to the other, since in reality these irrigation sites will be located in the lowlands of the CRV.

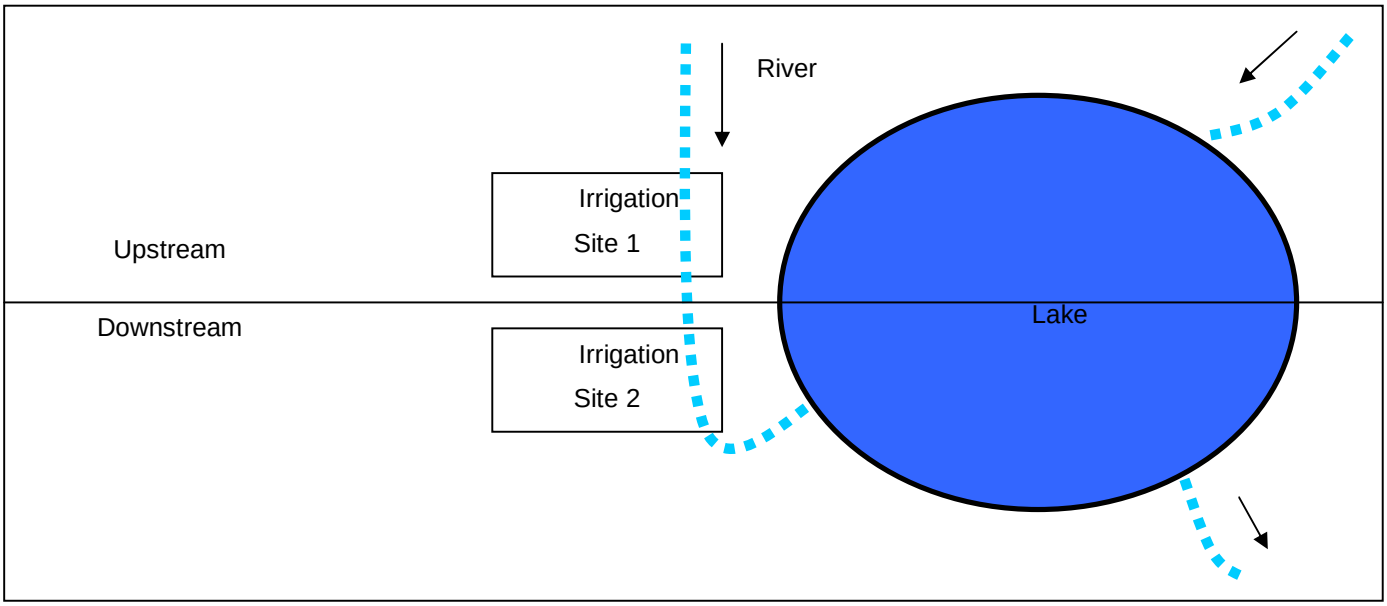

Figure 10. Description of the spatial setting of one upstream a downstream irrigation sites

There are two irrigation sites located one upstream and one downstream. These two irrigation sites have the same area and are cropping the same products, so in theory they both have the same water demand.

To specify the model, there are only two sources of water to irrigate for both sites. River water and lake water are perfect substitutes. These two sources have different levels of water supply or

capacity. The water supply from the river (R) is low, so the use of river water is restricted such that it cannot meet the total water demand from upstream ($i=1$) and downstream ($i=2$) irrigation sites at the same time:

$$\sum_{i=1,2} r_i \le R \le \sum_{i=1,2} \bar{w}_i \quad (1)$$

Where $\bar{w}_i$ is the demand from the river without capacity constraint. The water supply from the lake (L) is high, it can satisfy the maximum water demand ($\bar{w}_i$) of both irrigation sites at the same time. For each of the irrigation sites water use is either from river water (r_i) or from lake water (l_i) such that:

$$w_i = r_i + l_i \quad (2)$$

The costs of pumping water differ between lake and river. The pumping cost from the river is lower than the cost of pumping from the lake ($C_i^j, j = r, l$), for both irrigation schemes. The following equation describes the relations in costs for both irrigation sites and by source. It is assumed that costs are linear.

$$C_2^l(w_i) = C_2^l(w_i) \ge C_1^r \ge C_2^r \quad (3)$$

Regardless of the water source, irrigation costs are dependant on the quantity of water demand (w_i). So the higher each irrigation site demands water the higher it would be their cost:

$$C_i = c_i^r * r_i + c_i^l * l_i \quad (4)$$

Water is a productive resources and the agricultural yield (Qi) is a function of the water applied to the crop (w_i). The assumption that more water use gives to higher yield up to a certain point is made here.

$$Q_i = Q(w_i) \text{ with } \frac{\partial Q_i}{\partial w_i} > 0, \ \frac{\partial^2 Q_i}{\partial w_i^2} < 0 \quad (5)$$

The maximization problem of irrigation site 1 in a non cooperative strategy will have the following structure. I assume that that for both schemes costs of other inputs such as fertilizer, land and labour are already accounted for:

$$\underset{r_1, l_1}{Max} \prod_1 = P * Q_1(r_1 + l_1) - C_1^r * r_1 - C_1^l * l_1 \text{ s.t. } r_1 \leq R, \ 0 \leq l_1 \quad (6)$$

With (P) being the output price, this price is equal for both irrigation schemes. The restriction in (6) refers to the fact that water use from the river cannot exceed water supply. Using the Lagrange method to solve the maximization problem, we have:

$$\xi(r_1, l_1, \lambda) = P * Q_i(r_1 + l_1) - C_1^r * r_1 - C_1^l * l_1 - \lambda_1(R - r_1) - \lambda_2 l_1 \quad (7)$$

The first order conditions of this maximization are:

$$\frac{\partial \xi}{\partial r_1} = 0 = P * \frac{\partial Q}{\partial r_1} - C_1^r + \lambda_1 \quad (8)$$

$$\frac{\partial \xi}{\partial l_1} = 0 = P * \frac{\partial Q}{\partial l_1} - C_1^l - \lambda_2 \quad (9)$$

$$\frac{\partial \xi}{\partial \lambda_1} = 0 = R - r_1 \quad (10)$$

As defined later in (3) pumping from the river is cheaper than pumping from the lake. This means that if the second constrain is binding it means that water demand form the lake is zero, whereas if it's not binding then λ_2 is zero. This shows how in a non cooperative scenario irrigation site 1 will only pump from the river.

Figure 11 shows the water consumption from the river by irrigation site 1 in a non-cooperative scenario. The gross benefit of irrigations site upstream is B1.

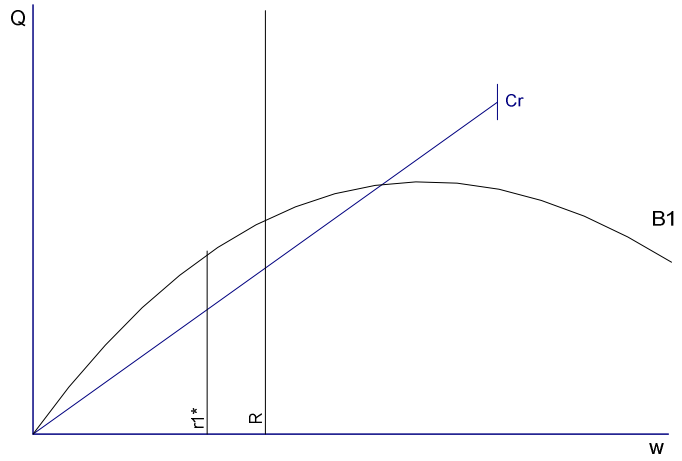

Figure 11. Water consumption irrigation site 1: non cooperative scenario

Additionally, the maximization problem of irrigation site 2 in a non cooperative strategy has the following structure:

$$\underset{r_2,l_2}{Max}\prod_2 = P*Q_2(r_2+l_2) - C_2^r * r_2 - C_2^l * l_2 \text{ s.t. } r_2 \le R - r_1 \quad (11)$$

Using the Lagrange method to solve this, we have:

$$\xi(r_2,l_2,\lambda) = P*Q_2(r_2+l_2) - C_2^r * r_2 - C_2^l * l_2 - \lambda(R - r_2 - r_1) \quad (12)$$

The first order conditions of this maximization are:

$$\frac{\partial \xi}{\partial r_2} = 0 = P*\frac{\partial Q}{\partial r_2} - C_2^r + \lambda \quad (13)$$

$$\frac{\partial \xi}{\partial l_2} = 0 = P*\frac{\partial Q}{\partial l_2} - C_2^l \quad (14)$$

$$\frac{\partial \xi}{\partial \lambda} = 0 = R - r_2 - r_1 \quad (15)$$

It is clear then, that the marginal cost of pumping from the river are equal to the marginal cost of pumping from the lake, plus a shadow value that reflects the availability of water from each source.

When analyzing graphically the problem for the irrigation site downstream, one can observe that the water consumption from the river is constrained by the capacity of the river minus the abstraction of the irrigation site upstream. Then irrigation site 2 will to use an amount of water where the marginal benefit is equal to the marginal cost, in order to be efficient.

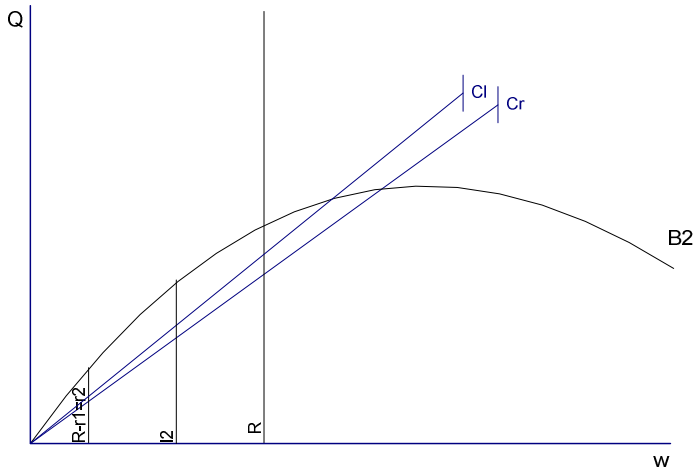

Figure 12. Water consumption irrigation site 2: non cooperative scenario

On the other hand, if there is cooperation among irrigation sites, the maximization of the social net benefits ($\prod_S$) will have the following form:

$$\underset{r_1,r_2,l_1,l_2}{Max} \prod_S = P*\left[Q_1(r_1+l_1)+Q_2(r_2+l_2)\right]-C_1^r(r_1)-C_2^r(r_2)-C_1^l(l_1)-C_2^l\ (l_2)$$

s.t $r_1+r_2 \le R$ (16)

Using the Lagrange method to solve the maximization problem, we have:

$$\xi(r_1,r_2,l_1,l_2,\lambda_1,\lambda_2) = P*\left[Q_1(r_1+l_1)+Q_2(r_2+l_2)\right]-C_1^r*r_1-C_2^r*r_2-C_1^l*l_1-C_2^l*l_2 - \lambda(R-r_1-r_2)$$

(17)

The first order conditions are:

$$\frac{d\xi}{\partial r_1} = 0 = P * \frac{\partial Q_1}{\partial r_1} - C_1^r + \lambda \quad (18)$$

$$\frac{d\xi}{\partial r_2} = 0 = P * \frac{\partial Q_2}{\partial r_2} - C_2^r + \lambda \quad (19)$$

$$\frac{d\xi}{\partial l_1} = 0 = P * \frac{\partial Q_1}{\partial l_1} - C_1^l \quad (20)$$

$$\frac{d\xi}{\partial l_2} = 0 = P * \frac{\partial Q_2}{\partial l_2} - C_2^l \quad (21)$$

$$\frac{d\xi}{\partial \lambda_1} = 0 = r_1 + r_2 - R \quad (22)$$

From the first order conditions it can be seen that marginal benefits minus marginal cost from using water from the river are equated for both irrigation sites, as well as for using water from the lake.

When both irrigation sites cooperate, the benefit for society is maximized instead of private benefits, so then irrigation site 1 will use mostly water from the lake, while irrigation site 2 will mostly use water from the river, and based on the costs difference between the two sites, the downstream site will use more river water from the river than the upstream site.

The overall benefits for society can be represented as ($\prod_{OS}$), the value of the benefits in a cooperative scenario minus the summation of private benefits of both irrigation sites under a non cooperative scenario.

$$\prod_{OS} = \prod_S - \prod_1 - \prod_2 \quad (23)$$

Finally, if irrigation site 2 has a higher productivity than irrigation site 1, there is an opportunity of introducing a water market –no transaction costs assumed-. So any initial allocation of water rights will lead trough trade of water between irrigations sites to an efficient allocation of water from the river and the lake.

7. Economic assessment of irrigated agriculture

Based on the economic indicators for the assessment of irrigated agriculture presented in Jansen et al. (2007), this section focuses on expanding the analysis of these indicators, as new information is available for small scale irrigations schemes in ATJK woreda. These indicators are water productivity, land productivity as defined by Jansen et al. (2007) and the ratio between net margin and labour costs.

The sample contains information of about 80 farmers with each 0.25 ha irrigated plots (Wendimu, 2008). Constant rates of returns are assumed here to compare this information with the preliminary indicator values of Jansen et al. (2007). Prices are “farm-gate” prices and costs relate to the costs of inputs, i.e. machinery, labour, seeds and fertilizers. The net margins of presented in Table 5 are used to calculate the information presented in Tables 6 and 7.

Irrigation water productivity is defined as the net income received by farmers per unit of irrigation water applied, expressed in Birr per m^3 of water. Table 5. shows 1 m^3 of water in cash crops (tomato, onion, and green beans) has a higher economic value than in crops for homestead consumption (maize). This is associated to differences in market prices. The yield data and economic value of water presented here are lower than those given in Jansen et al. (2007).

Land productivity defined as the net income received by farmers per unit of land, depends highly on prices (Jansen et al., 2007) as higher prices result in higher land productivities with given yields (Table 4). And these prices are set by the market and by the bargaining capacities of the farmers.

Table 4. Irrigation water and land productivity for various irrigated crops in the CRV

Product[7]	Yield (Kg/ha)	Price (Birr/Kg)	Land Productivity (Birr/ha)	Total production costs (Birr/ha)	Water applied (m3/ha)	Value of water (Birr/m3)
Onion	10,942	3.4 - 2.3	15,539 -27,425	9,064	14,450	1 - 1.8
Tomato	10,374	3 - 2.8	19,698- 21,774	9,093	17,100	1.2 - 1.3
Maize	3,897	1.85 – 2	3,073 - 3,615	3,931	11,800	0.2 - 0.3
Green bean	7,226	1.85 - 2	4,517 - 5,600	8,851	14,450	0.3 - 0.4
Tomato (State farm)	37,800	0.72 - 2.2	9,287 - 65,771	17,389	17,100	0.6 - 3.8
Maize hybrid seed (state farm)	6,000	2.55	7,071	8,229	11,800	0.6

Labour productivity is defined as the ration between net benefits and total labour costs for the production of certain crop. According to the data presented here, a birr spent in labour for the production of green beans represents fewer benefits than a birr spent in the production of maize (Table 5).

Table 5. Ratio of net benefits and labour costs for different irrigated crops in the CRV

Product[8]	Labour costs (Birr)	Labour productivity
Onion	1,883	4.3 – 7.6
Tomato	3,755	5.5 – 6.1
Maize	1,729	2 – 2.4
Green bean	4,476	1.1 – 1.4

[7] Information for tomato (state farm and Maize hybrid seed (state farm) based on Jansen et al., 2007 and for the rest of products from Wendimu., 2008.

[8] Idem

The comparison of water and land productivity and the ratio of net benefits and labour costs is only done here for open production systems, this is not compared with close production systems, since the technologies differ vastly.

Low economic performance by smallholders in terms of low yields relates partly to the development of new agricultural skills as well as to a farmer's restricted marketing power since they have few means to take the harvest to the markets. Here, small land farmers have to negotiate with intermediaries that generally pay less than the market prices.

8. Discussion

The assumed cause-effect relationship between forest and more stable stream flows has not been clearly established. However, Gessesse and Kleman (2007) give support to the assumption that more forest helps to stabilize water flow throughout the year, resulting in an increase flow during the dry season. However, this relationship is not necessarily true in tropical areas (Bruijnzeel et al., 2005; Bruijnzeel and Critchley, 1994; 1996). Thus, more research is required to identify land use types that regulate the-stream-flow of rivers over the year.

Climate change and its effect on erratic rainfalls should also be addressed, since this is a threatening factor for the provision of environmental services provided by watersheds.

Moreover, key ecosystems in the watershed should be identified in order to understand opportunity costs and transactions costs better, as well as the identification of users and providers of the environmental services.

A study on willingness to pay of highland and lowland irrigation users could contribute to a more diversified water fee system as the applied technology, i.e. pump and gravity, respectively, is a determinant for water demand. Also, the estimation of transaction costs should be studied more in-depth for the area.

The case of setting up a PES schemes at the micro watershed level was not studied here, but it is worthy to see if high conservation and transaction costs can be reduced at a lower scope level.

It is also necessary, in order to reduce pressure on forest resources for domestic use, to study the introduction of government's incentives related to security in land tenure for the establishment of landscape management tools i.e. living hedgerows, wind breaker barriers, dendro-energetic forests.

9. Conclusions and recommendations

Firstly, despite the existence of a clear formal institutional environment regarding water and environment, governmental rules are hardly, if at all, implemented at the local level. Therefore water resources in the CRV are under the threats of open access resources.

Secondly, the evolution of self-governance community institutions for agricultural water use in the CRV is still in an emerging state, due to the recent introduction of irrigation in the lowlands. So far, water rules have developed within irrigation schemes. Ad-hoc allocation rules among irrigated agriculture and other demands are only applied at times of severe scarcity.

Thirdly, the estimated irrigated area in the CRV is larger than the estimates by Jansen et al. (2007) and Halcrow et al. (2007). It is estimated here that the total irrigated area in the CRV at 12,000 ha, by water sources: Ketar (3,337ha), Meki (1,315 ha), Lake Ziway (3,782 ha), Bulbula River (467 ha), Groundwater (3,071 ha) and Spring (204 ha). The associated water extraction for irrigation is estimated at about 200 M m3/year. In contrast, the total demand by urban water users is 1 M m3/year, .

Planning based on incomplete information can on the one hand increase the competition for water – domestic, agricultural, cattle and ecosystem- and on the other hand generate perverse incentives for water resources use and management. Both aspects put pressure on ecosystems, which might have dramatic consequences, such as increased salinity of Lake Ziway(Jansen et al., 2007).

Under the high poverty levels in Ethiopia and specifically in the CRV incentives are provided for economic development and livelihood improvement through the exploitation of water resources. However, the natural resource base is limited, and this should be acknowledged by policy makers. For this reason it is necessary to identify the development potential of irrigated agriculture in relation to the carrying capacity of the natural resource base, in order to prevent a collapse of the whole socio-ecosystem.

Fourthly, the transition from feudalist to communist and to capitalist and the corresponding approaches towards land tenure and agricultural production in Ethiopia have influenced the *modus operandi* of farmers. There are no clear incentives to invest in land improvements, instead the current land tenure system stimulates the short term over-exploitation of land resources.

Fifthly, population growth puts a high pressure on available land resources. One of the consequences is that pastoralists are marginalised. Therefore, various pastoralists have become sedentary and some of them are engaged in irrigated agriculture often with public or private support. These former pastoralists have few agricultural skills and even less expertise on more knowledge-intensive irrigated agriculture. This is one of the reasons contributing to the poor economic performance of small-scale irrigated agriculture in the CRV.

Sixthly, the value of irrigation water depends on market product prices and yields. For small irrigated agriculture, low marketing capacities and bargaining power lead to lower prices received from middlemen.

Seventhly, the PES illustration assuming forest providing ecosystem services for the irrigation sector, showed that opportunity costs of land (value of land rent) to avoid conversion of forest in agricultural land requires financial resources in the order 1% of regional GDP. In addition, lack of institutions and low level of problem awareness by users suggest that the design of PES in the CRV may need more time. This conclusion together with the lack of incentive mechanisms for the sustainable land, forest and water management calls for other incentives such as differential land tax incentives to reduce land degradation (Kassahun, 2006) and environmental taxes which could be re-invested in watershed protection. Special attention is needed for how such policy instruments can be implemented ‘on the ground’. Furthermore, their effect on and interaction with existing policies requires careful consideration. So far, little, if any, attention is paid to required policy coherence. Better understanding is required of the conditions for successful institutional change aimed at sustainable development (Huang et al., 2007).

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Annex 1. Interviewed authorities

Organization	Contact person	Contact info
Abine Germana Irrigation site	Ato. Debebe (Seda)	Adami Tullu Jido Kombolcha 0912007285
Adami Tullu District Irrigation Office	Ato. Belda	0464412334
Arsi Investment Office	Ato. Amele Belte	0912091358
Bureau of agriculture SNNPR	Ato. Adane Kefele	0912060028
Central Statistical Agency	Ato Biratu Yigezu	0111564226
Elder Dasta Abiajata Kebele	Ato. Dase Hajiamhed	
Elder Arba Bulbula Kebele	Ato. Mokona Hassana	
Digelo Tijo District Irrigation Office	Ato. Abebe Yifa Fole	0912239734
Dugda District Irrigation Office	Ato. Girma Sileshi	
East Shewa Investment Office	Ato. Alemo Regassa	alemur@yahoo.com
Hellaku Irrigation site	Ato. Idris Haser (RCWDA)	Adami Tullu Jido Kombolcha 091134720767
Horn of Africa regional Environment. Programme (Meta Meta)	Mrs. Jasmina van Driel	0912007428
Intermon Oxfam	Mrs. Imma Guixe	0911364223
Ministry of water resources - Project coordinator of the RVLB Master plan	Ato. Asmamaw Yetemegne	
Munessa District Irrigation Office	Ato. Gamechew	02233370537
Oromia Environmental Protection Office	Ato. Ahmed Hussein	0911842155
Oromia Irrigation Development Agency	Ato. Abera Chala	0911984445
Oromia Water Resource Bureau	Ato. Lamesa Tarefa	0911442531
Oromia Water resource Bureau – Irrigation (Arsi Zone)	Ato. Tesfaye	0911703602
Oromia Water resource Bureau - Irrigation (East Shewa Zone)	Ato. Girma Negisse	0911353886
Oromia Water Resource Bureau – Watershed management	Ato. Tesfu Tasema	0911473151
Oromo Self Help Organization	Ato. Dedefo Tenesho	0916821173

Organization	Contact person	Contact info
Rift Valley Children and Women Development Association (RCWDA)	Ato. Tibebu Kogi Ato. Idris Haser	0911670273 0911347204
Selam Environmetal Development Association	Ato. Ibrahim Kasso Ato. Debebe	0912007285 0911347723
SNNPR Agriculture and Rural Dvelopment Bureau	Ato. Tesfaye Dubale	0911059486
Southern Nations, Nationalities, and People's Region Water Resource Bureau	Ato. Jemal	0462206364 0916580617
Tiyo District Irrigation Office	Ato. Belete Wolde	0911067565
Water Resource Office (Arsi Zone)	Ato. Getachew Abebe	0911750709
Water Supply and sanitation (East Shewa Zone)	Ato. Bacha Nigussie	0916820663
Ziway Gugda District Irrigation Office	Ato. Faye Alamu	0913521868

Annex 2. Questionnaire Government organizations

Name
Position
Office

A. Water demand

1. Does the government/authority perceive that there is water shortage in the CRV? Where?

2. Do you think that the CRV is much worse of than other areas in Ethiopia?

3. What are the plans/policy instruments of the Government to address water management in the CRV?

4. Does this ministry influences land use/ water use decisions of farmers (type of crop, timing, irrigation type, amount of water)? If yes how?

5. Does this ministry stimulate farmers to use less water? If yes, how?

6. What are the future plans concerning water use in the valley?

	Yes/no	**Specify**
Allocation of water		
Water pricing for agriculture		
Expansion of irrigated area (and where)		

7. What are the future plans concerning landuse in the valley

	Yes/no	**specify**
Types of crops to be grown		
Expansion of agricultural area		
Expansion forest area (and where reforestation)		
Export based		

B. Institutions responsibilities and decentralization

8. What are the plans to attract foreign investment? Will this increase and in what area of field?

9. What measurements/tools do this ministry has to control the flow of waste water into fresh bodies?

10. How this ministry does controls pollution waste water (flower companies)?

11. How well does water policy reflect water law?

12. How does the law reflect in real life?

13. If not so good, what are the main constraints and how can these be overtaken?

14. When referring to decentralization, does the existing division of government legal responsibility favor an integrated planning and management of water in the area (coordination)?

15. In your opinion, how integrated are water laws with other laws related to agriculture, forest, and environment?

16. What does this ministry see as major challenge for the CRV?

Annex 3. Questionnaire farmers

Smallholder irrigation-farmer Questionnaire

Date of interview:_____

Location:_____

Stakeholder_____

Name:

Activities: Agriculture__, Pastoralist_ Other sources of income

Nr of employees:

Size of plot:

Kebele:

1. Which are your main sources of water?

2. Do you have problems with the sources of water you are using now (awareness of less discharge and water table levels)?

3. Do you foresee problems with your sources of water within the coming 10 years?

4. Do you intend to change your source of water in the future?

Rules: Access to water

5. Are you a member of water user association? Cooperative? What is the importance of been a member?

6. Are there any rules/regulations from the government for using water?

7. Are there any rules/regulations from the peasant association/water user association community for using water?

8. Are there any rules/regulations for distributing water/grazing lands among pastoralists groups?

9. What are the coping mechanisms of people along the…….. at times when the river or resource falls dry?

Erosion and water problems

10. Do you see problems of sedimentation on your field (loss soil from other fields, yield loss)

11. What kind of measures have you taken to control soil loss from your field. If not why?

12. Do you have the intentions and the financial capacity to invest in controlling measures?

13. What do think the benefits from these (erosion) protection measures can be? (infiltration, less input needed)

14. Do you identify a water problem?

15. Which is the explanation for less water?

16. Water conflicts?

Annex 4. Ketar irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Shalad	Shelada	75	300	Modern	Ketar	Coop	ZG
Unshiti	Unshiti	65	138	Modern	Ketar	WUA	ZG
Sambaro	Sambaro	20	80	Traditional	Ketar	WUA	ZG
Hallo	Hallo	12	48	Traditional	Ketar	Coop	ZG
U/Baricha	U/Baricha	17	68	Traditional	Ketar	Coop	ZG
Oticha	Golbe	45	180	Modern	Ketar	Coop	ZG
Wajag trading		17	1	Modern	Ketar	Priv	ZG
Biruukitaayidt Dawit		7,5	1	Modern	Ketar	Priv	ZG
Waarda Abduula		50	1	Modern	Ketar	Priv	ZG
David Calo Makfira Haroom	Golbe	20	1	Modern	Ketar	Priv	ZG
Aratachufa	Arata	100	317	Modern	Chufa	Coop	ZG
Arat Geno	D/Rarat	20	91	Traditional	Chufa	WUA	ZG
Arat Dawo	Arata	8	48	Traditional	Chufa	WUA	ZG
Dodicha	Dodicha	69	162	Modern	Gotu	Coop	ZG
Golba Aluto	Golba Aluto	76	203	Traditional	Gotu	Coop	ZG
Hero Bilalo	Bilalo	6,75	23	Traditional	Bilalo River	WUA	Tiyo
Dugda Ukolo	Boshaa 2	62	191	Modern	Boosha River	Coop	Tiyo
Dosha	Dosha	6,3	32	Traditional	Doshaa River	WUA	Tiyo
Oda Daweta	Oda Daweta	29	43	Traditional	Gonde River	WUA	Tiyo
Katar Genet	Katar Genet	110	289	Modern	Katar River	Coop	Tiyo
Katar Genet	Katar Goijaa	204	415	Modern	Katar River	Coop	Tiyo
Hemsa Gasha	Katar Hemsa Gasha	154	370	Modern	Katar River	Coop	Tiyo

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Gora Silingo	Gora Silingo	9,3	16	Traditional	Kulumsa River	WUA	Tiyo
Tijo 1	Menkula Nagele	269	462	Traditional	Gusha River	WUA	Digelo
Tijo 2	Tite Waji	210	489	Traditional	Gusha River	WUA	Digelo
Tijo 3	Ansha Lekicha	120	369	Traditional	Haliila River	WUA	Digelo
Tijo 4	Sheldo Jigesa	96	299	Traditional	Dhangalet River	WUA	Digelo
Tijo 4	Bura Jale	15	142	Traditional	Xeemela Rivers	WUA	Digelo
Digalu 1	Digalu Arabi	200	278	Traditional	Gusha River	WUA	Digelo
Digalu 2	Digalu Kideme	75	459	Traditional	Gurracha River	WUA	Digelo
Digalu 3	Kubsa Bora	205	259	Traditional	Girrisa River	WUA	Digelo
Digalu 4	Digalu Bora	85	399	Traditional	Boora Rivers	WUA	Digelo
Digalu 5	Kogo Ashebeka	70	185	Traditional	Daanisa River	WUA	Digelo
Digalu 6	Jemo	25	190	Traditional	Daanisa River	WUA	Digelo
Sagure 1	Gusha Temela	55	139	Traditional	River	WUA	Digelo
Samera	Damu Dinbiba	20	52	Traditional	River Matana	WUA	Munessa
Tajii 1	Koma Jebo	25	27	Traditional	River Tajii	WUA	Munessa
Kersa	Adera Golba	10	30	Traditional	River Kersa	WUA	Munessa
Tajii 2	Damu Dinbiba	150		Traditional	River Tajii	WUA	Munessa
Werga 1	Konche	120		Traditional	River Werga	WUA	Munessa
Werga 2	Gunguma	95		Traditional	River Werga	WUA	Munessa
Katar	Koji Albeso	200		Traditional	River Katar	WUA	Munessa
Tajii 3	Chopa	90	250	Traditional	River Tajii	WUA	Munessa
Werga 3	Koji Albeso	20	50	Traditional	River Werga	WUA	Munessa

Annex 5. Meki irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Malka Dilbo	Haxe Lamen	3.25	13	Modern	Meki River	WUA	Dugda
Malka Qurqura	G/Q/Adii	6.25	25	Modern	Meki River	WUA	Dugda
Melka Aba Godana	Welda kalina	7.8	0	Modern	Meki River	WUA	Dugda
Oda Bokota	Oda Boqota	5	0	Modern	Meki River	WUA	Dugda
Shubi	Shubi Gemo	5.8	0	Modern	Meki River	WUA	Dugda
Sombo Genet	Shubi Gemo	6,3	0	Modern	Meki River	WUA	Dugda
Sombo Aleltu	Shubi Gemo	5	0	Modern	Meki River	WUA	Dugda
Melka Kalo	Giraba K. Adi	5.5	0	Modern	Meki River	WUA	Dugda
		649	258	Traditional	Meki River	WUA	Dugda
Sibisto	-	20	80	Traditional	River	WUA	Sodo
Aleltu	-	7	28	Traditional	River	WUA	Sodo
Weldia	-	10	40	Traditional	River	WUA	Sodo
Gorte	-	5	20	Traditional	River	WUA	Sodo
Woldiya	Firshe	80	320	Modern	River	WUA	Sodo
Lebu	Kela	100	400	Modern	River	WUA	Sodo
Adele	-	70	280	Modern	River	WUA	Sodo
Shershera Biro	-	30	120	Traditional	River	WUA	Meskana
Waija	-	20	80	Traditional	River	WUA	Meskana
Misrak Meskana	-	30	120	Traditional	River	WUA	Meskana
Dobi	Dobi	40	160	Modern	River	WUA	Meskana
Dobena	Dobena	150	600	Modern	River	WUA	Meskana
Rinzaf	N/A	60	240	Modern	River	WUA	Meskana

Annex 6. Lake Ziway irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Im/Abu Kawo	Bochesa	5	20	Traditional	Ziway	WUA	ATJK
Abushere Kawo	Bochesa	1	4	Traditional	Ziway	WUA	ATJK
T/Weld Benana	Bochesa	2	9	Traditional	Ziway	WUA	ATJK
Kula Safewo	Bochesa	1	4	Traditional	Ziway	Priv	ATJK
Mula Harache	Bochesa	3,5	14	Traditional	Ziway	Priv	ATJK
Abraham W/Hasa	Bochesa	1	1	Traditional	Ziway	Priv	ATJK
Morki Klajira	Bochesa	1	1	Traditional	Ziway	Priv	ATJK
Jado Tibeso	Bochesa	1	1	Traditional	Ziway	Priv	ATJK
Aweke Gebire	Bochesa	3	15	Traditional	Ziway	WUA	ATJK
Asnake Yobanis	Bochesa	8	24	Traditional	Ziway	WUA	ATJK
Bochessa 3 WUA	Bochesa	13	34	Modern	Ziway	WUA	ATJK
Awake Gebire	Bochesa	6	25	Traditional	Ziway	WUA	ATJK
Tesfaye Alemu	Bochesa	3,5	14	Traditional	Ziway	WUA	ATJK
Aweka Gebire	Bochesa	9,5	41	Traditional	Ziway	Coop	ATJK
Bochessa 3 WUA	Bochesa	14	35	Modern	Ziway	Coop	ATJK
Wallinbula 2 WUA	Wallin Bula	17	38	Modern	Ziway	Coop	ATJK
Kassahue Kidane	Wallin Bula	5	25	Traditional	Ziway	Priv	ATJK
Wallinbula 1 WUA	Wallin Bula	12,5	35	Modern	Ziway	Coop	ATJK
Negalig WUA	Negalig	15	36	Traditional	Ziway	Coop	ATJK
Eriya Bonso	Negalig	7	30	Traditional	Ziway	WUA	ATJK
Mengistu Abeco	Negalig	16	1	Traditional	Ziway	Priv	ATJK
Ilka WUA		12	27	Modern	Ziway	WUA	ATJK
Abossa Irrigation Project	Negalig /Ilka	83	240	Modern	Ziway	WUA	ATJK
Meseret Taye	Negalig	4	16	Traditional	Ziway	Coop	ATJK
Yohanis Befay/Greenland	Elka Chelemo	19	35	Traditional	Ziway	Coop	ATJK
Mulufeta Fekice	Ido Gojola	4	16	Traditional	Ziway	WUA	ATJK
Beyene Anulo	Ido Gojola	5,5	18	Traditional	Ziway	WUA	ATJK
Zewdu Habte	Ido Gojola	1	4	Traditional	Ziway	WUA	ATJK
Salomon Abebe	Ido Gojola	4	20	Traditional	Ziway	WUA	ATJK

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Salomon Kefele	Ido Gojola	9	35	Traditional	Ziway	WUA	ATJK
Salomon Birhanu	Ido Gojola	65	-	Traditional	Ziway	Priv	ATJK
Zintu Balcha	Ido Gojola	6	-	Traditional	Ziway	Priv	ATJK
Edogojola 2 WUA	Ido Gojola	10	19	Modern	Ziway	Coop	ATJK
Sh/Abdela	Ido Gojola	8	20	Traditional	Ziway	WUA	ATJK
Edogojola 1 WUA	Ido Gojola	12	26	Modern	Ziway	Coop	ATJK
Gure Ashemi	Ido Gojola	3	1	Traditional	Ziway	Priv	ATJK
Belay Zebene	Ido Gojola	7	21	Traditional	Ziway	WUA	ATJK
Allemayehu Tadese	Ido Gojola	8	24	Traditional	Ziway	WUA	ATJK
Tadele Dennisse	Ido Gojola	9,5	-	Traditional	Ziway	Priv	ATJK
A. Mekonum Gebabaw	Abine Garmana	8,5	28	Traditional	Ziway	Coop	ATJK
Seyu Arebu	Abine Garmana	4,5	15	Traditional	Ziway	WUA	ATJK
Abne Garmama 4 WUA	Abine Garmana	15	128	Modern	Ziway	WUA	ATJK
Abne Garmama 5 WUA	Abine Garmana	15	48	Modern	Ziway	Coop	ATJK
Abne Garmama 1 WUA	Abine Garmana	9	30	Modern	Ziway	Coop	ATJK
Abne Garmama 2 WUA	Abine Garmana	16	45	Modern	Ziway	Coop	ATJK
Abne Garmama 3 WUA	Abine Garmana	9	67	Modern	Ziway	WUA	ATJK
Sher Ethiopia	Worja Washigula	500	1	Modern	Ziway	Priv	ATJK
Oda Jidha	X/Coroqee	15	60	Modern	Ziway	Coop	Dugda
Meki-Ziway	Bekele Girisa	216	0	Modern	Ziway	Coop	Dugda
Tepo 140	Tepo Coroqe	13	0	Modern	Ziway	Coop	Dugda
Cheleleka Danbel	Dodota Danbel	10,3	0	Modern	Ziway	Coop	Dugda
Dodota Danbel	Dodota Danbel	10	0	Modern	Ziway	Coop	Dugda
Wayo Sariti	Wayoo Gebri`el	17	0	Modern	Ziway	Coop	Dugda

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Wayo Gebri`el	Wayoo Gebri`el	10,4	0	Modern	Ziway	Coop	Dugda
Melka Korma	Welda kalina	16,8	0	Modern	Ziway	Coop	Dugda
Kelina Denbel	Welda Kelina	8,6	0	Modern	Ziway	WUA	Dugda
Oda Chisa	Welda Maqidela	5,25	0	Modern	Ziway	WUA	Dugda
Beda Gosa	Tuchi Denbel	4,75	0	Modern	Ziway	WUA	Dugda
Oda Bilbila	Abono Ga bri`el	4,5	0	Modern	Ziway	WUA	Dugda
Melka Kofe	Giraba K. Adi	5,5	0	Modern	Ziway	WUA	Dugda
Garba Danbal	Dodota Danbal	9	0	Modern	Ziway	WUA	Dugda
Agritech Vegetable Farm	Dodota Danbal	17	1	Modern	Ziway	Priv	Dugda
Blen Asaaminawu	Welda Maqidela	2	1	Modern	Ziway	Priv	Dugda
Biruktayit Dawit	Welda Maqidela	36	1	Modern	Ziway	Priv	Dugda
Elen NaTile	Tepo coreke	61	1	Modern	Ziway	Priv	Dugda
		709	277	Traditional	Ziway	WUA	Dugda
C/Jila	C/Jila	95	260	Modern	Ziway	WUA	ZG
Sadicho	A/Danara	75	152	Modern	Ziway	WUA	ZG
Golbe	Golbe	29	168	Traditional	Ziway	Coop	ZG
Borka Lamafo	Borka Lamafo	21	83	Traditional	Ziway	Coop	ZG
Herara	Herara	23,75	95	Traditional	Ziway	Coop	ZG
Bachira Chafa	Bachira Chafa	27	133	Traditional	Ziway	Coop	ZG
Maya Shanan	Maya Shanan	6,5	26	Traditional	Ziway	Coop	ZG
Ganale	Ganale	15	60	Traditional	Ziway	WUA	ZG
Chopa	Chopa	55	220	Modern	Ziway	Coop	ZG
AAI Natle	Maya Shanan	480	1	Modern	Ziway	Priv	ZG
Elfora Agto Ind	Maya Shanan	600	1	Modern	Ziway	Priv	ZG
Samuel Kaseda	Borka Lamafo	40	1	Modern	Ziway	Priv	ZG
Ruuman Ibrahim	Borka Lamafo	10	1	Modern	Ziway	Priv	ZG
Addisu Kinfagar	Borka Lamafo	31,8	1	Modern	Ziway	Priv	ZG
Duet Flowe	Golbe	100	1	Modern	Ziway	Priv	ZG
Girma Damee	Borka Lamafo	10	1	Modern	Ziway	Priv	ZG

Annex 7. Bulbula River irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Halleku Mieso WAU	Haleku Gulenta	36	85	Modern	Bulbula River	Coop	ATJK
ETECO farm	Anano Shisho	86,8	1	Modern	Bulbula River	Priv	ATJK
Samuel Ayele	Haleku Gulenta	5	1	Modern	Bulbula River	Priv	ATJK
SEGEL	Gerbi Wudena	95,5	1	Modern	Bulbula River	Priv	ATJK
Bochessa 2 WUA	Bochesa	23	57	Modern	Bulbula River	Coop	ATJK
Bochessa 1 WUA	Bochesa	15	24	Modern	Bulbula River	Coop	ATJK
Bochessa 4 WUA	Bochesa	8	24	Modern	Bulbula River	Coop	ATJK
Bochessa 5 WUA	Bochesa	19	50	Modern	Bulbula River	WUA	ATJK
Sisay Derebe	Bochesa	10	26	Modern	Bulbula River	WUA	ATJK
Heteweld Urgesa	Bochesa	3	12	Modern	Bulbula River	WUA	ATJK
Washgula WUA	Worja Washigula	5	15	Modern	Bulbula River	WUA	ATJK
Ethioflora	Garbi Boramo	65,5	1	Modern	Bulbula River	Priv	ATJK
Sepel	Garbi Boramo	95,7	1	Modern	Bulbula River	Priv	ATJK

Annex 8. Groundwater irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Malka Gudo	Tuchi Danbal	6	24	Modern	Ground water	WUA	Dugda
Malka Shisha	Abono Gabre`il	6	24	Modern	Ground water	WUA	Dugda
Burqa Danbal	A/Q/Adi	3	12	Modern	Ground water	WUA	Dugda
Odaa Fattii	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Gabinaa	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Odaa kicha	W/Maqidaala	2,75	11	Modern	Ground water	WUA	Dugda
Burqa Daglagaala	Shubi Gamoo	3	12	Modern	Ground water	WUA	Dugda
Golloolee	Shubi Gamoo	3	12	Modern	Ground water	WUA	Dugda
Darraara Jittuu	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Warree Darraara	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Darraara Burqituu	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Malka Sugee	Ab. Gabre`il	3	12	Modern	Ground water	WUA	Dugda
Gicoo Odaa	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Idee Baldhoo	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Biqiltuu Lalisa	Shubi Gamoo	3	12	Modern	Ground water	WUA	Dugda
Akuuruu	Shubi Gamoo	3	12	Modern	Ground water	WUA	Dugda
Caffee Gemoo	Shubi Gamoo	3	12	Modern	Ground water	WUA	Dugda
Chirchira Jituu	W/Maqidaala	3	12	Modern	Ground water	WUA	Dugda
Muka Arba	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Harawee Daraara	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Yuuboo Haara	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Sida Dalaacha	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Daraara Walqixee	D/Daalacha	3	12	Modern	Ground water	WUA	Dugda
Bakalcha Barsisa	B/D/Bagi	3	12	Modern	Ground water	WUA	Dugda
Samharoo	D/Dalacha	3	12	Modern	Ground water	WUA	Dugda
Cafee Horaa	B/D/Bagi	3	12	Modern	Ground water	WUA	Dugda
Qilxuu Borofa	W/Maqidaala	3	12	Modern	Ground water	WUA	Dugda
Burqaa Badhatuu	B/D/Bagi	3	12	Modern	Ground water	WUA	Dugda
Malka Konbolcha	Abono Gabre`il	3,25	13	Modern	Ground water	WUA	Dugda
Oda Cupha	D/Danbali	6	24	Modern	Ground water	WUA	Dugda
Malka aba Qanoo	G/Q/Adii	2,75	11	Modern	Ground water	WUA	Dugda
Adoyee	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Gotuu Gudittii	W/Qalina	3	12	Modern	Ground water	WUA	Dugda
Haroo Jatoo	Sh/Gamoo	3	12	Modern	Ground water	WUA	Dugda
Hara Danbal	Wayo Gabriél	8		Modern	Ground water	WUA	Dugda
Melka Sirba	Abono Gebreil	12		Modern	Ground water	Coop	Dugda
Melka Gerba	Tepo coreke	3		Modern	Ground water	WUA	Dugda
Oda kera Leman	G.Q.Adi	3		Modern	Ground water	WUA	Dugda
Oda Shubi	Shubi Gemo	3,75		Modern	Ground water	WUA	Dugda
Wayo Derara	D/Delecha	3,75		Modern	Ground water	WUA	Dugda
Burka Gudo	B/D Begi	3,75		Modern	Ground water	WUA	Dugda
Ahimad Mohammad	Tepo coreke	25	1	Modern	Ground water	Priv	Dugda
		2543	2046	Traditional	Ground water	WUA	Dugda
Sango	Sango	20	80	Traditional	Ground water	WUA	ZG
A/Chafa	A/Chafa	5,5	20	Traditional	Ground water	Coop	ZG

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Kassahue Kidane	A/Chafa	100	1	Modern	Ground water	Priv	ZG
Humberu Farm	A/Chafa	100	1	Modern	Ground water	Priv	ZG
Fedis Agri	A/Chafa	100	1	Modern	Ground water	Priv	ZG
Figadu Midhagso	A/Chafa	30	1	Modern	Ground water	Priv	ZG

Annex 9. Springs irrigations schemes

Name of scheme	Kebele	Area (Ha)	Number of beneficiaries	Type of irrigation	Source of water	Coop/WUA	Woreda
Laga Illu	Dugda Ukolo	12,275	35	Traditional	Ilu River-Spring	WUA	Tiyo
Dingate	Dugda Ukolo	11,125	25	Traditional	Ilu River-Spring	WUA	Tiyo
Burka Gabreli	Dugda Ukolo	6,8	16	Traditional	Ilu River-Spring	WUA	Tiyo
Burka Daro	Dugda Ukolo	3	12	Traditional	Ilu River-Spring	WUA	Tiyo
Ukulo	Dugda Ukolo	3	6	Traditional	Ilu River-Spring	WUA	Tiyo
Chefe Misoma	Boshaa 1	76	221	Modern	Spring	Cooperative	Tiyo
Denkaka Konicha	Denkaka Konicha	12	25	Traditional	Spring	WUA	Tiyo
Burga Guda	Chefe Misoma	36,5	123	Traditional	Spring	WUA	Tiyo
Burga Xiqa	Chefe Misoma	6,025	20	Traditional	Spring	WUA	Tiyo
Dh Amanure	Chefe Misoma	32,2	93	Traditional	Spring	WUA	Tiyo
Burka Chilalo	Burka Chilalo	5,3	21	Traditional	Spring	WUA	Tiyo