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Awash Basin Authority

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The Study of Water Use and Treated Wastewater Discharge Charge

Water Abstraction Charge Setting for Domestic and Non-Domestic Water Supply

Final Report

Submitted to

Federal Democratic Republic of Ethiopia Awash Basin Authority

MelkaWerer, Ethiopia

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October, 2018
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1 Introduction

1.1 Background

Ethiopia covers 12 river basins with an annual runoff volume 123 billion m^3 of water with an estimated more than 26 billion m^3 of ground water potential. The Abbay, Baro-Akobo, Tekezeand Omo-Gibe are trans-boundary Rivers and contribute 80-90% water and while Denakil, Ogaden and Ayisha basins are naturally dry and do not have main rivers. The water resource potential varies from basin to basin. There is a spatial and temporal variability in water resources across the basin in the country. Considering the available and current population, the distribution of the available water resource to the individuals is 1384 m^3 of water per person per year. This figure reveals that the water is scarce to use for individual domestic use.

As water is becoming scarcer, its economic value is rising and the use of economic instruments for sharing its use or consumption by competing sectors or groups becomes more important for societies. As it is stated in Ethiopian Water Sector Policy, the key problem of the country is the temporal variability and spatial distribution of water resources. These means that, Ethiopia gets only good rainfall for three consecutive months and then water becomes scarce across the country. On the other hand occurrence of the water resources across the basins is uneven.

In addition, pollution of the limited water resources is occurring due to the use of agro-chemicals in agriculture, expansion of Urbanization and industrialization and their wastes. Therefore, these situations trigger the country to use the available and limited water resources efficiently and in an economic manner by integrated water resource management approach.

Integrated water resources management requires arrangements for reconciling the different uses of water resources within a river basin to achieve balance and sustainable development of water resources as economic as well as environmental resources. The Ethiopian water resource policy states that water should be recognized as a natural resource with an economic value and ensures that fees are paid for services rendered. According to the policy water is recognized as a vulnerable and scarce natural resource and ensures and promotes that all pricing systems and mechanisms should be geared towards conservation, protection and efficient use of water as well as promotes equity of access. The price for water should be neither too high (and discourage water use) nor too low (and encourage abuses and over abstraction) and charge setting shall be specific, depending on the particulars of the project, location, the users, the cost and other characteristics of the schemes. River basin councils and Authorities' proclamation No. 534/2007 gives the mandate and duties for authorities and councils of proposing to the government the rate of the water charge to be paid by water users in the basin.

This and other proclamations require implementation tools in order to ensure sustainable and integrated water resources management and realize the mandate of particularly Awash Basin Authority. Since water is considered both as social and economic good, and ensuring the efficient and sustainable utilization of water resources is given for basin authorities, there should be a mechanism to empower basin authorities to exercise their mandate. The whole idea of the TOR for water abstraction study is focused in materializing the various policies and proclamations through designing appropriate implementation tools.

1.2 The Problem

Since the release of the Ethiopian Water Resources Policy in 2001a number of proclamations and regulations are released to ensure IWRM at basin scale by acknowledging that water is an economic good. The Ethiopian water resource policy (2001) states that water should be recognized as a natural resource with an economic value and ensures that fees are paid for services rendered. Accordingly, water is recognized as a vulnerable and scarce natural resource and ensures and promotes that all pricing systems and mechanisms should be geared towards conservation, protection and efficient use of water as well as promotes equity of access.

Despite the presence of enabling policies, proclamations and regulations there is no clear national guideline to charge water abstractionfor all types of uses including wastewater discharge to water bodies.

With regard to domestic (for human and livestock consumption) and non-domestic water supply (public, commercial and industrial); the Ethiopian Water Resources policy states that rural water supply end users charge should be based on covering operation and maintenance cost while urban should be based on full cost recovery. However, there is no regulation or guideline about how much utilities or direct water users who abstract surface or subsurface water from a basin, distribute for end users or consume by themselves shall be charged by the basin authorities in order to ensure sustainable supply of the scarce water resources. The TOR prepared by the Awash Basin Authority in collaboration with the Ministry of Water, Irrigation and Electricity, in general aims to encourage efficient utilization of water resources and ensure sustainable Integrated Water Resources Management. There should be a means to collect water abstraction charge for utilities or direct water abstraction entities like industries so that sustainable water supply from a basin is ensured by introducing water source protection and conservation measures.

1.3 Study Objectives and Key Tasks

1.3.1 General Project Objective

As stipulated in the TOR of the Awash Basin Authority, the general project objective of the water abstraction charge study is to develop appropriate and implementable water abstraction charge for the implementation of the Proclamation 197/2000/Ethiopian Water Resources Management/, Regulation No.115/2005 /Ethiopian Water Resources Management Regulations/, proclamation No. 534/2007 /River Basin Councils and Authorities Proclamation/ and Regulation No.156/2008 /Awash Basin High Council and Authority Establishment/ through consultation and participation of relevant federal institutions, Regional States and different water users for management of the limited water resources of the basins within the framework of Integrated Water Resources Management (IWRM) principles. That in turn strengthens the financial capacity of water resource regulatory institutions /organizations, to use the scarce water resource for a sustainable socio and economic development and services provision. This will lead to minimize misuse and effect of natural resource utilization and to generate revenue from water resource for the country at large.

1.3.2 Specific Objectives (WP3)

The specific objective is to determine the water abstraction charge to be set on domestic and non-domestic water utilities or public or private institutions and industries, through:

- Estimating the cost of watershed or basin management and rehabilitation
- Estimating the cost of protection of water abstraction points
- Estimating the cost of controlling, monitoring and evaluating the water quantity and quality in the basin
- Developing basic water abstraction charge in consultation with wp1
- Developing guideline for water abstraction planning and management

1.3.3 Core Tasks

The core tasks of WP3 – Domestic and non-domestic water abstraction charge setting - as specified in the TOR are presented including necessary sub-tasks that would lead to the accomplishment of the objectives is presented in table 1.1.

As indicated in the table 1.1, review of past experience and literature; and early conceptualization of charge setting were completed and compiled as interim report 1. In interim report 2 detailed data collection was carried out through instruments developed and findings are presented. This final report focuses on the required modification of the model developed in the

early conceptualization report based on field findings and further literature review, and set the water abstraction charge for domestic and non-domestic water supply. The required institutional arrangements and regulatory frameworks for this sector are included too.

Table 1-1 Tasks for domestic and non-domestic water abstraction/use charge setting

Task #	Major Tasks	Sub-Tasks
Task-1:	Review of Past Experiences and Earlier Studies on Water Use/Abstraction Charge Setting for Domestic and Non-domestic water supply	- Review of available policies, strategies, and guidelines water use/abstraction charge setting - Review of available local experiences - Review of International Experiences - Review of previous studies
Task-2:	Early Conceptualization of the Water Use Charge System for Domestic and Non-Domestic Water Supply	Based on the above review - Analyzing alternative water use/abstraction charge systems - Selecting the most relevant water use/abstraction charge system - Conceptualizing the selected system - Determining basic cost of water use/abstraction
Task-3:	Economic and Financial Analysis	In cooperation with WP1 carrying out - Economic Analysis - Financial Analysis
Task-4:	Setting Charge for Water Use	In cooperation with WP1 Setting Water Use/Abstraction Charge or Charge by considering - Affordability and Willingness to pay - Fairness and equity - Transparency and feasibility
Task-6:	Regulatory Framework to Support Pricing System	Assist WP1 in developing regulatory framework for water pricing system
Task-7:	Institutional Arrangements	Assist WP1 in devising institutional arrangement for water use charge administration
Task-8	Mechanism for Strengthening Institutional Capacity of basin authorities for collecting charges	Assist WP1 in designing continuous capacity development strategy to enhance the water uses/abstraction charges collection.

2 Literature Review

The literature review attempts to highlight what are the available materials for charge setting in the Ethiopian context and cite some international experiences in this area.

2.1 Principle of Water Abstraction/ Use Charging

2.1.1 General Principles

The nine major objectives in charge setting for different water uses; from lakes, springs and rivers for income generation seeks to achieve (MoWIE, 2013):

a) Economic efficiency: to ensure water resources are used in the most efficient way at the lowest possible social cost, etc;
b) Full cost-recovery: the water supply service is able to recover the cost of operation and maintenance of the WSS systems as well as the cost of investments.
c) Financial stability: charges should minimize risks of unexpected revenue fluctuations;
d) Fairness: charges should treat all consumers
e) Equity: - equals be treated equally, and unequals be treated unequally.
f) Social orientation of water services: guaranteed provision of water rights to all consumers regardless of income etc,
g) Resource conservation: charges should encourage resource conservation by the utility itself and consumers;
h) Conservation of treated water: - an incentive to conserve water through payment for actual consumption (metering of consumption) and progressive charges to control wastes/misuses
i) Environmental protection: - the environment has to be protected for the use of the future generations thus, the excessive use of ground water has to be avoided in order to prevent a permanent decline of the groundwater level and sewerage has to be treated adequately before being released into the environment.

The following considerations are made to handle constrains of charge setting

a) *Public acceptability*: a successful charge design is one that is not controversial, or which does not serve as a focus of public criticism of the water supply agency.
b) *Political acceptability:* a charge design that is objectionable to political leaders will lead to loss of political support and may cause increased political interference in the operations of the agency.
c) *Simplicity and transparency*: a charge design should be easy to explain and understand. It should be possible for most users to know what price they are paying for water.

d) *Ease of implementation*: the promulgation and implementation of the revised charge should not encounter significant barriers in terms of legal authority, administration Competence, information requirements, or billing procedures.

2.1.2 International / National Experience

2.1.2.1 Water Abstraction Charge

Water abstraction charge is a charge which is paid to river basin management agency in order to ensure the sustainability of water resources. An OECD initiative document (2010) "Economic instruments for mobilizing financial resources for supporting IWRM" summarizes the practices in some European countries with regards to water abstraction charges. This is shown in table 2.1.

Table 2-1 Abstraction charges and taxes in different OECD countries

Country	Source of water	Unitary rate	Total Annual Revenues	Payers	Appropriation of funds
Australia (Australian Capital Territory) (ACT 2009, ACTEW 2010)	All sources of water	0.49 USD/m³ urban water supply, 0.21 USD/m³ all other licenses	USD 23 million (2009)	All users	Full cost recovery (Water supply, scarcity values, environmental costs)
Belgium (Flanders) (OECD 2009, OECD 2010)	Groundwater	0.08 USD/m^3	USD 25,7 million (2007)	All users; except drinking water (higher charge)	Fund for the protection of ground waters
Denmark (Ecotec 2001)	All sources of water	0.84 €/m^3	€ 209 million (2000)	Domestic users only	General taxation
France (Seine-Normandy) (AESN 2008, Strosser & Speck 2004)	Surface water (basic rate) Groundwater (basic rate)	0.00071 €/m^3 abstracted, 0.04 €/m^3 consumed 0.024 €/m^3 abstracted, 0.04 €/m^3 consumed	€ 64,8 million (2008)	All users	Water management in the river basin (water treatment, water protection, research, administration), international cooperation projects
Germany (11 of 16 Federal States) (OECD 2010, UBA 2005, Gaulke 2010)	All sources of water	Range from 0.015 €/m^3 (Saxony) to 0.31 €/m^3 (Berlin)	Range from € 1.7 million (Mecklenburg-Vorpommern) to € 86 million (Nordrhein-Westfalen); 376.1 million € from all 11 states together (2008)	All users, except fishery and low amounts (less than 2000 – 10000 m³) – depends on Federal State	Depends on Federal state, e.g. Nature conservation, protection of ground and surface water, reforestation, soil protection and decontamination
Netherlands (OECD 2009, CFE 2001)	Groundwater	0.1883 €/m^3	€ 184 million (2006)	All users; farmers only if more than 40000 m^3/a	General taxation
Netherlands (Provinces) (OECD 2010, VROM 2006)	Groundwater	Range from 0.081 – 2.54 €/m³ (2003)	€ 14 million	All users	Expenditures in the field of water resources, anti-hydration studies

The French Water Act of 2006, which translates the Water Framework Directives in to French Law contains an article (article 82) that allows a river management organization to implement compensation for environmental services that would work as a charge. The following formula is

used to estimate the charge on water abstractors – farmers, drinking water companies and industry – which benefit from two large dams of Naussac and Villerest on Allier and Loire River in order to keep ecological flow of two rivers:

Compensation = volume*annual rate*user rate*seasonal rate*geographical rate

Where;

*Volume :*Maximum volume abstracted within the last 3 years

Annual rate : Fixed every year according to foreseen expenses

*User rate :*Drinking water = 1; Industry = 0.8; Agriculture = 0.4

Seasonal rate : Agriculture 1; Drinking Water and Industry =0.5

Geographical rate: depends on the location of the withdrawal (ranges between 0.5 and A very good experience on charge setting for both water use and abstraction is that of South Africa. The National Water Pricing Strategy for Water Use Tariff (2015) categorizes water charges into five major categories. These are:

- Water resources management Tariff
- Water resources infrastructure Tariffs
- Waste discharge mitigation
- Water research commission Tariffs
- Economic regulation Tariffs

Except the waste discharge management, the principles set in the four charges could be one of the basis for the setting of water use/abstraction charge for domestic and non-domestic uses.

2.1.2.2 Water Use Charge

2.1.2.2.1 Urban Water Use Charge Setting

In the same year (2013), the Ministry of Water and Energy of the Federal Democratic Republic of Ethiopia prepared a National Guideline for Urban Water Utilities Tariff setting. This guideline focuses on setting a charge that is going to be collected by urban water utilities to recover capital and operation and maintenance costs. It does not deal with the charge that should be collected for the abstraction of water from water resources in a basin by water utilities or direct users like industries.

According to the World Bank study “a tariff is affordable as long as the bill does not exceed 5% of the household’s budget". "Willingness to charge" is also as important as "willingness to pay"

when considering tariffs. Therefore, testing willingness to charge is also as important as willingness to pay. The total annual operation and maintenance cost divided by total annual water sold will give "social tariff/m3 i.e. water tariff/ m3 paid at public fountain and this tariff will be the base for other tariffs. The first Block water tariff for residential connections should be the same with the public fountain tariff because; each person has the right to receive a minimum level of drinking water supply at an affordable price. Because water is a basic need for every human being and everybody must have access to a certain amount of safe drinking water for cooking and drinking. The major operation and maintenance costs are personnel cost (which includes staff salaries and related benefits to employees and other expenses), energy cost, chemical cost, Repair & Maintenance cost and new connection cost (MOW&E, 2013).

With regard to municipality water charge structure there are different approaches sometimes used in combination. For example, as stated by Whittingiton (2002), water utilities mainly utilize four types water charge structures, namely: fixed charge, uniform volumetric charge, increasing block and decreasing block. The percentage of utilities applying one or the other form of charge structure is presented in table 2.2.

Table 2-2 Water Charge Structure (%age of Utilities)

Country	Fixed Charge	Uniform Volumetric Charge	Increasing Block Tariff	Decreasing Block Tariff
Australia		68	27	5
Canada	56	27	4	13
France	2	98		
Hungary		95	5	
Japan		42	57	1
Netherlands	7	90	3	
Norway	87		13	
Spain		10	90	
Sweden		100		
Turkey			100	
UK	90	10		
USA	2	33	31	34

2.1.2.2.2 Rural Water Use Charge Setting

The Water Policy of Ethiopia mentions that water charge for rural water supply should be based on operation and maintenance requirements and it does not mention what should be the charge for the protection of catchment, immediate vicinity of water supply source.

A guideline prepared by the Ministry of Irrigation and Water Development of Malawi considers the following to be incorporated in the development of Rural Gravity Fed Piped Water Supply charge.

- Materials: consumables, chemicals, tools, spare parts (fast wearing) and equipment;
- Operational personnel (mostly field based): staff involved in everyday system operations, routine preventative maintenance, repairs, and minor rehabilitation works, supervision;
- Management staff (office based): planning, financial management (management and bills collection, auditing), general administration, monitoring and evaluation and general management
- Financial costs: interest on loans and advances, amortization, network depreciation, exchange rate variations, inflation, etc.
- *Environmental costs: for water source and catchment protection and conservation*
- WUA Registration, Membership Fees, Water Rights, etc.
- Board of Trustees/Directors' costs
- Quarterly Meetings and Annual General Meetings (AGM)
- Water levy, Future investment costs: mostly for minor system improvements, replacement and extension
- Other costs: transport, services out-sourcing (contractors, specialists and experts, unaccounted- for-water (UfW) provision, illegal connections and vandalism, customer services, etc.

The above cost items include under environmental cost category water source and catchment protection and conservation.

2.2 Non-Domestic Water Uses

2.2.1 Industrial Water Use

Industrial water uses are water uses mainly utilized for manufacturing various types of industries, mining, cooling water in thermal plants… If one takes the example of India, among the industrial uses, as shown in table 2.3, thermal power plants share is nearly 88%, followed by engineering firms (5%) and pulp and paper (2.3%).

Table 2-3 Industrial water use and wastewater discharge in India

Industrial Sector	Annual wastewater water discharge (million cubic meters) (%)	Annual consumption (million cubic meters)	Proportion of water consumed in industry
Thermal power plants	27000.9	35157.4	87.87
Engineering	1551.3	2019.9	5.05
Pulp and paper	695.7	905.8	2.26
Textiles	637.3	829.8	2.07
Steel	396.8	516.6	1.29
Sugar	149.7	194.9	0.49
Fertilizer	56.4	73.5	0.18
Others	241.3	314.2	0.78
Total	30729.2	40012.0	100.0

One of the challenges in Indian Industries is their inefficiencies on water use is the ratio of water consumption and economic value creation in Indian industry is poor. For every cubic meter of water that Indian industry uses, as presented in table 2.4, it generates merely US $7.5 economic productivity. The next lower productivity rate is US$ 23.4 which is almost 3 times that of Indian industry's water productivity.

Table 2-4 Comparison of industrial water productivity

Country	Industrial water use (billion cubic meters)	Industrial productivity (million US $)	Industrial water productivity (US $ / cubic meter)
Argentina	2.6	77171.0	30.0
Brazil	9.9	231442.0	23.4
India	15.0	113041.0	7.5
Korea, Rep.	2.6	249268.0	95.6
Norway	1.4	47599.0	35.0
Sweden	0.8	74703.0	92.2
Thailand	1.3	64800.0	48.9
United Kingdom	0.7	330097.0	443.7
Source: World Bank, 2001			

The comparison of water consumption by Indian industries with global average values, presented in table 2.5 shows that there is problem of efficiency in the Indian industrial water utilization and management.

Table 2-5 Comparison of average water consumption of Indian industries with global average

Sector	Average water consumption in Indian industry	Globally best
Thermal power plant	On an average 80 m^3/ mwh(1)	Less than 10 m^3/mwh(2)
Textiles	200-250 m^3/ tonne cotton cloth(3)	Less than 100 m^3/ tonne cotton cloth(2)
Pulp & Paper	. Wood based mills: 150 - 200 m^3 / tonne(3) . Waste paper based mills: 75 -100 m^3/ tonne(3)	• Wood based mills: 50 - 75 m^3 / tonne(4) • Waste paper based mills: 10-25 m^3/tonne(4)
Integrated Iron & steel plant	10-80 m^3 per tonne of finished product (average	5 -10 m^3 per tonne of finished product. Best is around 25 m^3)(practice - less than 0.1 m^3 wastewater per tonne finished product(5)
Distilleries	75-200 m^3/ tonne alcohol produced(6)	Data not available
Fertilizer industry	• Nitrogenous fertilizer plant - 5.0 - 20.0 m^3/ tonne(3) • Straight phosphatic plant - 1.4 - 2.0 m^3/ tonne(3) • Complex fertiliser - 0.2 - 5.4 m^3/ tonne(3)	An effluent discharge of less than 1.5 m^3/ tonne product as P2O5(2)

A study carried out in industrial water use in India by FICCI (2011), in fig. 2.1 shows that only 24% industry water supply source is Municipal while the remaining 76 % is extraction from industries, surface water (41%) and groundwater (35%).

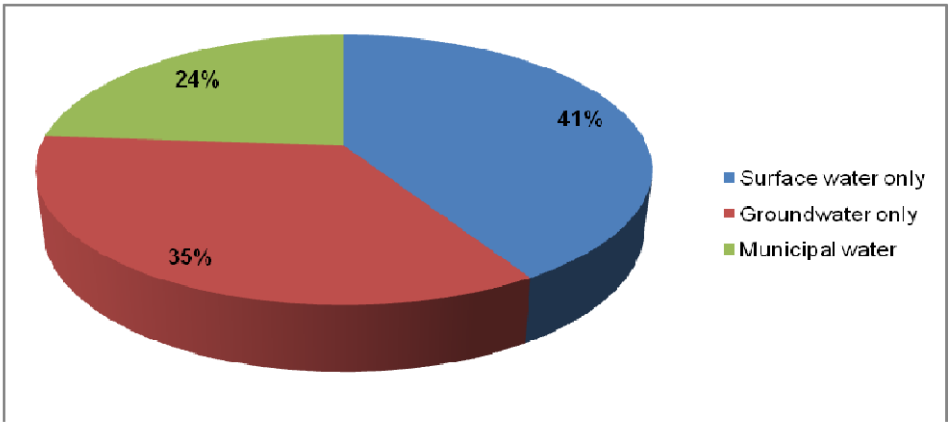

Figure 2-1 Type of water source for Industrial Water Use in India (FICCI, 2011)

Key problems identified in the same study with regard to water supply for industry are shown in fig. 2.2. The main problem is inadequate availability (37%) followed by regulatory or policy framework in respect of allocation of water (15%) and poor water quality and effect of environmental change each (14%).

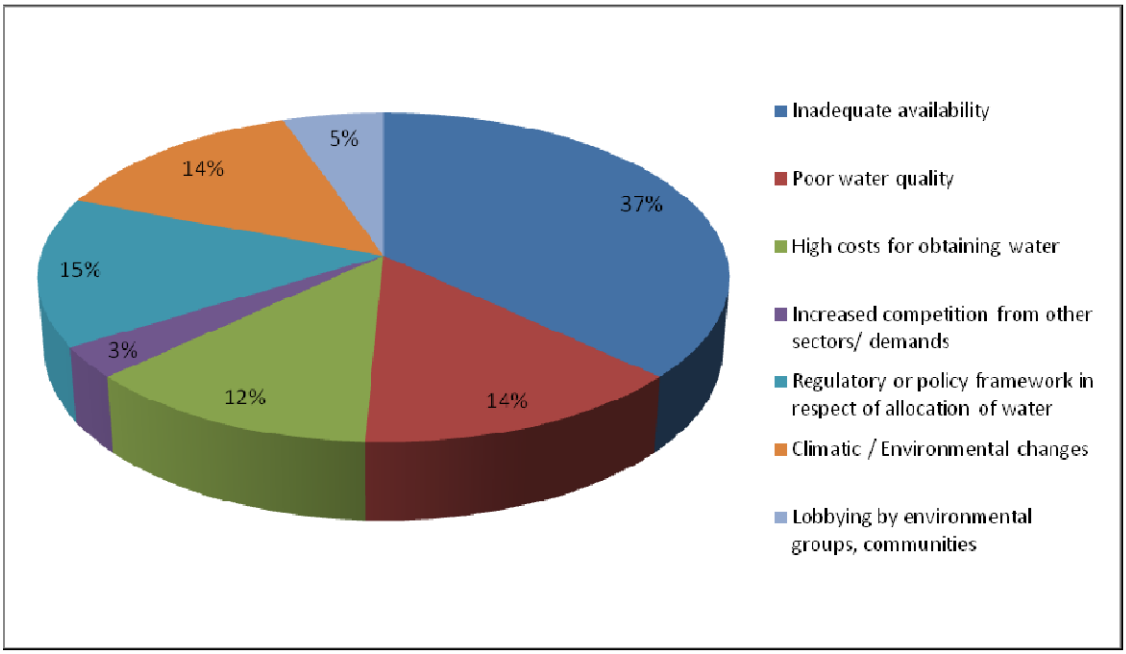

Figure 2-2 Key problems of Industrial Water Use in India (FICCI, 2011)

2.2.2 Water use in livestock production

Sustaining human and economic development, and maintaining ecosystems, requires more effective management of water resources (OECD, 2009). Water abstraction (WA) is the amount of water that is removed from any source, either permanently or temporarily, in a given period of time for consumption and production activities. Water can be abstracted for distribution or for own use (once it is used it can be delivered to another user for treatment or re-use) (Alberta-Facts, 2009). Likewise, water is one of the most valued resources for livestock, so saving and protecting water quality can enhance livestock production (Fabian, et al. 2008)

Providing adequate water to livestock is critical for animal health and production. A 10 percent loss of body water is fatal to most species of domestic livestock. Water accounts for more than 98 percent of all molecules in the body and between 50 and 81 percent of an animal's total body weight at maturity. Water is required for regulation of body temperature, growth, reproduction, lactation, digestion, lubrication of joints, and eyesight. Livestock water requirements vary significantly depending on the species (Table 2.5). Water consumption is influenced by a number

of factors, including age, rate of gain, pregnancy, lactation, activity, type of diet, feed intake and environmental temperature. Livestock obtain water to meet their requirements from wells, fountains, surface water and moisture found in feedstuffs (Miranda, et al. 2015).

Table 2-6 Estimated water requirement of livestock under Sahelian condition (air temperature of 27OC), (l/day)

S.No.	Species	Average Water requirement per head
1	Camel	50
2	Cattle	27
3	Sheep	5
4	Goat	5
5	Donkey	3
6	Chicken	0.1-0.2

Source: Adapted from Pallas (1980)

According to Lardy et al. (2008) the overall demand for water in livestock production is influenced by several factors such as type of animal, its activity, feed intake and diet, quality of available water, temperature of water and temperature of the ambient environment. Conditions that will influence the water requirement of livestock are the physiological condition of the animal and the availability of water. Cattle with constant availability to water compared with cattle only allowed water access twice a day will produce more milk and more butterfat. In the same way a gestational or lactating animal will have larger water consumption than a non-gestational or non-lactating one. The diet also has an impact on drinking water consumption of poultry. An increased level of fat, protein, salt, potassium and high level of crude fiber in the diet will increase the drinking water consumption.

Different products will require different amounts of water in their production. This requirement is as mentioned also depending on production site, water use efficiency of feed baskets and specific time as well as other production conditions. To produce a certain amount of meat, milk or egg it is necessary to take into consideration a number of parameters. What kind of animal is used for production, where the animal is kept, what the animal diet constitutes of, where the feed is produced etc. will have an impact on the water requirement of the product (Steinfeld et al., 2006). Consumptive water uses in livestock are generally divided into two categories: a) Drinking and process water – direct blue water use and b) Water use for production of feed, fodder and grazing – blue and green water use. Most calculations have been performed on the

first category of consumptive water use but recently numerous scientists have highlighted the importance of including consumptive green water use in calculations regarding water use in livestock (Stenifeld et al., 2006; Falkenmark &Rockström, 2004). The second type of consumptive water use is significantly larger than the first one referring only to blue water requirements.

Livestock production requires high amounts of water. One kilogram of grain used in livestock feed requires about 1000 to 2000 kg of water if the feed is grown in the Netherlands or Canada. The same grain will, however, require approximately 3000 to 5000 kg of water if grown in an arid region like Egypt or Israel. That difference in water requirement will have an impact on the total water use for a specific product relying on the grain from a particular region. Livestock in itself contains between 5 and 20 times more virtual water per kg product than crop products (Chapagain & Hoekstra, 2003).

Animals suffering from water deficiency can experience a depression of vital physiological functions more quickly and drastically than any other nutrient deficiency and domestic animals can only survive without water for seven days. Furthermore, signs of dehydration are tightening of skin, weight loss and drying of mucous membranes and eyes (Lardy et al., 2008).

Processing of animal products, including slaughtering and tanning of skins, demand a high level of hygiene and quality when processed. This in turn results in a large consumption of water and a large amount of waste water generated from these activities. Generally poultry processing facilities and dairy products have a higher demand for water per unit of weight than processing facilities for carcasses of cattle and pork. Tanning consumes large amounts of water as well. However, the environmental impact of the emitted pollutants from such processing is considered to be of greater concern (Steinfeld et al., 2006).

There is also a water requirement for services such as cooling and washing of the animal and feed production. Production facilities need to be kept clean and animal product production need processing, which also requires water (Deutsch et al., 2010). The water use per animal differs with different production systems. In extensive systems the water requirement per animal will be greater than for intensive (industrialized) production systems. However, the intensive system will have a larger service water demand for cooling and cleaning of the facilities. Extensive systems tend to use more water for the animals´ feed supply. In some regions, where extensive livestock systems are dominating, the fresh water withdrawal for the drinking and servicing of livestock will be a large fraction of the total withdrawal. In most regions, however, the water use for drinking and servicing livestock constitutes only a small fraction of the total water requirement for the livestock production. Globally the water consumption of these processes is estimated to be only 0.6 percent of all freshwater use (Steinfeld et al., 2006).

3 Methods

3.1 Conceptual Framework of Charge Setting

An introductory field visit was carried out before developing the conceptual framework in order to get sense of the practice in the domestic and non-domestic water supply sector in relation to water abstraction / use charge and existing institutional and legal framework. The salient features of the field visit are presented in the following sub-section prior to the conceptual framework development.

3.1.1 Field Visit Summary

Afar and Oromiya Regions and Federal and Regional Offices in Addis Ababa Administration were visited from May 29/2017 to June 03/2017; . ; and a separate team also visited Amhara Region from June 18 to 12/ 2017. The purpose of the field visit was to get primary and secondary information on the current situation of water abstraction/use and wastewater discharge charges, and also to discusswith AWBA to get an in-depth information about the project from the management.

The team members of WP3 focussed on getting first hand information on the existing charge structure, institutional set up of the water supply management in urban and rural areas, and check also on issues of industrial water supply and their opinion on introduction of water abstraction charges. The main findings of the field visit are briefly elaborated in the following sub-sections.

3.1.1.1 Water charge

The field visit revealed that there is no as such water abstraction charges for both domestic and non-domestic water supply. There exist water charge both in urban and rural water supply systems.

3.1.1.1.1 Urban Water Supply Tariff

The visit to Afar region towns of Semera, Logia and Awash Sebat and Adama town of Oromiya region utilize almost similar tariff system though there is some difference in rates as shown in table 3.1.

Table 3.1 Urban water use tariff in some towns of Awash Basin

Region	Town	Monthly Water Consumption Range (m^3/month)	Rate (Birr/m^3)	Remark
Afar	Logia/Semera	0 - 5	1.5	High budget deficit and source and transmission line construction carried by Water Bureau and no revision since 2005
		6-10	2.5	
		11 - 30	3.4	
		>30	4.2	
	Awash Sebat	0 - 5	2.0	Ditto but there is higher tariff where the community is willing to pay
		6-10	3.2	
		11 - 30	5.8	
		>30	7.35	
	Adama	0 - 5	5.25	This is for domestic for public 5.65/ commercial 6.5
		6-10	6.30	This is for domestic for public 6.65/ commercial 8.3
		11 - 30	7.95	This is for domestic for public 8.05/ commercial 9.35
		>30	8.95	This is for domestic for public 9.1/ commercial 10.75

The Urban Water Supply tariff is even not sufficient for operation and maintenance in Afar Region while in Oromia, Adama Town covers its operation and maintenance and is expected to cover at least 50% of the cost.

3.1.1.1.2 Rural Water Supply Tariff

In Afar Region, the visit to Awash Fentale Woreda Rural Water Supply and Water Resource reveals that when only the water source is deep well where pumping requires diesel or electricity the people pay a fixed lump sum of Birr 20/ month; but for shallow and hand dug wells where manual pumping is used there is no payment and the Woreda desk assists when there is a problem.

However, the Adama Wereda Water, Mines and Energy Office informed us that the tariff for water supply depends on the type of scheme. Accordingly:

Public tap for community in Gimbichu Fentale System = 4 Birr/m^3

House Connection in Gimbichu Fentale System = 6 to 10 Birr/m^3

Deep well utilizing electricity = 1 Birr/ 50 liter; i.e. 20 Birr/m^3

Gravity System = 0.5 Birr / 50 liter; i.e 10 Birr/m^3

3.1.1.1.3 Industrial Water Supply

Bottling Company

In Afar Region, the industries usually have their own source and do not pay abstraction fee and it is the same in Oromia region. A water bottling company in Gelan town – Aqua Silva - was visited and it only pays Birr 54/year for Oromia Region Water, Mines and Energy Beureau to extract 60 m3/day as a license fee. The good point about the factory is, it is exemplary in its environmental activities for others.

Livestock

Seyoum Balcha Animal fattening and export Farm: during the visit the owner of the farm (Ato Seyoum Balcha) was willing to give information about his farm. At the moment, he has 900 cattle being fattened and he needs at least 50 liters of water per animal per day. He is getting 20-25% of the water for his cattle from the nearby deep well where he shares with the local community and to pump the water from the deep well they use generator which costs about 250,000 Birr. His farm is about 11 years old and there was time that he himself was forced to buy a new generator to pump the water and it is not easy to maintain and run the generator. The 75-80% of his farm water demand is covered by buying 10,000 liters of water for 1000-1300 Birr from trucks delivering water from Awash River. He further mentioned that in the locality of his farm (Adama and Lomie districts) there were about 50 livestock fattening farms. Now there are about 15 of them still operating and the main reason for the closure of the majority of the fattening farms was lack of access to sufficient water. He also stressed that, he is happy to hear that there is a water charge study for Awash Basin and he is eager to have access to sufficient water for his farm.

Ethiopian Live Animal exporters Association: Fortunately, as the farm of Ato Seyoum Balcha was being visited; the chair person (W/ro Kibret Mulat) of the Ethiopian Live Animal Exporters Association came to the farm of Ato Seyoum for a visit and she was willing to discuss with us about the water charge study. She described the major challenges of the association (Access to sufficient water, land, livestock feed, electricity, and the quality of the live animal exported) and she further stressed that any effort towards availing sufficient water to the livestock fattening farms is a plus towards the development of the sector and bringing in additional foreign exchange. She added that the association looks forward to benefit from the results of the water tariff study.

3.1.1.2 Institutional Arrangements

All towns visited have water supply and sanitation offices which are accountable to respective municipalities and are managed by board in which usually the Mayor is the chair. In all cases development of water supply sources, laying of transmission lines and reservoirs is carried out by regional bureaus and/or Zonal bureaus and the role of water supply and sanitation offices is to extend distribution lines and operate, maintain and manage the system.

In the case of rural water supply, water committees are the main actors who are usually supported by Woreda or Zonal Water Offices.

The main gap, especially in towns is that the offices have the name and the mandate to provide sanitation services, however they do not have a structure that address sanitation issues. Usually, private vacuum trucks are used to empty latrines or septic tanks and dump in open areas without followup and further management measures.

The other important matter is the link with Awash Basin Authority. In almost all cases the municipalities or water desks have no relationship with Awash Basin showing that there is lack of awareness of the importance of basin management and the need to have water abstraction charge.

3.1.2 Conceptual Framework

The overall water use/abstraction charge setting of the domestic and non-domestic water supply work package (WP3) will follow the conceptual framework shown on fig.3.1. The conceptual framework is based on three aspects:

- the central one is connecting the basin authority with water utilities, committees or boards and sometimes direct users and finally domestic and non-domestic water users.
- on the left side, the supply side which is based on sustainable water resources management by basin authority and water infrastructure development and delivering appropriate quality of water to users by water utilities.
- on the right side the financial aspect which is usually of two types water abstraction fee which mainly should be collected by basin authority from water utilities and water use charge from end users mainly to water utilities.

As shown in the figure 3.1., the sustainable provision of fresh water resources is dependent on the availability of fund collected in the form of water abstraction and water use charge. It also shows that basin authorities, though they do not have direct institutional connection with water

utilities, they have a role in ensuring sustainable water supply through charging appropriate water abstraction.

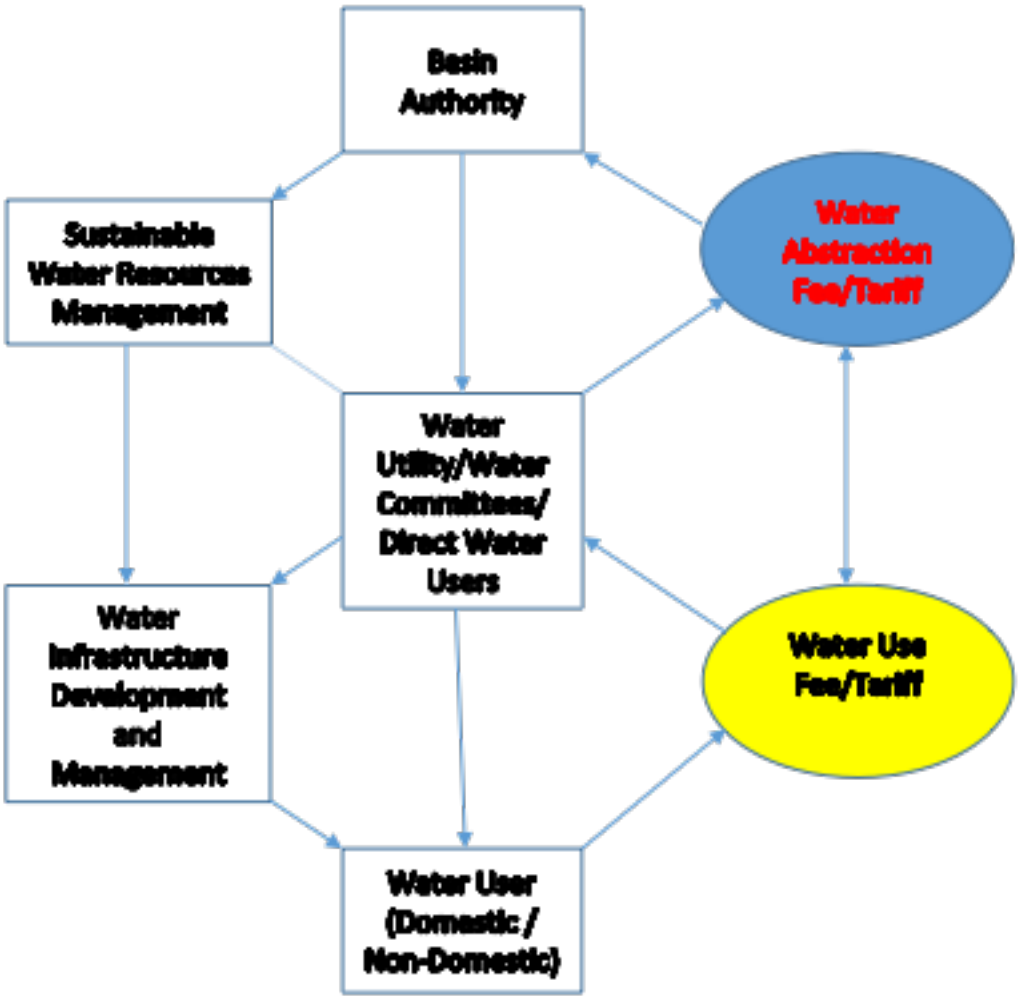

Fig. 3.1 General Conceptual Framework of Domestic and Non-Domestic Water Supply

In interim report 1, early conceptualization of water abstraction charge setting, the financial aspect where water use/abstraction charge is considered. The conceptualization which shows what the components should be considered while setting water use / abstraction charges is presented on fig. 3.2

In fig. 3.2, seven indices that could contribute for the building up of Water Use/Abstraction charge for domestic and non-domestic water supply are shown. The contribution of each index to water abstraction charge could be direct or indirect and might not have the same weight. On the other hand, the ratio of water abstraction charge to the charge paid by the end users to intermediate utilities could not be the same. Thus development of appropriate indices for each component as indicated in the conceptual framework of fig. 3.2 is necessary. Each component is further elaborated in the following section.

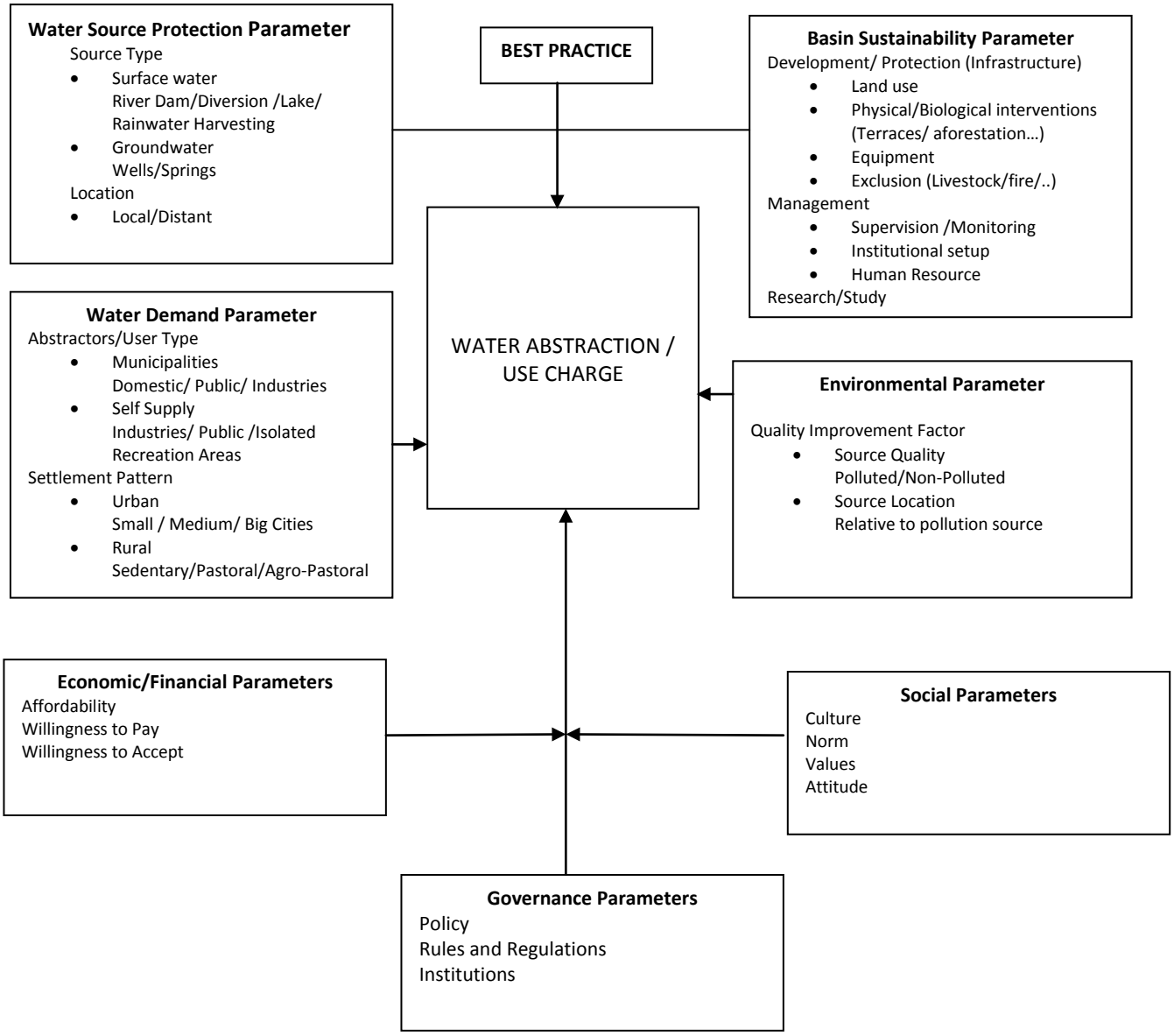

Fig. 3.2 Conceptual Framework of Water Use/Abstraction Charge for Domestic and Non-Domestic Water supply

3.1.10.2 Water Source Protection Parameter

Water source protection depends on the type and location of water supply source.

Source Type Factor

Water sources are broadly categorized in to two major categories -surface and groundwater. Surface water could also be subdivided into river through diversion or dams, natural lakes or through various rainwater harvesting mechanisms. Groundwater could also sub-divided into hand dug well, shallow well, deep wells or freely flowing springs. Depending on the source type, the effort required to protect the immediate protection zones differs. Location Factor

Water sources could provide service to communities or settlements nearby the sources or could also provide for those who are located even in another distant catchment or administrative entity. The protection effort and responsibility might vary and even those nearby the source might need encouragement to protect the source catchment so that water provision could be sustainable. It might also be necessary, to extend the protection to the route of the transmission lines.

3.1.10.3 Basin Sustainability Parameter

In principle, the water abstraction/use charge is required to ensure the sustainability of water resources in the basin. The Basin Authority should carry out stringent basin development planning and management so that sustainability is ensured. This is the key parameter to ensure sustainability. The following three factors contribute to the basin index.

Development and Protection

Basin monitoring, protection, rehabilitation and management require investing on physical catchment protection and rehabilitation activities, installation of instruments to register quantity and quality of water in the main river and its major tributaries. These infrastructures should be maintained regularly so that the status of water resource is properly known and catchment protection and rehabilitation activities are attended in time. The intervention should consider the type of land use in the different parts of the basin.

Management

The basin authority requires professional and support staff in sufficient quantity and quality to research, plan, manage, monitor and supervise the various basin wide and catchment rehabilitation and protection activities that would ensure the sustainability of water supply

sources. The human resource contribution to the water abstraction/use charge should be properly factored.

Management of the Basin is highly affected by the institutional setup, degree of decentralization and number and location of main and branch offices and available logistic. Thus, the institutional aspect of management is properly considered while determining the water abstraction/use charge.

3.1.10.4 Environmental Parameter

Quality Improvement Factor

Water supply catchment or sources could be from a natural environment which is not exposed to pollution or have natural contaminants or might have been exposed to various degree of pollution as a result of contaminants from anthropogenic sources. The effort required to sustain the quality of water in such different situations is not similar. Thus appropriate environmental parameter should be developed considering the particular situation of the water supply system.

3.1.10.5 Water Demand Parameter

Abstractors/Users type Factor

Water abstraction could be carried out by public utilities at various levels – municipalities, community water user associations, sector institutions or by private entities like self supply or abstraction for industrial purposes at various scales for different types of industries including livestock development.

Municipalities could provide for various demand categories like domestic, public and industries with the intention of public service while private industrial abstractors including water bottling companies utilize water to maximize profit. Thus appropriate factor should be developed considering the category of abstractors and their ultimate objective and their end users.

Abstractors/Users Settlement Factor

Scale and type of water abstraction depends on the type of settlement. Besides the end users water use charge setting depends on the type of settlement. According to our water policy, principles applied for residents of urban and rural settlements are not the same. Moreover, within rural context the settlement pattern various from sedentary to agro pastoral and pastoral. The water abstraction charge should consider the settlement pattern as the purpose and the rate of utilization and the capacity varies from one settlement pattern to the other.

3.1.10.6 Social Parameter

The value given to water depends on social and cultural background – norm, attitude and values - of the water abstractors/users. Some communities might consider that water is only social good. Thus, the different social and cultural setting should be considered to set acceptable water abstraction charge.

3.1.10.7 Economic/Financial Parameter

It is not only how the social and cultural settings consider water but their willingness to pay is also affected by such setting. Thus, while setting water abstraction charge the willingness to pay of that particular abstractor/user should be considered.

Moreover, water Abstraction/Use charge should be affordable considering the capacity to pay the abstractors or users. Thus appropriate factors are developed considering the economic capacity of the abstractors/users so that the charges are affordable.

3.1.10.8 Governance Parameter

Any water charge could not be set without considering the factors set in the water policy and governance documents and the institutional arrangements of water related activities. Thus, appropriate factors that consider water policy and governance and institutional issues of water abstraction or use charge are addressed.

3.1.11 Water Charge Estimation Model

Based on the conceptual framework the following preliminary model to estimate water abstraction/use charge is developed and presented in Eq. 1.

$$\mathbf{WAU_c = EF_f S_f G_f (WSP_c + BSA_c - EQI_c)} \quad \textbf{……(Eqn. 1)}$$

Where:

WAU_c = Water Abstraction/Use Charge
WSP_c = Water Source Protection Cost
BSA_c = Basin Sustainability Assurance Cost
EQI_c = Environmental Quality Improvement Cost (to be obtained from WP4)
EF_f = Economic and Financial Factors
S_f = Social Factors
G_f = Governance Factor

3.2 Method of Data collection and Analysis

The main purpose of the data collection is to get the necessary primary and secondary data to determine the water charge as per the models developed at the early conceptualization stage.

3.2.1 Methods

The principal sources of technical data were both primary and secondary. Accordingly:

- The secondary data is collected from both internet sources and during field visit from pertinent institutions and stakeholders who are directly and indirectly involved in water abstraction and management. Further literature review was also the means to get best practices from international experiences.
- Primary data was collected through questionnaires and checklists mainly through key informant interviews and questionnaires. Moreover, field observations of water supply sources, protection activities where any, distribution systems,… was also the means used to get the required data.

3.2.2 Instruments

The basic data collection instruments used to collect data are questionnaires and checklists. The annexed technical questionnaires (annex 1) is mainly prepared to get basic technical information from key informants who are usually water supply and sanitation offices, water bureaus and federal water institutions, agriculture offices, industries, universities, ….

3.2.3 Sampling

3.2.3.1 Sampling Framework

During the preparation of the field visit the sample size was determined based on the population in the various categories of domestic and non-domestic water supply.

The key population data required were:

- Type of water sources
- the total number of urban settlements (towns/cities) based on the category set by the Ministry of Water, Irrigation and Electricity, for urban water supply
- Industries by type and category for industrial water supply
- Public Institutions by Category
- Hotels and Lodges / by Category
- Rural water supply by category – Sedentary, pastoral, mixed

Stratified sampling technique was used to determine the samples. In general, if the population size is less than 10 all samples were taken as samples and when it is greater than 10 a minimum sample size of 10% was considered. As much as possible, it was tried to have fair distribution of samples in the different stretches of the Awash Basin and also representation from Upper, Middle and Lower Awash Basin.

On the other hand while determining the samples, other factors like representation of type of water supply, by source, distance, institutional set up, ... were also considered.

The basic sampling framework which guided the sampling is as presented in table 3.2.

Table 3-1 Sampling framework

Source	Abstractors	Criterion	opulation (N)	Samples
Surface (Dam and Diversion)	Municipality	Population		
	Industry	Type		
	Public Institution	Type		
	Hotels and Lodges	Level		
	Rural/Community			
Groundwater (Shallow, deep, spring)	Municipal	Population		
	Industry	Type		
	Public Institution	Type		
	Hotels and Lodges	Level		
	Rural/Community			

3.2.3.2 Urban Centers

As most abstractors, except rural community are located in urban areas selecting representative urban areas is necessary since water abstraction charge focuses mainly on urban abstractors. Rural abstractors for domestic use (human and livestock) are not expected to pay for abstraction charge. It was also necessary to align the selection of urban samples with industries. The urban centers are selected with the aim of representing all categories of cities and/or towns as per the categorization of urban centers by the Ministry of Water Irrigation and Electricity (MoWIE) as presented in Table 3.3.

Table 3-2 Sampling of Urban Centers

No.	Urban Category by Population	Number of Urban Centers	# of Sample	Identified Samples	Remark
1.	> 1,000,000	1	1	Addis Ababa	
2.	100,000– 1,000,0000	2	2	Adama / Dire Dawa	
3.	50,000 – 100,000	2	2	Bishoftu / Dessie	
4.	20,000 – 50,000	2	2	Mojo / Kombolcha	
5.	2,000 – 20,000	105			
5.1	Afar	12	2	Semera/Logia // Awash Sebat	Sample size 10% and selection for 2/ higher and lower end by population number; for 3/ higher, average and lower and for 5/ higher, above average, below average and lower end
5.2	Amhara	31	3		
5.3	Oromia	45	5		
5.4	Somali	17	2		
	Total	**112**	**19**		

The selected and visited urban centers are indicated in fig. 3.3 and 3.4.

3.2.3.3 Industries

As indicated above, the sampled industries are of different types located mainly in selected cities or towns. Table 3.4 shows the categorization mechanism and selected industries. The sampled industries are considered if they are self-abstractors.

Table 3-3 Sampling of Industries

No.	Industry by Category/Type	Number of Industries	Number of Sample	Identified Samples	Remark
1.	Industry Parks	6	2	Bole Lemi / Kilinto / Dukem / Adama / Dire Dawa / Kombolcha	Less than 10/ All considered for sampling if greater 10% Functionality
2.	Other Industries				
2.1	Leather	25	3	Addis Ababa / Modjo / Kombolcha	ELCO / Ethio Tannery / Kombolcha
2.2	Textile		1	Kombolcha	
2.3	Water Bottling	10	3	YES / Aqua Addis/ Aqua	AA/Bishoftu/
2.4	Beverage				
2.4.1	Alcohol	11	2	National Alcohol and Bale Zaf	
2.4.2	Beer	3	3	St George / Meta / Walia	
2.4.3	Soft Drinks	2	2	Moha / East Africa	
2.5	Dairy Farm	4	2	Shola / Mama / Holland	Shola /Mama / Family / Holland
2.6	Metal Industries	12	2	Kaliti / EAST	
	Total		**20**		

3.2.4 Field Visit

The field visit is organized to reach the selected sample areas from 07/05 to 27/05/2018 covering the major samples except some institutions in the capital and some towns near the source of Awash – Ginchi.

3.2.4.1 Organization

The general organization of the field activities for the project is based on the samples selected by the four technical teams – WP2/ Irrigation, WP3/Water Supply, WP4/Treated Wastewater Discharge and WP5/ Hydropower, Recreation, Fishery and Aquaculture – and endorsed with modification and additions as required by the non-technical sub-teams of WP1 – Social, Economic and Legal and Institutional.

In particular, WP3 field visit is organized in to 3 routes namely:

- Route 1 Addis Ababa and its surrounding including upstream to Awash Source to Ginchi
- Route 2 – Addis Ababa - Shewa Robit – Efesson – Kombolcha – Dessie – Mille – Semera
- Route 3 – Addis Ababa – Dukem – Bishoftu – Mojo – Adama – Awash Sebat – Chiro – Dire Dawa

The detailed field schedule with estimate of number of days and proposed overnight towns is annexed as Annex 02 and the proposed route map is shown in fig. 3.3.

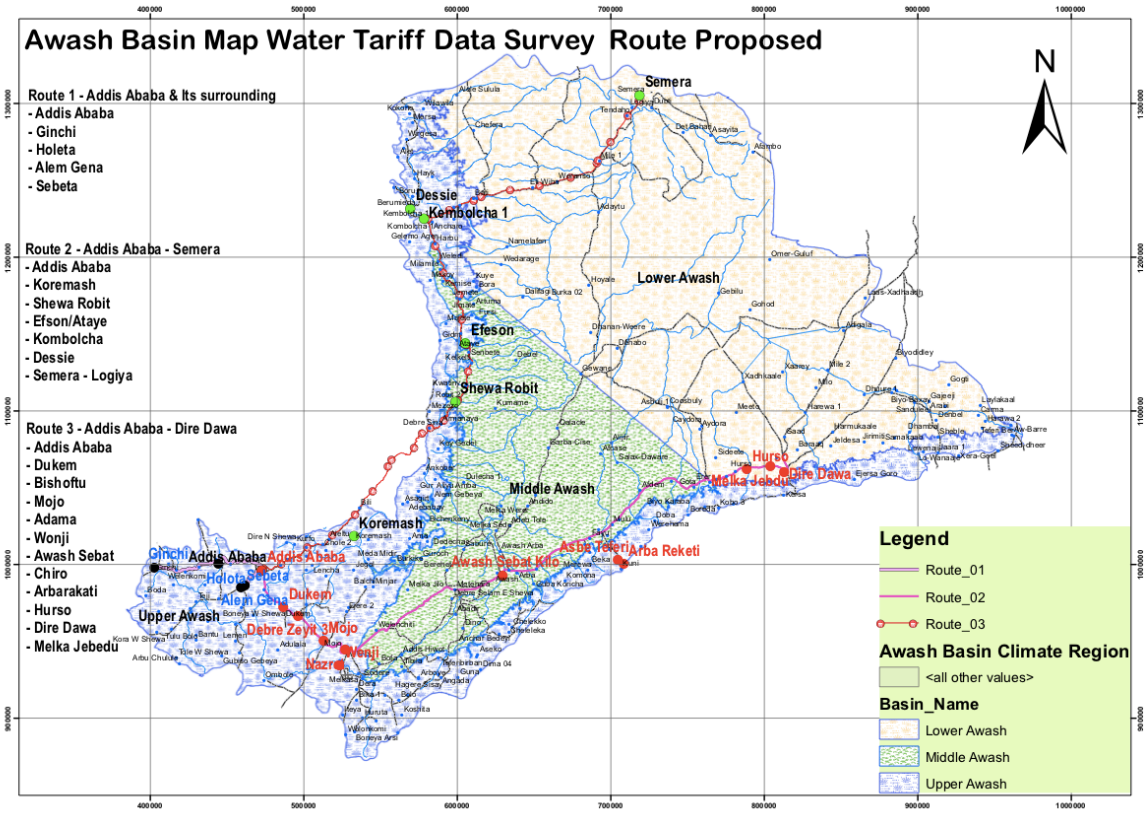

Figure 3-1 Proposed Field Visit Routes for WP3

3.2.4.2 Activities accomplished

The following activities were carried out during the field visit that took place from May 07 to May 26/2018 and the actual route followed and visited sites presented on fig. 3.4.

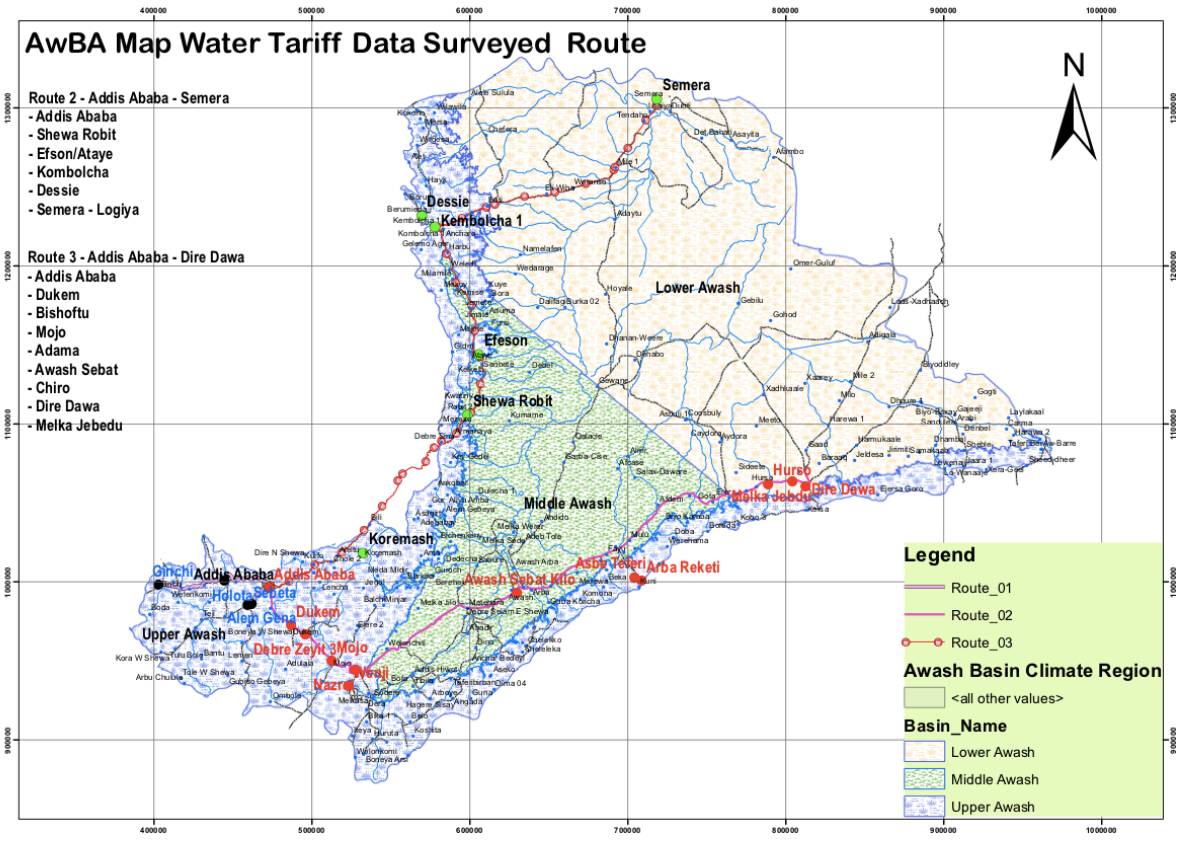

Figure 3-2 WP3 Surveyed areas

The number of visited locations is summarized in Table 3.5 and the detailed tables categorized as municipalities, industries and recreation Annex 03.

Table 3-4 Summary of number of Locations visited, universities and rural water supply is presented in

Description of Visited Locations	Number	Remark
Water Supply and Sanitation Offices	11	In addition to the offices/ Industries…, water sources, transmission lines, reservoirs and protection activities if any are visited
Industries	6	
Recreation Areas	2	
Universities	4	
Rural Water Supply	3	

3.2.4.3 Findings

3.2.4.3.1 General

As mentioned in the introduction, the main purpose of the field visit was to get the necessary input data for the model hereunder which was developed at the early conceptualization stage in order to estimate water charge presented in Eqn. 1.

$$WAU_c = EF_f S_f G_f (WSP_c + BSA_c - EQI_c) \quad \text{Eqn. 1}$$

Where:

WAU_c = Water Abstraction/Use Charge
WSP_c = Water Source Protection Cost
BSA_c = Basin Sustainability Assurance Cost
EQI_c = Environmental Quality Improvement Cost (to be obtained from WP4)
EF_f = Economic and Financial Factors
S_f = Social Factors
G_f = Governance Factor

The key parameters that require technical input based on the field visit to determine Water Abstraction Use Charge (WAUc) are Water Source Protection Cost (WSPc) and Basin Sustainability Assurance Cost (BSAc). Considering the basic principle of water source protection for water supply, international practice and related literatures show that, there are three levels of protection zones for source protection as presented in the sections below for both surface and groundwater.

3.2.4.4 Source Protection

The protection zone delineation for various types of water sources are based on the general principle of minimizing the risk of contamination and reduction of quantity of water supply. Though the principle of protection zone delineation is the same, there are specific guidelines for setting surface water and groundwater protection zones.

Surface Water

In principle most literatures consider three protection zones numbered from 1 to 3. In the absence of specific catchment information the following rules, presented in table 3.6 can be used as a guideline (Thompson, 2015). This is based on the experience of New Zealand. The values indicated in the guideline can also be determined by a specific study.

Table 3-5 Guide for protection zone delineation for river intake (Thompson)

Protection Zone	Description
Zone 1 (Intake Management)	5 m wide strip extending for up to 1,000 m upstream of the intake
Zone 2 (Immediate buffer)	100 m wide buffer strip extending for a distance of 8 hours travel time at median flow velocity
Zone 3 (Catchment)	Up to an entire upstream catchment

Source: adapted from Thompson (2015)

A study carried out by AquaResource (2010) on the vulnerability of protection zone areas for a Eramosa river intake in the City of Guelph, Source Protection Project indicates vulnerability decreases as one goes further from the source and the land use becomes closer to natural condition as shown in table 3.7. The source vulnerability factor range is from 0.9 to 1.0 and in this particular case the maximum value is taken considering the specific situation of the intake site and activities in the protection zones.

Table 3-6 Summary of Vulnerability Scores for Eramosa River Intake IPZs

Intake Protection Zone	Area Vulnerability Factor	Source Vulnerability Factor	Vulnerability Score
IPZ-1	10	1	10
IPZ-2	7	1	7
IPZ-3 Built Up Areas	5	1	5
IPZ-3 Agricultural Areas	3	1	3
IPZ-3 Natural Areas	1	1	1

Source: adapted from AquaResource (2010)

Groundwater

The center of groundwater abstraction is the well head and protections are established considering a radial distance from the well head or time of travel (TOT) to the well head. Usually there are 4 zones delineated from A to D. For example, well head protection zones for the City of Gulph are specified as presented in table 3.8.

Table 3-7 Well head protection areas category and description

Well Head Protection Area (WHPA)	Description
WHPA-A:	the surface and subsurface area centered on the well with an outer boundary identified by a radius of 100 meters;
WHPA-B:	the surface and subsurface areas within which the time-of-travel to the well is less than or equal to two years but excluding WHPA-A;
WHPA-C:	the surface and subsurface areas within which the time-of-travel to the well is less than or equal to five years but greater than two years
WHPA-D:	the surface and subsurface areas within which the time-of-travel to the well is less than or equal to twenty-five years but greater than five years

Source: adapted from AquaResource (2010)

Considering vulnerability of the WHPAs, as in the case of surface water vulnerability the further the protection zone boundary the less the vulnerability though its determination is complicated. The groundwater vulnerability score table developed by the Ministry of Environment of Canada (2009) shown in table 3.9 confirms this.

Table 3-8 Wellhead Protection Area vulnerability scores (Technical Rules (MOE, 2009)

Groundwater Vulnerability Category for the Area	WHPA-A (100 m)	WHPA-B (2-Year TOT)	WHPA-C (5-Year TOT)	WHPA-D (25-Year TOT)
High	10	10	8	6
Medium	10	8	6	4
Low	10	6	4	2

Note: TOT represents time of travel

Considering the above model, data from PZI and PZII or WHPA-A to C are inputs for WSPc and any data regarding PZIII are inputs for BSAc.

The generalized summary of the findings of the field visit with regard to getting data for the model and awareness and readiness to pay water abstraction charge is presented in table 3.10.

Table 3-9 Generalized summary of field visit findings

Abstractors	Practice /Opinion on Water Abstraction Charge	Protection Activities	Institutional Responsibilities / Guidelines	Challenges
Municipalities	- No payment for abstraction, some are skeptical but most agree if necessary services are provided that ensure sustainability of water sources abstraction charge can be reasonable	- Mainly fencing surrounding the water wells and it is difficult to get separate cost of the protection activities and there is no as such protection activity divided in to protection zones except some effort in Kombolcha and Dessie to preserve the watershed	- Fencing is carried out by the water utilities but catchment rehabilitation is implemented as part of the general environmental rehabilitation annual program not in direct relation with water source protection. The environmental rehabilitation is usually the responsibility of agricultural offices.	Water Utilities are not getting the required support to protect the immediate vicinity of water supply sources since allocation of land for housing and industry as the result of urbanization is endangering the existing water supply sources.
Industries	Same as above but some argue that why should they pay if they develop the source	Except fencing no protection activity	With regards to guideline, a proclamation by Amhara Regional State for delineation of immediate protection zones that can be considered as PZ1 is available but it does not cover the whole spectrum of protection of water supply sources.	

Universities	No payment and some argue if asked to pay as a budgetary institution it has an implication on their budget			
Recreation Centers	No payment some agree to pay as long as the water source is sustained while others are skeptical			

In general, the findings shows that there is no practical experience of water abstraction charge and systematic water supply source protection activity that could be the basis to determine the water abstraction charge. Hence, the water abstraction charge will be determine by utilizing international experience for the classification of water protection zones and activities to be carried out in each zone and utilizing local costs collected from activities that are pertinent for the estimation of the parameters of water abstraction charge estimation model.

3.2.4.4.1 Spatial and temporal aspects water source protection

Though there are common aspects of water source protection irrespective of location, the field visit revealed the need for water source protection and risks have spatial pattern. This can be seen from three perspectives.

- *Urbanization impact*

  The field visit revealed that most of the water sources developed before 15 to 20 years are at risk of contamination as they are encircled by urbanization in which significant land use change is observed through expansion of residential, commercial and industrial activities. Not only contamination reduction of yield was also observed. Fig. 3.5 shows the situation in Epheson town.

Figure 3-3 Residential development just upstream of fenced water supply well in Effeson

- *Upstream/ Highland sources*

The problem related to water source protection in upstream – highlands is mainly catchment protection. The degradation of the mountains which are usually water sources is the main concern and usually manifested in the decrease of yield of wells and springs. This situation can be observed upstream of the springs situated at mid and foot of Tossa Mountain (fig. 3.6).

Figure 3-4 Spring source at the foot of barren Tossa mountain in Dessie

- *Downstream/ Lowland sources*

Downstream sources are usually wells and the water sources are recharges from rivers flowing from highlands and usually the immediate concern of protection associated with flooding as can be seen the dismantling of well by flood from Logia river (fig. 3.7). Hence, special attention is

required while selecting abstraction points and determining the required protection particularly in PZI and PZII.

Figure 3-5 Dismantled and eroded well head, pump house… of well located adjacent to Logia river

3.3 Problems Encountered

The major problems encountered during the field visit were:

- Absence of organized data in various offices though the cooperation especially from staff of Water Supply and Sanitation Offices is exemplary.
- Lack of cooperation by some industries to provide data
- Absence of existing link with the Awash Basin Authority and those responsible for water abstraction for domestic and non-domestic purposes.
- Except a proclamation by Amhara National Regional State, absence of guideline and awareness on water protection and water abstraction issues.

4 Water Abstraction/ Use Charge Setting

4.1 General

As clearly presented in the above sections, despite the presence of water policy and proclamation that enables basin authorities to collect water abstraction charge from water abstractors and/or users this is not practiced in the domestic and non-domestic water supply sector. Thus, there is no practical national experience to set water abstraction charge. Thus, the issue is what should the water abstraction charge be based considering the model developed for charge estimation in the above section. The other question is there a need to modify the model? What is required to be introduced in the Basin Authority since in its current form there is no section which is concerned with the domestic and non-domestic water supply sector activities.

International experiences shown in the previous sections show that the main activity of a basin authority is a water resource management activity so that sustainable provision of water in sufficient quantity and acceptable quality is ensured. Thus, the major activities are monitoring and supervision works. This requires both fixed and variable costs to be covered by the charge to be collected.

According to literature and practices in developed countries, with regard to the domestic and non-domestic water supply sector, sustainability is ensured through the development of protection zones for water supply sources and the monitoring and supervision of the conditions of the protection zones. Normally, charges collected from water abstraction are used for the monitoring and supervision activities.

The points previously discussed on protection zones indicate that protection zones are the key for sustainable provision of water in sufficient quantity and acceptable quality. To ensure this water utilities and other water abstractors are the key actors in the development and day to day follow up of the protection zones especially protection zones I and II in the case of surface water and depending on the situation from WHPA A to C in the case of groundwater sources.

The basin authorities should make sure that protection zones are properly implemented through monitoring and supervision activities and also responsible for the watershed management.

4.2 Cost basis for charge development

Considering the issues discussed above and the situation on the ground at water utilities, industries and Awash Basin Authority, the need for a strong Water Supply Supervision and Monitoring section is apparent. Currently, water abstraction charge, water protection practice and

monitoring and supervision of water protection zones are practically non-existent. The charge development for domestic and non-domestic water supply considers the following.

- Water utilities and other abstractors are responsible for the development and day to day follow up of protection zones
- Catchment protection or watershed management activities are going to be carried out by pertinent regional and federal authorities
- Basin authority is responsible for the supervision and monitoring of protection zones and upstream watershed management.

Thus, fixed and variable costs required for protection zones monitoring and supervision and the cost for watershed management are considered as a basis for charge development.

4.3 Modification of Water Charge Estimation Model

The need for modification of the model developed at early conceptualization stage is carried out based on three points.

- The first point is discussion carried out on governance factor and social factors revealed that though factors can be developed they could not be applied on developed charges as they are not basically based on quantitative but only qualitative factors. Thus such factors could be discussed in the report and some recommendations could come out from the factors that could support the charge development and its implementation.
- The second point is the need to separate the fixed and variable costs and includes the annual abstracted water volume (V_{annual}) in the formula while calculating annual variable charge amounts.
- The third point is the fact that the subtraction based on Environmental Quality is to be handled by the K factor from WP4 which has a maximum value of unity. The K_f will be less than 1 if the water source in an area where the assimilative capacity of the river is reduced due to anthropogenic activities.
- A water user factor (U_f) is introduced to differentiate municipality and industrial abstractors.
- In the case of industrial use an industrial factor (I_f) to differentiate between water based (beverage and bottling) and other companies introduced.

Thus, considering these facts the annual Water Charge Estimation Model is modified as follows in Eqn. 2

$$WAU_{charge} = E_{f*}\ I_f\ (WSP_{mcf}+WSM) + E_f*K_f\ *U_f*I_f(WSP_{cv}*V_{annual}) \ldots\ldots..(Eqn.\ 2)$$

WAU_{charge} = Water Abstraction / Use Charge [Birr/year]
E_f = Economic factor [1]
K_f = Location factor [1]
U_f = User factor [1]
I_f = Industry factor [1]
WSP_{cf} = Water Source Protection Management Cost : Fixed [Birr/year]
WSM = Watershed Management Cost [Birr/ year]
WSP_{mcv} = Water Source Protection Management Cost : Variable [Birr/m^3]
V_{annual} = Volume of Water Abstracted/Used annually [m^3/year]

Reconsideration is made based on international experience and due to lack of detailed data and prevalent existing policy and legal frameworks like:.

- No difference is based on type of sources
- Difference is made between municipal and industrial water abstractors
- Abstraction charges for rural water supply not considered – domestic and livestock is assumed to be subsidized
- Municipalities' annual water abstraction volume and population are used to calculate the annual variable and fixed charge respectively.
- Industries are categorized in to two – water based and others to differentiate them those who are almost totally dependent on water for their production and others who use it as input for manufacturing
- Previous water allocation modeling and conflict resolution study at Awash Basin Level and recent Water Demand study are utilized for some critical water demand data.

4.4 Charge Setting

Basic information/ assumption

- AWBA will establish a Water Supply Department or Directorate that will be involved on the monitoring and supervision of water source protection activities and watershed management activities at Head Office level and 3 branch offices at Dire Dawa, Semera and Kombolcha and required fixed and variable cost for this offices to carry out monitoring and supervision activities is estimated
- In Awash Basin a total population of 16 million is considered based on recent statistical data

- Charges will be reviewed periodically to consider changes in price of inputs for monitoring and supervision

4.4.1 Estimated Charge

4.4.1.1 Water Source Protection Cost

The following tables show the summary of estimated charge for water abstraction by municipality. The first step is to determine the annual total fixed and variable cost. Then this cost is used to determine the charge constants and coefficients based on annual abstraction volume, population for municipalities and population equivalent of industrial water consumption.

To begin with the Water Source Protection, variable and fixed costs are determined based on the detailed annual estimation of the cost for supervision and monitoring of protection areas. The summary of Annual cost is presented in table 4.1.

Table 4-1 Estimated Water Source Protection Cost

Item	Description	Fixed	Variable	Total
1	Human Resource	1,332,000		1,332,000
2	Infrastructure	1,406,470		1,406,470
3	Vehicle	850,000		850,000
4	Operating Cost (Supplies/Fuel and Lubricant /Perdiem / Repair and Maintenance/ Communication)		970,703	970,703
	Total Cost	3,588,470	970,703	4,559,173

The estimated cost in table 4.1 has fixed and variable component. The variable component is to be charged based on annual water abstraction volume while the fixed recovered based on population or population equivalent for industries.

4.4.1.2 Estimation of Watershed Management Cost

The watershed management cost is developed based on data collected and detailed watershed management cost developed for Hawassa Lake and others. The detailed estimation is presented in Annex 03. Based on the estimation the total watershed management cost is subdivided among the four technical work packages based on their consumption of water resources and the need for

watershed management. Accordingly, the watershed management cost for each sector is shown in table 4.2

Table 4-2 Watershed management cost by work package

WP#	Description	% of Water Management Cost	Watershed Management Cost by WP (Birr / Year)
WP2	Irrigation	50	6,631,875
WP3	Domestic and Non-Domestic Water Supply	20	2,652,750
WP4	Treated Wastewater Discharge	5	663,187.5
WP5	Hydropower / Aquaculture-Fishery / Recreation	25	3,315,937.5
	Total	**100**	**13,263,750**

4.4.1.3 Unit variable water source protection cost

The annual consumption estimated based on the water allocation and conflict resolution study is subdivided into rural, urban and industrial. Table 4.3 shows the summary of water demand between rural, urban, industrial and livestock as per the document.

Table 4-3 Water demand by consumption category and settlement pattern

Consumption Category	Settlement		Total	Remark
	Urban	Rural		
Domestic	197,235,000	241,065,000	438,300,000	35% urban population demands 45% of domestic production
Industrial	15,742,000		15,742,000	All industries in urban areas
Livestock	2,114,890	190,340,1000	211,489,000	1% of livestock in Urban areas
Total	215,091,890	431,405,1000	665,531,000	

Considering costs for rural water supply charges will be subsidized, the charge per m3 is calculated taking the total demand of urban domestic and industrial which is equal to 215,091,890 m3/year. Hence charge per m3 will be (Birr 970,703/215,091,890m3 = 0.0045 Birr/m3) 0.0045. This value is going to be multiplied with the annual water abstraction volume

to get the total variable charge. As the variable cost might vary from time to time, it is necessary to revisit the total variable cost and make the necessary adjustments in a certain year interval.

4.4.1.4 Fixed cost

The fixed cost has two components. The one for water protection zone 1 and 2 which is for domestic and non-domestic water supply source protection while the 2nd is the watershed management cost shared between the various sectors – irrigation, hydropower, fishery, recreation and treated wastewater discharge. The watershed management cost is taken as 15% of overall watershed development and management cost based on a recent study on watershed development project carried out for Hawassa Lake. The amount proportioned for WP3 is Birr 2,652,750 (20% of the total cost). Considering the fixed cost value for water source protection – Birr 3,588,470; the total fixed cost of WP3 is Birr 6,241,220/ year. This total fixed cost should be subdivided among the urban and industrial sectors and also in the urban context among the various municipalities depending on certain criteria. The following steps are followed.

Step 1 – Dividing fixed cost by demand category

The fixed cost is subdivided among municipality and industrial water supply based on the proportion of the annual water demand as shown in table 4.4. Based on this proportion the share of fixed cost for urban municipalities and industries is taken. The assumption is that most of the industry demand is satisfied through self-abstraction, but where this is not the case the municipalities are the ones paying the abstraction charge.

Table 4-4 Subdivision of annual fixed cost by abstractor and cost category

Demand Category	Annual Demand (m^3/year)	Proportion of Total	Annual Fixed Cost (Birr/year)		Annual Fixed Cost by Cost Category Birr/ Year	
			Water Source Protection	Watershed Management	Water Source Protection	Watershed Management
Urban	197,235,000	0.92	3,588,470	2,652,750	3,301,392	2,440,530
Industrial	17,856,890	0.08			287,078	212,220
Total	**215,091,890**	**1.0**			**3,588,470**	**2,652,750**

Step 2 : Determining municipalities fixed water abstraction charge

The fixed water charge for municipalities should be divided among municipalities based on the population they serve as it is difficult to relate it to water production. All municipalities should pay for the fixed cost based on their population. The annual water abstraction charge per person is determined considering the current estimated urban population of about 5.6 million (35% of total).

Thus, the per capita annual fixed charge for water source protection

= Annual Fixed Cost/ Population

= 3,301,392 (Birr/year)/5,600,000 person

= 0.59 Birr/ year – person

Similarly, the per capita annual fixed charge for watershed management

= Annual Fixed Cost/ Population

= 2,440,530 (Birr/year)//5,600,000 person

= 0.44Birr / year – person

Therefore, municipalities should pay this fixed cost corresponding to their population for a certain period and when the charge is revised both the change in fixed cost and the number of population need to be considered.

Step 3 Fixed cost for Industries

In order to determine the fixed cost for industrial use, the industrial water demand should be converted to population equivalent. For this the average per capita demand is required to be determined considering the overall domestic and industrial demand divided by the average population of the basin.

Accordingly, the average annual per capita demand is:

= (Domestic + Industrial + Livestock/Urban)/Total Population

= (438,300,000 + 15,742,000 + 2,114,890) (m^3/year)/ 16,000,000 person

= 456,156,890 (m^3/year) / 16,000,000 person

= 29 m^3/person-year

Hence, the equivalent population of the industrial demand is:

= Industrial Demand (m^3/year)/Per capita demand m^3/person-year)

= 17,856,890 (m^3/year) / 29m^3/ person-year

= 615,755 persons

Considering this equivalent population size, the average fixed per capita cost can be determined from the fixed cost calculated for water source protection and watershed management activities as follows:

Thus, the per capita annual fixed charge for water source protection is:

= Annual Fixed Cost/ Industrial Population Equivalent

= 287,078 (Birr/year)/ 615,755 person

= 0.47 Birr / year-person

Similarly, the per capita annual fixed charge for watershed management

= Annual Fixed Cost/ Industrial Population Equivalent

= 212,220 (Birr/year) /615,755 person

= 0.34 Birr / year – person

4.4.2 Final Water abstraction model and charge

Before presenting the final model the factors/constants and the equations for water protection management and watershed management are presented as follows:

4.4.2.1 Factors/Constants

E_f = 1.07 from economic/financial analysis

K_f = 1 for sources upstream of Addis Ababa and similar sites where the raw water is not significantly exposed for anthropogenic influences

= 0.83 for sources located between Addis Ababa and Koka Dam where there is significant pollution due to industrial and domestic wastewater and similar other sites in the basin

= 0.95 for sources downstream of Koka Dam where there is no that much industrial pollution and other similar sites in the basin

U_f = 1 for municipalities to encourage water savings with no charge reduction

= 0.8 for industries to encourage manufacturing through charge reduction

I_f = 1 for non-water based industries to encourage manufacturing

= 4.5 for beverages and water bottling companies as the major input is water (refer section 4.4.2.5

WSP_{cv} = 0.0045 Birr/m^3 – it depends on the annual variable cost and water demand of the basin hence requires frequent revision based on the current data

4.4.2.2 Sub-Equations

Municipalities

WSP_{mcf} = 0.59*P

WSM = 0.44*P; where P is the current urban population in the particular municipality

Industries

WSP_{mcf} = 0.47*P

WSM = 0.34*P; where P is the population equivalent for industrial water demand in the particular industry based on the current prevailing annual water demand of 29 m^3/person-year which could be revised from time to time.

4.4.2.3 Final Model and Equations

Thus, the final modified water charge model for municipal and industrial abstraction is presented in Eqn. 3 – I_f is applicable only for industrial water abstraction

$$WAU_{charge} = E_f(WSP_{mcf}+WSM) + E_f*K_f *U_f*I_f*WSP_{cv}*V_{annual}\ldots\ldots \text{Eqn. 3}$$

Substituting factors/constants and the sub-equations in Eq. 3 for municipal and industrial cases is presented in eqn. 3.1 and 3.2 coefficients and sub-equations for municipal and industrial

Municipal Utilities

Upstream of Addis Ababa (Similar areas)

WAU_{charge} = 1.07*(0.59*P+0.44*P) + 0.0045*1.07*1*1 *V_{annual}…Eqn. 3.1a

= 1.102P+0.00482V_{annual}

Where P = population of the town served (persons)

V= Volume of water abstracted annually (m3/year)

Between Addis Ababa and Koka Dam (Similar areas)

WAU_{charge} = 1.07(0.59*P+0.44*P) + 0.0045*1.07*0.83*1.0*V_{annual}…Eqn. 3.1b

= 1.102P+0.00400V_{annual}

Downstream of Koka

WAU_{charge} = 1.07(0.59*P+0.44*P) + 0.0045*1.07*0.95*1.0V_{annual}…Eqn. 3.1c

= 1.102P+0.00457V_{annual}

Industries (Keeping I_f constant 1 for the time being- for none-water based industries)

Upstream of Addis Ababa

WAU_{charge} = 1.07(0.47*P+0.34*P) + 0.0045*1.07*1*0.8*1*V_{annual}…Eqn. 3.2a

= 0.867P+0.00385V_{annual}

Where P = Population equivalent derived from the annual industrial and per capita water consumption

Between Addis Ababa and Koka Dam

WAU_{charge} = 1.07(0.47*P+0.34*P) + 0.0045*1.07*0.83*0.8*1*V_{annual}…Eqn. 3.2b

= 0.867P+0.00320V_{annual}

Downstream of Koka Dam

WAU_{charge} = 1.07(0.47*P+0.34*P) + 0.0045*1.07*0.95*0.8*1*V_{annual}…Eqn. 3.2c

= 0.867P+0.00366V_{annual}

4.4.2.4 Equivalent Volumetric Charge

The above equations gives the total annual charge for a water utility or industry abstracting water which is Birr /year upon inserting the population or equivalent population and the annual abstracted volume of water in m3 in the equations. Hereunder, the equivalent volumetric charge (Birr/m3 or Cents / m3) is calculated based on an annual average water consumption of 29 m3/year-person.

Municipal utilities

Upstream of Addis = 1.102/29 + 0.00482 = 0.0380+0.00482

= 0.0428 Birr / m^3

= 4.28 cents/ m^3

Between Addis and Koka Dam = 0.0380 + 0.00400

= 0.0420 Birr/m^3

= 4.20 cents/ m^3

Downstream of Koka Dam = 0.0380+0.00457

= 0.0426 Birr / m^3

= 4.26 cents/ m^3

From the above calculations, the average volumetric charge is 0.0425 Birr/m^3 or 4.25 cents/m^3.

Industries

Upstream of Addis = 0.867/29 + 0.00385 = 0.0299+0.00385

= 0.0338 Birr / m^3

= 3.38 cents/ m^3

Between Addis and Koka Dam = 0.0299 + 0.00320

= 0.0331 Birr/m^3

= 3.31 cents/ m^3

Downstream of Koka Dam = 0.0299+0.00366

= 0.0336 Birr / m^3

= 3.36 cents/ m^3

From the above calculations, the average volumetric charge is 0.0335 Birr/m^3 or 3.35 cents/m^3.

Considering the above charges developed for municipalities and industries, the charge for domestic purposes is about 30% more than the industries. This is necessary as saving is needed in domestic use and manufacturing needs to be encouraged.

4.4.2.5 Charges for Bottled Water

Bottled water is purified natural/mineral water abstracted either from wells or natural springs. The international practice regarding the charge for bottled water varies.

The experience from the USA indicates that there is no as such abstraction charge but initial license and annual renewal fee (Table 4.5). The charges differs from State to State. Other states do not impose either license / operating fee or abstraction fee.

Table 4-5 Bottled water license/ operating fee schedule (2012)

State	Fee for the original State License	Fee for license renewal	Notes:
Arkansas	$50.00	$50.00	
California	$473 -$1335.00	$473 - $1335.00	For bottlers distributing greater than 5000 gallons per week $473 for less than 5000 gallons per week
Connecticut	$300.00	$150.00	
Illinois	$150.00	$150.00	
Louisiana	$20.00	$20.00	License fee is $20.00 Per brand/resp party/type
Maine (Product)	$150.00	$150.00	
Maine (Bev Container Reg)	$500.00	$500.00	Initiator of deposit fee (may not be the responsibility of the bottler)
Massachusetts	$300.00	$300.00	
Michigan (Product)	$25.00	$25.00	License fee is $25.00 Per brand/type
Mississippi	$200.00	$200.00	
Nevada	$175.00	$175.00	
Nevada (labels)	$83.00	$83.00	Label review fee is assessed once/label @ $83.00 Per label
New Hampshire	$400.00	$400.00	
New Jersey	$1,000.00	$650.00	Initial license fee is per Source
North Dakota	$65.00	$65.00	License fee is $65.00 Per Brand/Type
Oklahoma	$350.00	$250.00	
Rhode Island	$550.00	$550.00	
Vermont	$1,390.00	$1,390.00	For an Operating permit per year per facility
West Virginia	$100.00	$100.00	
Wyoming	$100.00	$50.00	

The experience in UK differs. There is a stringent procedure to get the permit for abstraction followed by an annual abstraction charge per unit volume of water. A study carried out by Plymouth University (2003) discusses in detail about bottled water and indicates by then the water abstraction charge was £ 17.24/1000 m3 which is equal to £ 0.01724/m3 which was equivalent to 0.2586 Birr/m3 (considering £ 1 = 15 Birr in 2003) and with current prices almost 0.5 Birr/m3 which is the same as 50 cents/m3. Considering the level of economic development and environmental awareness starting with 30 % of the abstraction charge for UK the charge for bottled water shall be 15 cents/ m3.

Thus, based on this the industrial factor can be approximated from the average charge for non-water based industries : 15/3.35 = 4.5. This could be If for bottled water and other water based factories.

One point that should be noted here is the bottling companies are charged for water abstracted not for the bottled water sold as they are not the same and the limited literature referred suggested this.

4.4.2.6 Abstraction Charge Comparison

One of the challenges in this study is the fact that there is no as such water abstraction charge nationally for domestic and non-domestic use. The only possibility is to compare it with other countries with similar economic conditions. Though it is difficult to get such an information the China – UK, WRDMAP Integrated Water Resources Management Document Series (2010) gives a very good summary of abstraction charge as water resources fee as shown in Table 4.6

Table 4.6

Table 4-6 Water resource fees in different countries (US cents/m3)

Country	Surface water (SW)	Ground--water (GW)	Abstractor category			
			Water supply	Industry	Agriculture	Other (power)
Danish water supply tax			87.5	Exempt	Exempt	
Dutch GW tax			17.0	13.0	Exempt	12.0
Germany SW			5.0	5.0	0.5	5.0
Czech Republic	Variable	5.0				
Hungary	0.6-4.0	0.6-4.0	Different charges for different user categories			
Poland	2.8	8.4				
Slovakia	52	2-52	2.0	52.0	?	?
England & Wales	2.1-5.0	2.1-5.0	Same basic charges for all user categories,			
Brazil - Pariba dol Sul,			4.60	4.60	0.11	0.09
Canada (Quebec)	1.0	1.0				
South Africa (varies by river basin)						
- Median			0.19	0.19	0.12	0.07
- Minimum			0.06	0.06	0.04	0.04
- Maximum			0.46	0.46	0.18	0.11
China (varies by province)						
- Median	0.7	2.9	2.9	2.1	generally	0.1
- Minimum	0.01	0.3	0.3	0.3	exempt	0.01
- Maximum (unconf aquifer)	5.0	7.9	6.4	7.9		2.1
- Maximum (confined aq.)		18.5	18.5	18.5		

In addition to the above table which gives the water resources fees in different countries by source and user category, the percentage of the abstraction charge when compared with water service charge is presented in table 4.7.

Table 4.7 Comparison of WRF and urban WSC charge in UK

Region	Average WRF (p/m3)	WSC charge	WRF/WSC %
Anglian	1.66	79	2.1
Midlands	0.98	50-74	1.3-2.0
Northumbria/Yorkshire	0.70-1.75	45-59	1.2-3.9
Northwest	0.93		
Southern	1.28	42-98	1.3-3.0
South-western	1.36		
Thames	0.93		
Welsh	0.84	64-82	1.0-1.3

Table 4.7 indicates that the percentage of Water Resources Fee in UK ranges from a minimum of 1% to a maximum of 3 %.

Based on the above data comparing the charge developed with that of South Africa and China, the average charge for municipalities is 4.25 cents/m3 while in South Africa and China the minimum, median and maximum are 1.68, 5.32, and 12.88 cents/m3; and 8.4, 81.2 and 179.2 c/m3 respectively. The average charge is 80% and 51% of the median charge of South Africa and China respectively. On the other hand when comparing the percentage of abstraction charge with water service charge considering a minimum and maximum water use charge of 2 Birr /m3 and 8/m3 respectively the minimum and maximum percentage are 0.53 % and 2.13% respectively resulting with an average value of 1.33% of abstraction charge. This is in line with the values in table 4.7 though it seems it is at the lower end. This is acceptable considering the stage of economic development and degree of awareness on the need for abstraction charge.

5 Conclusion and Recommendation

5.1 Conclusion

- The study to develop water abstraction charge for domestic and non-domestic water supply shows that there is no such practice in Ethiopia. The conceptual model is developed and modified based on literature review and practices in other countries. But the factors and coefficients developed are the result of actual field work and estimates based on current prices and water demand data extracted from previous studies and data collected in this project.

- From institutional perspective, AWBA does not have a section that could handle water supply issues and most stakeholders contacted in field visit has no idea what is its role and possible contribution to their water supply activities.

- In most municipalities, what is available is facility protection. There is no as such water source protection in it is proper sense divided in protection zones and/or well head protection areas. The town administrations are not supporting the limited effort of protection.

- There is no legal backing to the establishment of protection zones except the one found from Amhara region which sets some recommendation for immediate protection which can be considered as protection zone 1

- The charges developed are in line with values from international practice and the social and economic studies have confirmed the affordability and the willingness of abstractors to pay.

- The charges developed for water based factories such as bottling companies is based on the volume of water abstracted not the volume sold and the international experience confirms this practice.

5.2 Recommendation

- AWBA should have a strong team both at head office and suggested branch office in order to monitor and supervise the water protection and watershed management activities.

- There should be appropriate policy and legal framework for water source protection delineation, development and monitoring.

- The developed equations and equivalent volumetric values needs revisiting from time to time as the charges should be dynamic.

- There is a need to enforce both municipalities / utilities and industries to have measurement of the water abstracted annually as the charges developed could not be implemented without measurement.
- Recent population data and equivalent water demand per capita estimate should be updated regularly in order to apply the developed model for charge collection.
- Awareness creation of the need for water abstraction charge to ensure sustainability of water resources and increase efficiency should be made to all pertinent stakeholders.

6 Reference

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7 Annex 01 – Data collection Instrument

The Study of Water Use and Treated Wastewater Discharge Data Collection Instrument

Questionnaire for Domestic and non-domestic water supply extractors/users

Code_____

My name [name of the enumerator] is ……..Signature…….

The Awash Basin Authority is planning to introduce water charge in the Awash Basin. This survey seeks to explore the socio-economic impacts of the water charge and the opinions of people with an aim to identify potential social impacts. Your contribution will help us assess the potential social impacts and develop mitigation measures. So, will you participate on this survey?

Interview date: date_____month_____year_____

Interview time: started: _____Ended: _____

8 Prefatory Information

1. Name of the respondent: _____
2. Name of the institution: _____
3. Household No: _____
4. Water Supply extractor/user category:
    - ○ Institutions extractors=1
    - ○ Institution user=2
    - ○ Individual extractor=3
    - ○ Individual user=4
5. Study location
    - Region _____
    - Zone_____
    - Woreda_____
    - Kebele_____

- Village/site_____
- Upper/middle/lower? _____
- GPS Coordinate: _____

9 Part I: Background Information

9.1 Background Information about the respondent

1. Sex of the respondent
   - ○ Male=1
   - ○ Female=0
2. Age of the respondent: _____[in years].
3. Educational background of the respondent
   - ○ Do not read and write=0
   - ○ Read and Write=1
   - ○ Elementary Complete=2
   - ○ Highschool complete=3
   - ○ Preparatory complete=4
   - ○ Diploma=5
   - ○ Degree=6

   Other, Specify: _____

9.2 Background Information about the household/Institution

4. Household size: _____[in number]

10 Part II. Technical Dimension

Code_____

10.1 Water Source and demand questions

1. What is/are your source of water supply?
   - ☐ River diversion/intake=1
   - ☐ Dam/Reservoir=2
   - ☐ Lake/pond =3
   - ☐ Rainwater harvesting=4
   - ☐ Spring source=5
   - ☐ Shallow well source =6
   - ☐ Deep water source =7
   - ☐ Infiltration gallery/subsurface dam=8

   If any other, please mention them _____
2. How far are beneficiary from the water source?.....in km……..in meter
3. What types of areas are between the source of water and beneficiaries
   - ☐ Marshy areas=1
   - ☐ Forest Areas =2
   - ☐ Grazing land=3
   - ☐ Farm land=4

   If any other, please mention them _____
4. For what purpose you are extracting the water?
   - ☐ To provide water to municipalities=1
     - ☐ Small town (Population 2,000 – 19,999)=11
     - ☐ Medium town (Population 20,000 – 49,999) =12
     - ☐ Large town (50,000 – 99,999)=13
     - ☐ Cities (Population 100,000 – 999,999)=14
     - ☐ Metropolitan (Population >1,000,000)=15
   - ☐ To provide water to rural areas =2
     - ☐ Sedentary [Agriculture]=21

- ☐ Pastoral [for animals]=22

If any other, please mention them _____

5. From the following, to which you supply by extracting water?

- ☐ Governmental Institutions=1
  - ☐ Governmental Educational Institutions=11
    - ☐ Nursery School/Kindergarten=111
    - ☐ High school/Secondary schools=112
    - ☐ Colleges/TVET=113
    - ☐ Universities =114
  - ☐ Governmental Health Institutions=12
    - ☐ health center/health post=121
    - ☐ Pharmacy =122
    - ☐ Clinic =123
    - ☐ Hospital =124
  - ☐ Governmental Administrative institutions=13
    - ☐ Ministries office =131
    - ☐ Authorities=132
    - ☐ Centers=133
    - ☐ Bureau =134
- ☐ Non-governmental Institutions/organizations=2
  - ☐ Local NGOs=21
  - ☐ International NGOs=22
- ☐ Private users=3
  - ☐ residential house=31
  - ☐ real states=33
- ☐ commercial users=4
  - ☐ Hotel/bar/restaurant/café=41
  - ☐ Garage=42
  - ☐ Supermarkets=43
  - ☐ Commercial Building
- ☐ Manufacturing/industries =5
  - ☐ Leather industries =51

- ☐ Food and Beverage industries=52
- ☐ Steel industry=53
- ☐ dairy farm/beef farm=54
- ☐ water bottling=55
- ☐ Recreation =56

6. What is your opinion about the quality of your water supply source?
   - ☐ Very good=5
   - ☐ Good =4
   - ☐ Uncertain=3
   - ☐ Poor=2
   - ☐ Very poor=1

7. What is your opinion on the water source quantity/amount?

- ☐ Very high=5
- ☐ High=4
- ☐ Uncertain=3
- ☐ Low=2
- ☐ Very low=1

8. Do you measure the amount of water that you collect from your water source?
   - ○ Yes=1
   - ○ No=0
9. If yes for Q8, how much is the volume in meter cube? _____per day _____ per month _____ per year?
10. Did you pay for your water abstraction?
    - ○ Yes=1
    - ○ No=0
11. If yes for Q10, how much (birr) per year_____
12. Does your water source quantity increasing or decreasing for the last five years compared to the initial designed quantity?
    - ○ Increasing=1
    - ○ Decreasing=0
13. Based on your answer for Q12, please indicate in percentage: _____
14. Have you made any water source assessment?
    - ○ Yes=1
    - ○ No=0
15. If yes for Q14, on what aspect you made an assessment?
    - ☐ Quantity=1
    - ☐ Quality=2
16. Based on Q15, what was the result?
    - 16.1. Quantity, _____
    - 16.2. Quality, _____
17. Is there any entity (entities) that regularly check your source water?
    - ○ Yes=1
    - ○ No=0
18. If yes for Q17, on what aspect checking is done?
    - ☐ Quantity =1
    - ☐ Quality =2

19. If yes for Q17, who is that entity? _____
20. If No for Q17, do you wish to have such an entity?
    - ○ Yes=1
    - ○ No=0
21. Have you checked or made inventory on possible source water contaminants in your water source?
    - ○ Yes =1
    - ○ No=0
22. If yes for Q21, please specify _____
23. Did you notify the public about threats identified as contaminant?
    - ○ Yes=1
    - ○ No=0
24. If yes for Q21, how much cost you spent to check on possible water contaminants?

    _____

25. Have you made critical source protection area based on your survey/inventory
    - ○ Yes=1
    - ○ No=0
26. How much cost you spent to check on possible water contaminants?

    _____

27. Have you made critical source protection area based on your survey/inventory result?
    - ○ Yes=1
    - ○ No=0
28. What is/are the type of source protection?

    _____

29. Are there different protection zones?
    - ○ Yes=1
    - ○ No=0
30. What is the key criteria to differentiate the type of protection zones?

    _____

10.2 Water source protection Questions

31. Do you have means/methods to protect your water source?
    - ○ Yes=1
    - ○ No=0
32. If yes for Q31, which one of it?
    - ☐ Land use control =1
    - ☐ Land acquisition/buffer zone protection=2

☐ Community awareness creation=3

if any other please, mention them

_____

10.2.1 Land use control

33. Do you have the right to control water source areas land use?
    - ○ Yes =1
    - ○ No=0
34. If yes for Q33, please describe

_____

_____

35. Is there any legal and institutional framework that supports the control of land use?
    - ○ Yes =1
    - ○ No =0
36. If yes for Q35, please describe

_____

_____

37. Do you have experience so far?
    - ○ Yes =1
    - ○ No =0
38. If yes for Q37, please describe

_____

_____

39. Does it have cost implication?
    - ○ Yes=1
    - ○ No=0
40. If yes for Q39, What are the possible cost items? (compensation cost, etc)

_____

41. If yes for Q39, how much does it cost (Birr)? _____
42. If yes for Q39, give us typical example

_____

10.2.2 Land acquisition/buffer zone protection

43. Is there any legal and institutional framework that supports this method?
    - ○ Yes=1
    - ○ No =0
44. If yes for Q43, please describe

    _____

    _____
45. Did you delineated/made protection zone for your water source?
    - ○ Yes=1
    - ○ No=0
46. If yes for Q45, please describe:

    _____

    _____
47. Do you have budget/ source of finance to protect the buffer zone?
    - ○ Yes=1
    - ○ No=0
48. If yes for Q47, please describe

    _____

    _____
49. Does it have cost implication?
    - ○ Yes=1
    - ○ No=0
50. If yes for Q49, what are the possible cost items? (compensation cost, etc)

    _____
51. If yes for Q49, how much does it cost (Birr)per year? _____
52. If yes for Q49, give us typical example

    _____
53. How do you evaluate the applicability of buffer zone delineation for water source protection?
    - ☐ The community is willing not to interfere on these buffer zone =1

- ☐ The community is not in favor of buffer zone protection =2
- ☐ Buffer zone management is challenging and not effective for source protection=3
- ☐ Buffer zone management is not efficient and effective way in our community=4

If any other, please mention them

_____

_____

10.2.3 Community awareness creation

54. How do you create awareness in the community about water source protection?

_____

_____

55. Is the community willing to participate on water source protection?
    - ○ Yes =1
    - ○ No =0
56. If yes for Q55, please describe

_____

_____

57. Is there any kind of incentives for the community while they participate on water source protection?
    - ○ Yes =1
    - ○ No =0
58. If yes for Q57, please mention the incentives:

_____

_____

59. How do you quantify in monetary term (in Birr) the contribution of the community on water source protection?

_____

_____

60. Do you have source of finance for water source protection via creating awareness?
    - ○ Yes =1
    - ○ No =0
61. If yes for 60 how much is it (in Birr)?

_____

_____

10.3 Basin sustainability management questions

Code_____

62. Have you made any kind of inventory on potential sources of contaminants of water source at a basin level?
    - ○ Yes =1
    - ○ No =0
63. If yes for Q62, please describe:

    _____

    _____

64. Have you made any kind of study on the watershed of your water source?
    - ○ Yes =1
    - ○ No =0
65. If yes for Q65, please describe

    _____

    _____

66. Did you implement management measures to prevent, reduce, or eliminate risks to your drinking water supply at a watershed level?
    - ○ Yes =1
    - ○ No =0
67. If yes for Q66, please describe

    _____

    _____

68. Did you develop contingency plan that address water supply contamination or service interruption emergencies?
    - ○ Yes=1
    - ○ No=0
69. If yes for Q68, please describe:

_____

_____

70. Do you have watershed conservation practice?

- ○ Yes=1
- ○ No =0

71. If yes for Q70, what are the common practices that your office is implementing?

- ☐ Terracing=1
- ☐ Afforestation=2
- ☐ Reforestation=3
- ☐ Gabion construction =4
- ☐ Buffer zone demarcation/ making areas free from human and animal intervention =6
- ☐ Check dams=6
- ☐ Dikes=7
- ☐ levees construction =8

If there is any other method of conservation practice, please mention

_____

72. If you say terracing for Q71, what is the average cost per ha or per linear meter length? _____birr/ha, _____birr/meter
73. If you say afforestation for Q71, what is the average afforestation cost per ha? _____birr/ha
74. If you say reforestation for Q71, what is the average reforestation cost per ha? _____birr/ha
75. If you say gabion construction for Q71, what is the average cost of gabion construction per ha or per cubic meter or per linear meter? _____birr/ha, _____birr/meter, _____birr/cubic meter
76. If you say buffer zone demarcation for Q71, is there any institutional or legal framework that support to apply this?
    - ○ Yes=1
    - ○ No=0
77. If yes for Q76, please describe

_____

_____

78. If you say buffer zone demarcation for Q71, in what kind of area, you are applying this method?

_____

_____

79. If you say buffer zone demarcation for Q71, does it have cost?
    - ○ Yes=1
    - ○ No=0

80. If yes for Q79, how much per hectare? Please describe

_____

81. If you say check dams for Q71, how much is the cost for check dam construction per linear meter or per cubic meter? _____
82. If you say dikes for Q71, how much is the cost for dike development per linear meter or per cubic meter? _____
83. If you say levees construction for Q71, how much is the cost for levees construction per linear meter or per cubic meter? _____
84. What type of Physical/Biological soil and water conservation measures do you do to take care of your land?

S. No.	Structure	Done by the respondent	Cost/meter	Total cost
1	stone/earth terraces			
2	stone/earth bunds (walls)			
3	check dams			
4	contour ditches			
5	retention reservoirs			
6	dams			
7	grass water ways			
8	planting pits			
9	afforestation			

85. What equipments are used during building the structures?

S. no.	Equipment	Needed by the respondent	Cost/unit	Total cost

1	Axe			
2	Spade			
3	Hoe			
4				

86. How do you manage your livestock?

- ☐ confined/tethered=1
- ☐ Free grazing =2

87. Has the number of your livestock increased or decreased over the past 10 years?

- ○ Increased=1
- ○ Decreased=0

88. Based on Q87, how much was the change? _____

89. Based on Q87 and Q88, do you expect this trend to continue into the future?

- ○ Yes=1
- ○ No=0

90. Based on Q87and Q88, do you have data to support this information?

- ○ Yes=1
- ○ No=0

91. Do you have livestock?

- ○ Yes=1
- ○ No=0

92. If yes for Q91, fill the appropriate information for the following household livestock assets table.

S.No	Type of Livestock	Number livestock	remark
a.	Bulls		
b.	oxen		
c.	Young bull		
d.	Local cows		

S.No	Type of Livestock	Number livestock	remark
e.	Crossbred Cows		
f.	Local heifers		
g.	Crossbred heifers		
h.	Local calves		
i.	Crossbred Calves		
j.	Sheep		
k.	Goats		
l.	Donkeys		
m.	Horse		
n.	Mule		
o.	Camel		
p.	Poultry		
q.			
r.			
s.			

94. Do you know the average amount of water used per animal on your farm?

- ○ Yes =1
- ○ No =0

95. If yes for Q94, please indicate livestock type and volume of water used

S.No.	Livestock type	Volume of water in liters per day	Remark
1.			
2.			
3.			
4.			
5.			
6.			
7.			

96. Do you know the watering frequency of your animals?

- ○ Yes =1
- ○ No =0

97. If Yes for Q96, how frequent you water your livestock? Household livestock watering frequency

S.No	Type of Livestock	Watering frequency	remark
a.	Bulls		
b.	oxen		
c.	Young bull		
d.	Local cows		
e.	Crossbred Cows		
f.	Local heifers		

g.	Crossbred heifers		
h.	Local calves		
i.	Crossbred Calves		
j.	Sheep		
k.	Goats		
l.	Donkeys		
m.	Horse		
n.	Mule		
o.	Camel		
p.	Poultry		
q.			
r.			
s.			

98. Which month of the year is with water shortage? And how do you cope with the problem?

Sr.No.	Month	Month with water shortage	Coping strategy	Remark
1	Sept			
2	Oct			
3	Nov			
4	Dec			

5	Jan			
6	Feb			
7	Mar			
8	Apr			
9	May			
10	Jun			
11	Jul			
12	Aug			

99. What are the criteria to select conservation area?

- ☐ Degradation of the area =1
- ☐ Flood risk on the area =2
- ☐ Gully formation =3

If any other please mention it

_____

_____

100. How do you explain contribution of the community in watershed area conservation?

_____

_____

101. Did the community benefit from it [watershed area conservation]?

- ○ Yes=1
- ○ No=0

102. If yes for Q101, in what way?

_____

_____

103. Are stakeholders and community participatnts encouraged on protection and conservation of the areas related to water sources?

- ○ Yes=1
- ○ No=0

104. How do you evaluate the initiation of stakeholders on watershed area conservation practice participation?

_____

_____

105. What is the main source of finance for watershed area conservation?

_____

_____

106. Is there a method that regulate the quantity and quality of water in the watershed?

- ○ Yes=1
- ○ No=0

107. If yes for Q106, please describe

_____

_____

108. What is your opinion on your water source watershed area that needs to be addressed in this study?

_____

_____

109. Which part of the watershed area you recommend to be studied to increase your water quality and quantity and why?

_____

_____

110. Have you made a plan to manage your watershed area?

- ○ Yes=1
- ○ No=0

Questionaries' for industries

1. In which group your industry can be categorized?
   1) Food and Beverage Industry (soft drink factories, fruit juice factories, …)
   2) Water Bottling
   3) Brewery industry
   4) Leather/Tannery industry
   5) Steel industry
   6) Chemical Industry
   7) Dairy farm/Livestock industry
   8) Mining industry
   9) Construction industry
   10) Hotel & recreational industry
   11) If other, specify _____
2. What is/are your source of water supply?
   2.1. Independent source from surface water
      1) River diversion/intake
      2) Rainwater harvesting
      3) Water Tracking from River source
      4) Water Tracking from lake/pond/borehole
      5) Other _____
   2.2. Independent source from subsurface water
      1) Spring source
      2) Shallow well source
      3) Deep water source
      4) Other _____
   2.3. If your source of water is independent how much cost you invest to develop it _____ in birr
   2.4. Combined source independent and from Municipality Yes or No
   2.5. If yes, what is the proportion Own ……% Municipality ……..%
   2.6. How far your source of water ……in km ……..in meter
   2.7. How do you rate your water supply source quality?
      1) Bad/poor
      2) Good
      3) Very good
      4) Hard to rate
      5) Any _____
   2.8. How do explain your water source quantity?
      1) Not enough
      2) Enough/adequate

3) Satisfactory
4) Hard to rate
5) Any_____

3. Water Abstraction / Consumption

3.1 How much is the daily average water production from the source in m3……

3.2 How much is the daily average water consumption for industrial production purpose in m3 ……..

3.3 How much unit of products are produced daily (appropriate unit, area / pc/ kg/ton / liter/m3…)

3.4 What is the water consumed to produce unit product in m3…….

4. Water Abstraction Cost

4.1 Do you pay to get permit to abstract water? Yes or No

4.2 If yes How much for what period? (Birr / period) …….

4.3 Do you pay for the amount of water abstracted? Yes or No.

4.4 If yes how much? ……Birr / m3

5. Source Protection

5.1 Do you carry out source protection activities? Yes or No

5.2 If yes what type of protection?

1) Fence around the source

2) Watershed rehabilitation / protection

5.3 What is the cost of water protection for

1) Fencing ……Birr/m

2) Watershed rehabilitation ……Birr / ha

Thank You!

Questionnaire for Universities

6. How much is the University Community?
   12) Students Residing in University……..
   13) Students residing outside…….
   14) Faculties / Support Staff with Residence within University……..
   15) Faculties / Support Staff residing outside University…….
7. What is/are your source of water supply?
   7.1. Independent source from surface water
      6) River diversion/intake
      7) Rainwater harvesting
      8) Water Tracking from River source
      9) Water Tracking from lake/pond/borehole
      10) Other _____
   7.2. Independent source from subsurface water
      5) Spring source
      6) Shallow well source
      7) Deep water source
      8) Other _____
   7.3. If your source of water is independent how much cost you invest to develop it _____ in birr
   7.4. Combined source independent and from Municipality Yes or No
   7.5. If yes, what is the proportion Own ……% Municipality ……..%
   7.6. How far your source of water ……in km ……..in meter
   7.7. How do you rate your water supply source quality?
      6) Bad/poor
      7) Good
      8) Very good
      9) Hard to rate
      10) Any _____
   7.8. How do explain your water source quantity?

6) Not enough
7) Enough/adequate
8) Satisfactory
9) Hard to rate
10) Any_____

8. Water Abstraction / Consumption

3.1 How much is the daily average water production from the source in m3…….

3.2 How much is the daily average water consumption by the University community in m3 ……..

9. Water Abstraction Cost

4.1 Do you pay to get permit to abstract water? Yes or No

4.2 If yes How much for what period? (Birr / period) …….

4.3 Do you pay for the amount of water abstracted? Yes or No.

4.4 If yes how much? ……Birr / m3

10. Source Protection

5.1 Do you carry out source protection activities? Yes or No

5.2 If yes what type of protection?

1) Fence around the source

2) Watershed rehabilitation / protection

5.3 What is the cost of water protection for

1) Fencing ……Birr/m

2) Watershed rehabilitation …….Birr / ha

Thank You