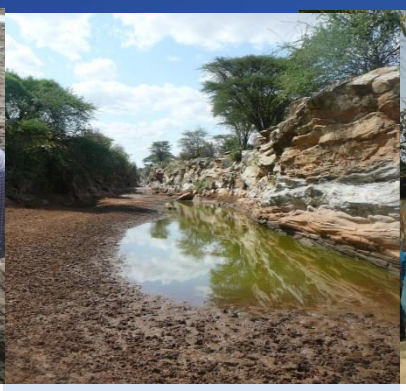
Dec 8, 2020

Baseline Survey Report

For the IWRM4WASH project Addis Ababa, in the Upper Great Akaki sub-catchment, Ethiopia

Final report






VEi

ACACIA WATER

aquacon ENGINEERING PLC

Executive summary

The Integrated Water Resources Management for Water Sanitation and Hygiene (IWRM4WASH) project is a five-year EKN-funded project that aims to improve water resource protection in Addis Ababa's water catchment by upscaling and anchoring IWRM approaches with special focus on increased water and sanitation supply, benefiting approximately 1.3 million people and strengthening market-based approaches. For the implementation of IWRM4WASH a baseline study is required with regard to the existing legal and governance frameworks, the socioeconomic and biophysical watershed status as well as the hydrological resources.

Acacia Water together with AquaCon conducted the survey and studies to establish the biophysical and socio-economic baseline conditions as initial step to the planned IWRM4WASH activities. These will lay a foundation for subsequent studies and implementation. This Baseline Survey Report describes the understanding of the project area through analysis of the data collection results in the field of biophysical characteristics, institutional, socio-economics, environment and gender, to determine the key project indicators for the overall IWRM4WASH project.

The main findings of the Baseline Survey assessment reveals that there is an encroachment of development interventions coupled with poor social & economic infrastructure that pave way for over-cultivation and shortage of land. Besides the existing sanitation facilities such as liquid and solid waste disposal sites are at rudimentary stage that calls urgent attention of stakeholders. All these factors also influence the availability and quality of water in the catchment.

The end result is a long list of 28 potential project objectively verifiable indicators, which the Consultant related to the IWRM4WASH Project Results.

Colophon

Document title	.	Baseline Survey Report
Client	.	VEI
Status	.	Final report
Datum	.	Dec 8, 2020
Project number	.	201094
Author(s)	.	S. de Wildt, R. van der Meulen, A. Ketema
Reference number	.	AW_208_SW_201094
Peer Review	.	V. Langenberg
Released by	.	

Table of contents

Acronyms

3R	'Recharge, Retention and Reuse of (rain)water'
AAWSA	Addis Ababa Water and Sewage Authority
ATA	Agricultural Transformation Agency
BDA	Basin Development Authority
BOD	Biological Oxygen Demand
CMIP5	Coupled Model Intercomparing Project Phase 5
CMP	Catchment management plan
DFID	United Kingdom Department for International Development
EKN	Embassy of the Kingdom of the Netherlands
EC	Electrical conductivity
EEU	Ethiopian Electric Utility (before: Ethiopian Electric Power Corporation, or EEPCo)
EFCC	Environment, Forest and Climate Change, woreda/district office
EIA	Environmental impact assessment
EPA	Environmental Protection Authority
ESIA	Environmental and social impact assessment
EU	European Union
FGD	focus group discussions
FMD	Foot-and-mouth disease
FMNR	farmer managed natural regeneration
GDP	Gross Domestic Product
GIS	Geographic Information System
GoE	Government of Ethiopia
GPS	Global Positioning System
GSE	Geological Survey of Ethiopia
GTP II	Growth and Transformation Plan, Phase II
HH	Household (survey)
INBO	International Network of Basin Organizations
IWRM	Integrated Water Resources Management
KII	Key-informant interviews
L/c/d	Liters per capita per day
L/s	liters per second
LSD	Lumpy skin disease
M&E	Monitoring & Evaluation
m^3/day	cubic meters per day
m asl	meters above sea level
m bgl	meters below ground level

Mm^3	Million cubic meters
mm/y	millimeters per year
MoA	Ministry of Agriculture
MoE	Ministry of Education
MoEFCC	Ministry of Environment, Forest and Climate Change
MoFED	Ministry of Finance and Economic Development
MoH	Ministry of Health
MoWIE	Ministry of Water, Irrigation & Energy
NGO	Non-governmental organization
NMA	National Meteorology Agency
NRW	Non-revenue water
NTU	Nephelometric Turbidity Units
NWCO	National WASH Coordination Office
NW-SE	northwest – southeast (direction)
OWERDB	Oromia Water and Energy Resources Development Bureau
OVI	objectively verifiable indicator
PTS	Participatory training session
RCP	Representative Concentration Pathway
SAFE	Safe Access to Fuel and Energy approach, FAO (2018)
SBWSSE	Sendafa-Beke Water Supply Service Enterprise
SDG	Sustainable Development Goal
SLM	sustainable land management
SME	small and medium enterprise
SWC	soil and water conservation
SWOT	strength, weakness, opportunity & threat (analysis)
TDS	Total dissolved solids
TVET	Technical and Vocational Education and Training
UAP	Universal Access Plan
UGA	Upper Great Akaki (sub-catchment)
UNIDO	United Nations Industrial Development Organization
VEI	Vitens Evides International
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

Abstract

In Chapter 1 the background of the IWRM4WASH project is explained whereby the Upper Great Akaki (UGA) sub-catchment as study area and its two main dam reservoirs – Dire and Legedadi – as water sources to Addis Ababa City are being introduced. Located about 32 km northeast of Addis Ababa City, the catchment is facing a host of socio-economic and environmental issues, most notably caused by landcover changes and environmental degradation. Furthermore, the purpose of executing a Baseline Survey as inception to the IWRM4WASH project is elaborated. The Baseline Survey is required to assess the current situation in various intervention areas as well as to establish the baseline status of project indicators.

Chapter 2 explains the chosen methodological approach to carry out the Baseline Survey, which broadly followed the following steps: 1) desk study review, 2) a qualitative data collection phase including fieldwork and an extensive household survey and 3) analysis and interpretation of the collected data spread over the following main themes: biophysical properties of the UGA sub-catchment, water supply analysis, institutional framework, socio-economic analysis, environmental analysis and gender & youth analysis. Due to the amount of data collected, GIS & database management was an integral part of the assignment method.

Chapter 3 discusses the biophysical properties of the UGA sub-catchment, such as topography, climate, soil and geology. Climate change forecasting analysis using CMIP5 indicate that without comprehensive measures combating climate change there will be a precipitation increase of 123mm and a temperature increase of 1.14°C in the UGA catchment by 2050. Land cover change from native forests to agricultural land and settlements is omnipresent and comprehensive throughout the project area, however land degradation and soil erosion is most prominent in the Upper Dire and Bosena tributaries in the northwest of UGA sub-catchment where slopes can reach up to 60% and were bare landcover allows runoff, erosion and landslides to occur extensively. Landscape restoration and soil loss reduction through sustainable land management, application of soil and water conservation (SWC) techniques, reforestation and protection of forested areas must therefore be given full attention.

The current water supply provision is discussed in Chapter 4, with a focus on the significant contribution of the Dire and Legedadi dam reservoirs and the Legedadi production wells to the water supply of Addis Ababa by AAWSA. The current estimated production of these sources is 214,000 m^3/day, thereby covering 39.5% of AAWSA's total daily production and supplying an estimated 2.6 million people in Addis Ababa with water. The Sendafa-Beke water supply system, the rural water supply as well as the quality of water source in the UGA sub-catchment are also discussed. The current potable water coverage in the UGA sub-catchment is 63.8% with more than 50% of its inhabitants dependent on (shallow) groundwater. The water sources are not always able to supply sufficient water seasonally, especially in periods of drought. The expected yields from new production wells for the Sendafa-Beke Water Supply Services Enterprise (SBWSSE) also seem to be (heavily) overestimated. Given the great dependence on groundwater in particular, the protection and replenishment of aquifers should be a political top priority. In addition, stronger and more dedicated focus on NRW reduction of AAWSA's and SBWSSE's supply systems is needed, as it is a significantly more cost-efficient investment. Moreover, more thought and awareness will have to be given about alternative water sources,

in particular on climate resilient rainwater harvesting and buffering techniques (e.g. 3R), and showcase the impact that such measures could achieve in terms of water provision.

In Chapters 5 – 8 the outcomes and analysis results of the Data Collection phase are discussed, with the Institutional Framework analysis being discussed in Chapter 5. In experience of the stakeholders of the UGA sub-catchment there is no responsible body to coordinate WASH, with water sector planning being fragmented and moving in isolation. On top of acute water shortages, there is no technical capacity among community water committees and water operators to manage water schemes. Survey respondents indicate to have little knowledge about the national land, water and environmental management policies, strategies and development programs in place at district (*woreda*) and regional level. On the other hand, there are enormous capacity limitations in the institutions that must manage and take charge of this, specifically at district (*woreda*) and *kebele* level in terms of human power, financial resources (budget) and operating systems. An important development goal is therefore to strengthen trans-regional dialogue and to promote appropriate linkage mechanisms for the coordination of water resources, sanitation and hygiene management activities, but also other related sectoral fields and departments such as forestry and agriculture, between the federal, regional and district agencies. It is highly desirable to form joint planning, implementation and monitoring mechanism for the WASH sector and smooth information sharing among the partners of the sector.

The socio-economic analysis in Chapter 6 looked into baseline indicators in the field of: population & household characteristics, agricultural production and access to inputs, social services including education, sanitation, waste management and health, and infrastructure and services such as: transportation, telecommunication, electricity and availability of credits and financial mechanisms The main findings of this socioeconomic assessment reveals that there is an encroachment of development interventions coupled with poor social & economic infrastructure that pave way for over-cultivation and shortage of land. Besides, existing sanitation facilities such as liquid and solid waste disposal sites are at rudimentary stage that calls urgent attention of stakeholders. All these factors also influence the availability and quality of water in the catchment.

The environmental analysis in Chapter 7 included identification of flora and fauna in the study area, assessment of the existing environment, impacts from industries, stone quarries and flower farms, and assessment of land use, land degradation, soil erosion prone and gully formation in the upper catchment. With over 50% and still growing, farm or crop land is the dominant land use in the UGA sub-catchment. Farmland is followed by urban settlement and grassland as dominant land uses, whereby grassland has decreased in acreage by 43%, while urban settlement has increased by exactly 100% in the past 50 years. With livestock heads fairly stable around 290,000 heads, this will inevitably lead to land use conflicts. An oil processing industry was found disposing unregulated and untreated industrial waste on its premises, but also to surrounding land and water bodies, thereby heavily contaminating the environment. This was confirmed by the water quality analysis. The majority of manufacturing industries do not have an environmental management plan in place, while regular monitoring by regulatory bodies is absent also due to low capacity and lack of integration among sectorial district and regional offices. Untreated industrial waste is being discharged into important water sources such as wetlands and dam reservoirs. Application of soil and water conservation (SWC) and sustainable land management (SLM) practices in Legedadi and Dire sub catchments is relatively weak, with only 54% of HH respondents indicating that they perform some sort of SWC works on their plot of land and 19% nothing at all. Land fragmentation induced by increasing population growth has put its contribution on land degradation and reduction of

farm productivity. Dividing and re-dividing of the landholding of a family among their offspring reduces size of land per household.

The gender & youth analysis in Chapter 8 focuses especially on the role of women in water management, and was assessed by using various data collection tools, including FGDs, KIIs and site observations. As opposed to the over-representation of women and girls in fetching water as part of household chores, it is observed that there is little participation of women in the water management. In general, women are in any case heavily underrepresented at the decision-making and strategic level, which means that their power influence is very limited formally and institutionally as well. The various women empowerment programs of the Berek Woreda Women & Youth Affairs office to enhance the status of women at all levels should be further supported and expanded. These empowerment programs vary from: 1) empowering women mentally and psychologically, 2) empowering women economically by a) providing high productive cows for poor women and b) distribution of fuel-efficient and improved cooking stoves, to 3) social empowerment by increasing the women participation in every aspect of the social life including political participation. According to the district Women & Youth Affair office the attitude of youth creates a challenge on the success of support programs set up by governments and agencies. Most youth have barely completed primary school and therefore are lagging behind in the labor market in the areas of knowledge, self-development, entrepreneurship and social skills. The municipality of Sendafa town has a plan to engage 2,000 youth on a yearly basis in various manufacturing activities by establishing SME associations and loans. Creating linkages with nearby TVET colleges and contributing to their applied curriculum development are ways to provide employable skill building and entrepreneurial trainings for youth.

Finally, after analyzing all findings and data results in the field of biophysical, institutional, socio-economic, environmental, and gender and youth aspects in the UGA sub-catchment project area, baseline status of IWRM4WASH project indicators are suggested in Chapter 9 that deem important for the execution and implementation of the IWRM4WASH project. This is preceded by an enumeration of the main identified observations and development goals. The end result is a long list of 28 potential project objectively verifiable indicators (OVIs), which have been linked to the four (4) formulated IWRM4WASH Project Results.

1 Introduction

Two of Addis Ababa City's main water sources are the Dire and Legedadi dam reservoirs. Both dam reservoirs are located in the Upper Great Akaki (UGA) sub-catchment, the most upstream part of the Great Akaki catchment which is part of the Awash Basin. The sub-catchment is located an approximate 32 kilometers northeast of Addis Ababa City and lies largely within Oromia Regional State. Collectively the two dam reservoirs contribute about forty percent (39.5%) to Addis Ababa's water supply, which is managed and operated by the Addis Ababa Water and Sewage Authority (AAWSA). See also Figure 1 below.

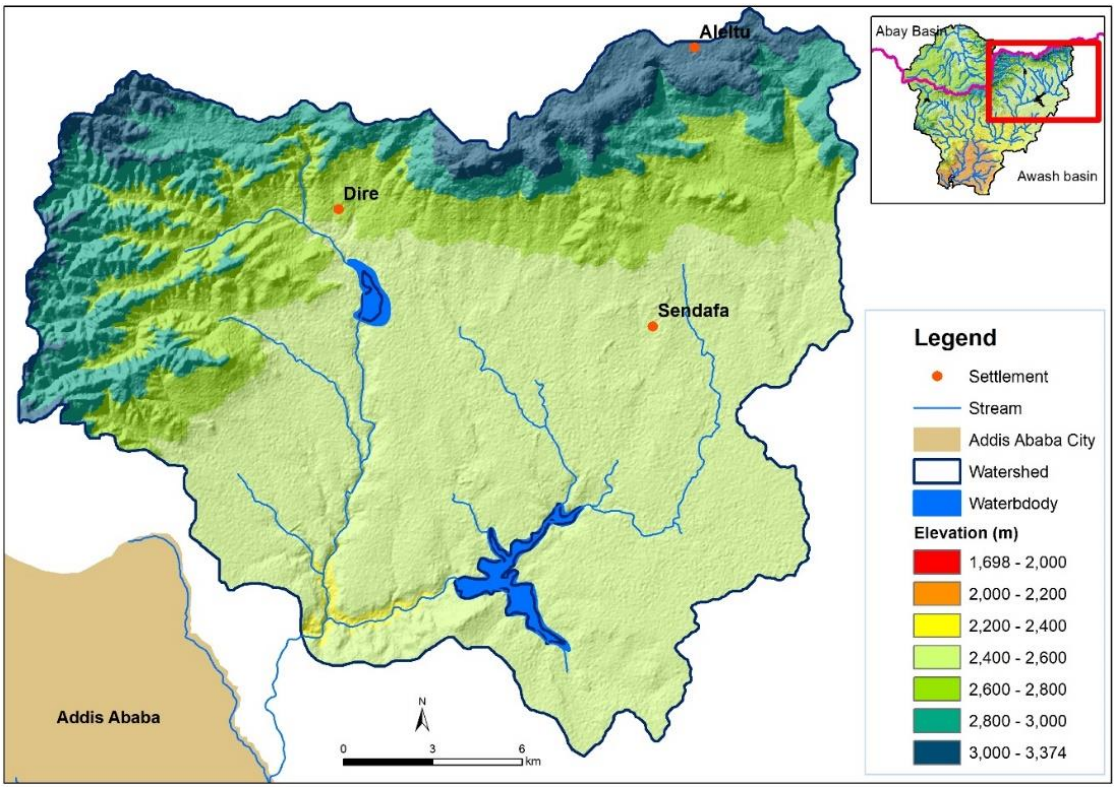


Figure 1. Topographic map of the Upper Great Akaki sub-catchment, encompassing the Legedadi and Dire dam reservoirs

The water supply sources in the UGA sub-catchment are confronted with siltation and associated cost increase of water treatment and reduction in reservoirs live storage capacity. Major land use changes in the catchment, population increase, urbanization and emerging industries are some of the main factors that contribute to this. The problems are interconnected and amplify one another to cause problems to the water supply system of Addis Ababa – which is managed by Addis Ababa Water and Sewage Authority (AAWSA) – as well as to the people living in the catchment. The problems demand for an integrated approach by which management mechanisms focus on environmental protection and proper natural

resources conservation intervention's with due attention to the socio-economic factors and livelihood of the people living within the catchment area.

The Netherlands-based Acacia Water together with the experts of Ethiopian-based AquaCon have conducted field surveys and studies to establish biophysical and socio-economic baseline conditions as initial step to the planned IWRM4WASH activities. This will lay a foundation for subsequent studies and implementation. This Baseline Survey Report presents the final findings of this study as well as baseline conditions and key indicators to enter the inception phase of the project.

IWRM4WASH project

The IWRM4WASH project aims to improve water resource protection in the catchments providing Addis Ababa with water, with specific focus on the UGA sub-catchment. Integrated Water Resource Management (IWRM) will provide the foundation for the strategy to achieve sustainable, equitable, and efficient development. The project aims to improve water and sanitation services provision, while also improving health due to safer drinking water, improving economy and reducing poverty through more resilient livelihoods, and improving catchment ecosystem stability and climate resilience.

'IWRM4WASH, a market-based approach' is a project initiated by Vitens Evides International (VEI) and supported by and for the good of AAWSA, Oromia Water and Energy Resources Development Bureau (OWERDB), and the water utilities of Akaki, Burayu, Gelan, Salulta and Sendafa. The IWRM4WASH project is funded by the Embassy of the Kingdom of the Netherlands (EKN) to Ethiopia.

Project objectives

The overall development objective of this IWRM4WASH project is to:

"Improve water resource protection in Addis Ababa's [main] water catchments by upscaling and anchoring IWRM approaches with special focus on increased water and sanitation supply and strengthening market-based approaches to stimulate self-sustainability in water and sanitation services provision towards realization of SDG 6[1]"

The IWRM4WASH project aims to achieve the overall development objective by addressing and implementing the following eight components and which also form the four (4) Project results as shown in Table 1 below.

Table 1. IWRM4WASH Project Results

Project Result	Project result description
R1	**Trans-regional dialogue** established and strengthened between Addis Ababa City Administration, AAWSA, OWERDB, MoWIE, BDA and other stakeholders in Upper Awash River Basin under the framework to promote IWRM and to foster trans-regional dialogue
R2	**Reservoirs protection**: Enhance the sustainability of the Legedadi and Dire dam reservoirs by improving the water quality and the rate of siltation
R3	**Market based livelihood improvement**: Sustainably enhance the livelihood/food security for people living upstream of Dire and Legedadi dam reservoirs by creating alternative opportunities as incentives to encourage conservation activities
R4	**WASH Development**: Inclusively improve WASH services for 100,000 people living in the catchment areas: 10,000 people (rural) dwellers and 90,000 people living in the cities of Akaki, Burayu, Gelan, Salulta and Sendafa

[1] SDG 6 is United Nation's Sustainable Development Goal 6: clean water and sanitation

In addition, the project will have a strong monitoring and evaluation (M&E) framework. The following cross-cutting themes will be incorporated into the project design and receive considerable attention during this Baseline Survey:

- Knowledge management;
- Gender mainstreaming;
- Climate resilience mainstreaming; and
- Environmental sustainability.

Purpose for a Baseline Survey

The reason for conducting a Baseline Survey is the fact that VEI sought the services of a qualified team of Consultants to carry out a Baseline Survey to assess the current situation in various intervention areas of the project. The Baseline Survey assessment aims to establish the baseline status of project indicators, while at the same time capture relevant issues in the project area which could be picked up by the IWRM4WASH project to improve the intervention logic. The baseline survey will capture a realistic set of indicator values against which the M&E team and other project staff will monitor their progress. These will form part of the monitoring and evaluation framework. The chosen approach, methodology and outcomes of the survey assessment follow in the following chapters.

Study area

As earlier mentioned, the IWRM4WASH project and this Baseline Survey assignment will have focus on the Upper Great Akaki (UGA) sub-catchment area, which also includes the Legedadi and Dire dam reservoirs. The catchment is facing a host of issues. Landcover changes have been observed over the last decades, with many natural areas – most notably forests – being converted to agricultural lands. A more extensive analysis of the characteristics and issues that play a role in the catchment will be elaborated on in the subsequent chapters of this report (Chapters 3 – 8), whereby a further selection of micro-watersheds as focus areas for project interventions will also be substantiated.

2 Methodology

The methodological approach used to carry out the Baseline Survey and associated Inception Phase with desk review study as well as the (qualitative) Data Collection Phase will be presented in this chapter. This cannot be done by first zooming in briefly on the project and development goals of the intended IWRM4WASH project.

2.1 Desk study

The Desk study was part of the Inception Phase and was meant for the Consultant to develop understanding of the context of IWRM4WASH, the project area and its biophysical and socioeconomic characteristics. It involved the reviewing of relevant documents and literature of various institutions regarding the institutional framework as well as the biophysical and socioeconomic context and developments within the Upper Great Akaki (UGA) sub-catchment. The Consultants' team received assistance from AAWSA and VEI with collecting relevant secondary information from previous studies conducted in the project area, readily available documents and sectoral reports.

2.2 Data collection

Field data collection was mainly executed by the following five experts of the Ethiopian consultant:

(1) a Hydrogeologist
(2) Institutional expert
(3) Socio-economic & livelihoods expert
(4) Gender expert
(5) Environmental and IWRM expert

They were assisted by three (3) data collection teams, consisting of in total 19 household survey data collectors (i.e. enumerators) and three field supervisors. These multidisciplinary teams consist of employees from AAWSA, OWERDB and relevant department offices of Berek Woreda. See also Table 2 on the next page.

The Data collection plan has been drawn up to record how survey is executed, data are collected, fieldwork is prepared, which tools are used for this, which sampling protocol and procedures for the household (HH) survey, key-informant interviews (KIIs) and focus group discussion (FGDs) are applied. Some of the main aspects and backgrounds of this methodological approach are explained in the following sections.

2.2.1 Formation of survey teams

The formation of the Data Collection Team has been done in consultation between the Client (AAWSA & VEI) and the Consultant, with input from key stakeholder authorities such as the water bureau and agricultural bureau of the Oromiyaa Regional State Government. This has created a diverse mix of data collection team groups with people from different organizational and professional backgrounds, both public and private, but all with people who know the

Oromia culture and the study area well. For the formation of survey teams the following main activities were carried out:

1. Consultation meetings and discussion with the client's;
2. Nomination and organization of field data collectors;
3. Training data collectors and key informant members' interviewers in participatory baseline survey methods (general).

Participatory Training Sessions

Prior to starting the data collection, data collectors attended a 2-day participatory training session (PTS) organized by VEI in the training center of AAWSA situated near the Legedadi Dam site area to get acquainted with Questionnaires and checklists. The training was held on September 4th and 5th, 2020.

Table 2. IWRM4WASH – Upper Great Akaki catchment – Data Collection Team

	Name	Position	Tel. number	Organization
1	Nebiyu Getachew	Team Leader	0910-689852	VEI
2	Debrie Tujo	Team Leader	0911-407481	AAWSA
	Group 1 (Sire Goyo, Laga Bolo, Walgawooa)			
1	Gudissa Leta	Group 1 Team Leader	0913-021146	Oromoiya Agricultural Bureau
2	Hana Yeshaw	Supervisor	0920-518681	AAWSA
3	Wandu Bashada	Data collector	0922-633643	G.A.O.N.F.
4	Wandu Sisay	Data collector	0973-851845	
5	Buruk Tediros	Data collector	0910-615575	G.A.O.N.F.
6	Dawit Daraje	Data collector	0933-004849	G.A.O.N.F.
7	Masarat Mekonen	Data collector	0910-723107	
	Group 2 (Sendafa)			
1	Mekonen Zerfu	Group 2 Team Leader	0913-343371	Oromiya Water Bureau
2	Feyida Benti	Supervisor	0930-484654	VEI
3	Habtamu Kebede	Data collector	0919-148972	
4	Alemu Dadi	Data collector	0912-962203	
5	Fitsum Bekele	Data collector	0922-466089	
	Group 3 (Dire Urban & Dire rural)			
1	Girma Aredo	Group 3 Team Leader	0913-077145	Woreda Administration
2	Zemenu Tadesse	Supervisor	0918-536168	AAWSA
3	Adugna Kebede	Data collector	0910-846427	
4	Seboka Abera	Data collector	0920-213201	
5	Charuu Tartoo	Data collector	0932-114512	
6	Minoo Tsagayee	Data collector	0940-514934	
7	Galanaa Sefu	Data collector		

The objective of these training days was to provide the basic knowhow on the proposed socio-economic data collection job and to make sure that the identified data collection team collects correct information for HH survey to the expected standard and quality as per the prepared questionnaire. The training was moderated by the socio-economist expert of the Consultants' team (Ato Demei Abara) with assistance of the senior experts of the project (Dr. Abebe Ketema, Mr. Nebiyu Getachew and Mr. Feyisa). The training has been conducted in Oromifa language and successfully completed with active participation of the proposed data collection team members.

During this training phase, the trainees were made familiar through different participatory survey methods, involving self-reflections, group exercise, group works, presentation and plenary discussions, and the like. The sessions in this training give full attention to survey

tools (both qualitative and quantitative), sampling and sampling methods, and data types and data collection.

The main learning goals per training day were:

Day 1 – September 4, 2020

- Explanations on the objective of the baseline survey and methodology;
- Briefing on the content of the draft questionnaires, item by item and guidance on how to fill the answers to the questions and on issues that need special attention in understanding the question itself;
- Questions and answers session by the participants for issues not clear;
- Identifications of points for further clarifications, additions or omissions for the preparation of the final questionnaire for use during the actual survey;
- The draft questionnaires have been distributed to the participants to take home and exercise by interviewing their respective family and bring the result for assessment on the next day before going to the pre-test session out there in the field.

Day 2 – September 5, 2020

- Data Collection Teams are in the field for a half-day pre-testing mission;
- The afternoon session was dedicated for exhaustive evaluations of the filled questionnaires, identifications of issues and points that have been practically tested in the field so that these can be re-consider and corrected in the final production of the questioners and, giving detailed advice to the team for execution of the actual planned survey work which was scheduled to commence starting from Tuesday Sep 08, 2020.
- Provided the necessary advice and notice to the supervisors for the day to day follow-up of the work; so that the survey shall be completed possibly within 7 to 8 working days without compromising to the quality;
- The program was concluded with some logistical plans and action points to be executed before or in preparation to the actual field data collection.

Practicing Phase

After the participatory training session was finalized, participants practiced the knowledge and skills they acquired from the training. The practical sessions gave attention to data collection and facilitation methods.

The actual implementation of the household (HH) survey questionnaires with the 3 groups took place simultaneously from 7 to 10 September and could therefore be completed within four days.

2.2.2 Surveys and data to be collected

In order to assess the IWRM data will be collected from the community residing in the UGA sub-catchment and Berek woreda as well as other key stakeholders. The Consultants' team will be assisted by enumerators of AAWSA to conduct field assessment and relevant data generation, data sampling as well as through stakeholders' consultants and validation to fill data gaps of the inception phase. Participation of AAWSA will be mostly through conducting:

- secondary data;
- Survey of statistically represented sample households through Household (HH) surveys;
- Key informant interviews (KII) with key stakeholders;
- Focus group discussions (FGD).

Secondary data from study area

The field supervisors will collect the following secondary data from the study area:

- Available institution & stakeholders working on IWRM and their role and responsibility;

- Health institution survey including number of health institution & professionals, ten top diseases, soiled & liquid waste management knowledge, attitudes & practices;
- Number of schools, students and teachers populations in each school;
- Rules, regulation & operational guidelines regarding IWRM;
- Collaboration among different stakeholders.

Both the supervisors as well as the data collectors will be responsible for collecting field data using the surveys questioners & checklist prepared for the assessment.

2.2.3 Quasi-random sampling

The data collection in the rural villages, most notably through the household (HH) survey, will focus on the areas where IWRM4WASH interventions will take place. Based on this, villages have been sampled according to statistical boundary conditions, with focus on kebeles in Berek Woreda, Sendafa town and Beke town within Aleiltu Woreda. A protocol for quasi-random sampling was used for the HH survey.

Random sampling is the process in which any person or any household (depending on the focus of the survey) has an equal or know probability of being selected. Basically, that means that anybody should have a chance of being selected in our survey. The reason is that because we cannot interview everyone, we need selection that is similar to the whole population of interest. If we exclude people, we risk a non-representative sample.

Simple random selection increases the likelihood that our sample is representative for the population but maybe more important is that all the formulae we use are based on a random sample. This means if we do not aim to have a random sample, we cannot use the calculation used in statistics because they are based on such samples. In statistics the population are all the people that will be represented in your sample, which means all people, need to be able to be selected. How to do a quasi-random sampling can be briefly explained by following this three-step approach:

(1) Divide a selected village/kebele into sampling units
(2) Determine the sample size for each sampling unit
(3) Selection of households in a village, neighborhood or block of houses.

A total of 408 households spread across the catchment were visited with the HH survey. The targeted area runs roughly from Legedadi dam in the south, through the urban area of Weligewo and Sendafa to the kebeles at the northern border of the Upper Great Akaki sub-catchment in the mountainous Upper Dire. These 408 households represent 2,545 residents of the catchment of the total of 86,458 inhabitants who live there. This results in a sampling size of 3%. The chosen geographic and socio-economic distribution throughout the area ensures a good representation of the sampling size

2.2.4 Monitoring during data collection

During field data collection data was continuously checked by the supervisors. With data being processed and cleaned right after finalization of the field data collection, additional checks were made during data clearing, encoding and analyses when memories of the collected data are still fresh and corrections can still easily be made. Responsibility for whether or not to retain, modify or delete sample data therefore rested with the three team supervisors (Mrs. Hana Yeshaw, Mr, Feyida Benti and Mr. Zemenu Tadesse) in consultation with the Consultant's Ethiopian lead expert and the Clients' overall Team Leaders ((Mr. Nebiyu Getachew and Mr. Debrie Tujo). See also next section 2.2 hereafter.

2.3 GIS & database management

2.3.1 GIS mapping

The GIS work includes but is not limited to the following major activities:

- GIS open source data collection and review;
- Georeferencing raster maps and images and digitizing features using QGIS software;
- Preparation of base maps of the project area which includes location of water points and utilities, infrastructures, topography, drainage, and field inventory points for field work in particular;
- Processing field data into GIS format as input for thematic maps;
- Processing and classification of satellite data for identification of biophysical features;
- Compiling, collating and harmonizing different data for thematic maps, including soil, landcover and geology;
- Preparation and production of various maps of the project area at the required scale using an QGIS platform.

2.3.2 Database management

Collected data used for the study will be processed and stored:

- Literature will be organized, structured and stored in a literature folder;
- All collected GIS data as mentioned in section 2.3.1 will be organized, structured and stored in their respective category, and a GIS database file will be created in QGIS;
- Timeseries data will be analyzed both statistically and graphically in Excel;
- Data from field surveys will be organized, structured and stored in a field survey folder;
- Data quality will be checked to identify data errors and inconsistencies so they can be resolved via data cleansing tasks;
- Data from different sources will be integrated in a database system and shared with the client upon completion of the project.

3 Biophysical context

In this chapter we present the biophysical properties of the Upper Great Akaki (UGA) sub-catchment, such as topography, climate, soil and geology. The descriptions are based on review of existing literature and reports, satellite and remote sensing analysis using GIS, supplemented by key informant interviews as well as expert judgment observations in the field.

3.1 Topography

The Upper Great Akaki (UGA) sub-catchment enclosed under this study is located an approximate 32 kilometers northeast of Addis Ababa City. The UGA sub-catchment comprises a total areas of 393 km^2, and when including Beke town, which shares a (domestic) water system with Sendafa town, the total project area amounts to just under 460 km^2. The catchment includes the dam reservoirs of Legedadi, situated at the lower part of the catchment on the main Great Akaki River, and the Dire reservoir, located at the upper part of the catchment on the Legedadi River.

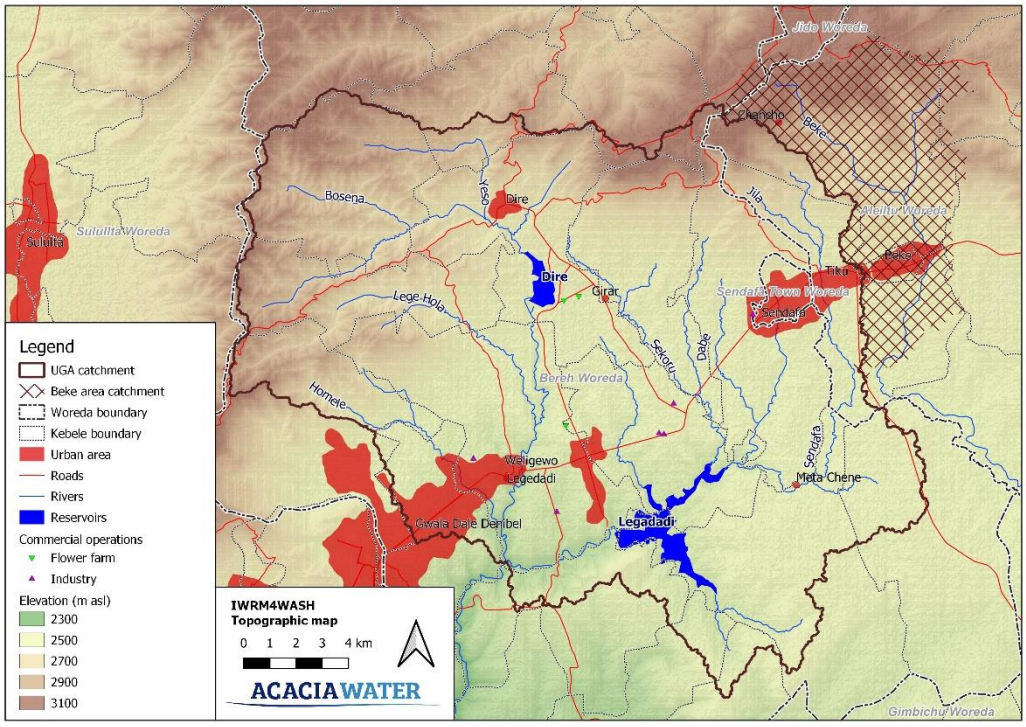


Figure 2. Topographic map of UGA catchment (source: SRTM)

The topography of the project area (Figure 2) is characterized by an undulating and gently sloping landscape, with a steep hilly and mountainous terrain with a series of escarpments to the north and northwest, which are connected to the Entoto Hills to the north of Addis Ababa.

These Highland escarpments from the origin of most streams in the catchment. Elevations range from 2,400 meters above sea level (m asl) in the Akaki River valley to about 3,200m asl around the upper water divide on the northern escarpments. The major mountains within the area are Berek (2,700m asl) and Yarer (3,228m asl).

Slope

The escarpments in the north and northwest have by steep slopes ranging up to 60% (Figure 3). Away from the escarpments, topography is less extreme and most of the area is relatively flat, with only locally slightly higher slopes in eroded river valleys and beds.

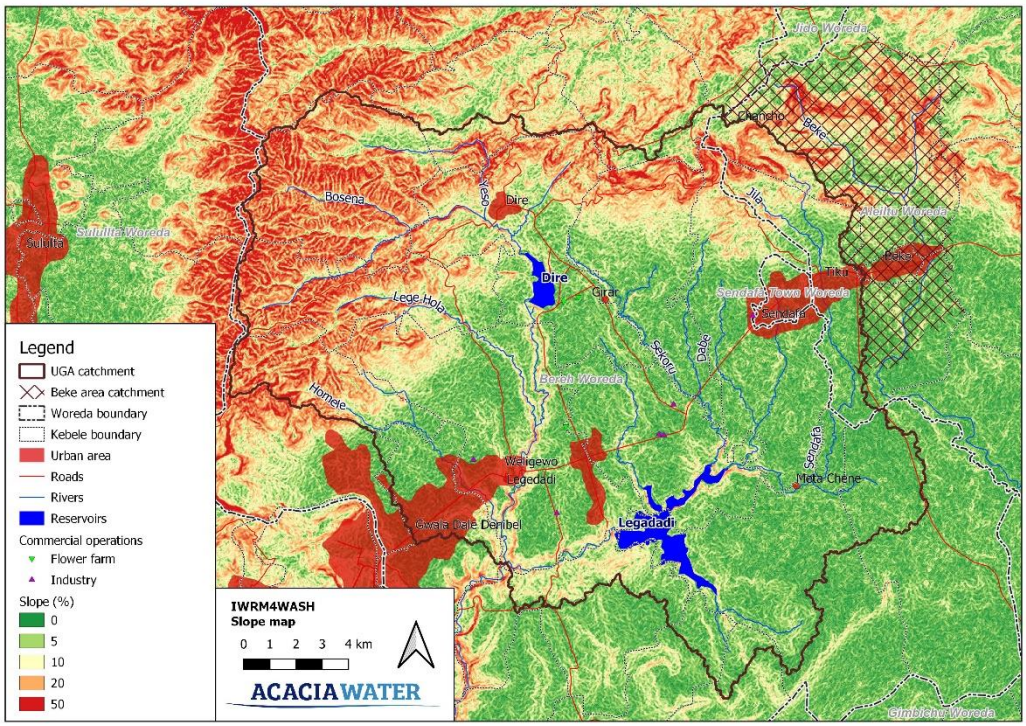


Figure 3. Slope map of UGA catchment (derived from SRTM)

To the northeast of the UGA catchment, there is another smaller catchment which is relevant to mention: the Beke area catchment. Here, the rivers of the Legadadi sub-catchment and Beke area catchment almost meet. They are now separated by a road and Tiku town, but it is possible there were some past connections between the rivers. More importantly however, is that Beke town is located in the Beke area catchment, outside the focus catchment of this study. Nevertheless, the water supply of Beke town is tied to the water supply of Sendafa town, which is inside UGA catchment. Therefore, the Beke town area and its associated catchment are also illustrated and will be considered (secondarily) in the analyses in this study.

3.2 Climate

The climate of the Akaki catchment is characterized by two distinct seasonal weather patterns.

Precipitation

Measured precipitation data was available from a meteorological station in Addis Ababa, which is used as reference for precipitation in the project area. This data is illustrated in Figure 4 on the next page. Average precipitation lies around 1100 mm/y, with moderate variation throughout the years. A clear seasonal pattern is observed, with the main rainy season (known as *Kiremt*) between June and September contributing about 70% of the total annual rainfall,

and a dry season from October to February. A minor rainy season, locally known as *Belg*, is observed contributing moisture to the region from March to April (Molla *et al.*, 2006).

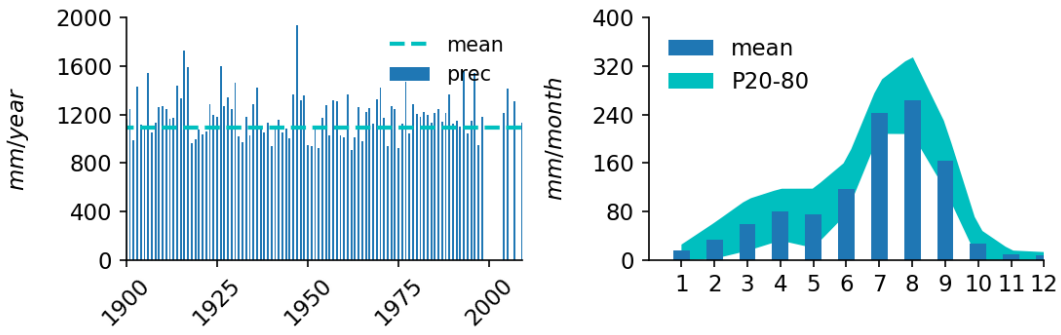


Figure 4. Precipitation data from meteorological station at Addis Ababa, yearly statistics (left) and monthly statistics (right)

Spatial patterns of precipitation according to WorldClim2 are illustrated in Figure 5, together with the location of Addis Ababa meteorological station. It can be seen that in most of the catchment, precipitation is slightly lower than at the Addis meteorological station, around 1050 mm/y on average. In the highest peaks of the catchment, in the north and northwest, precipitation is modestly but significantly higher, up to 1200 mm/year on average.

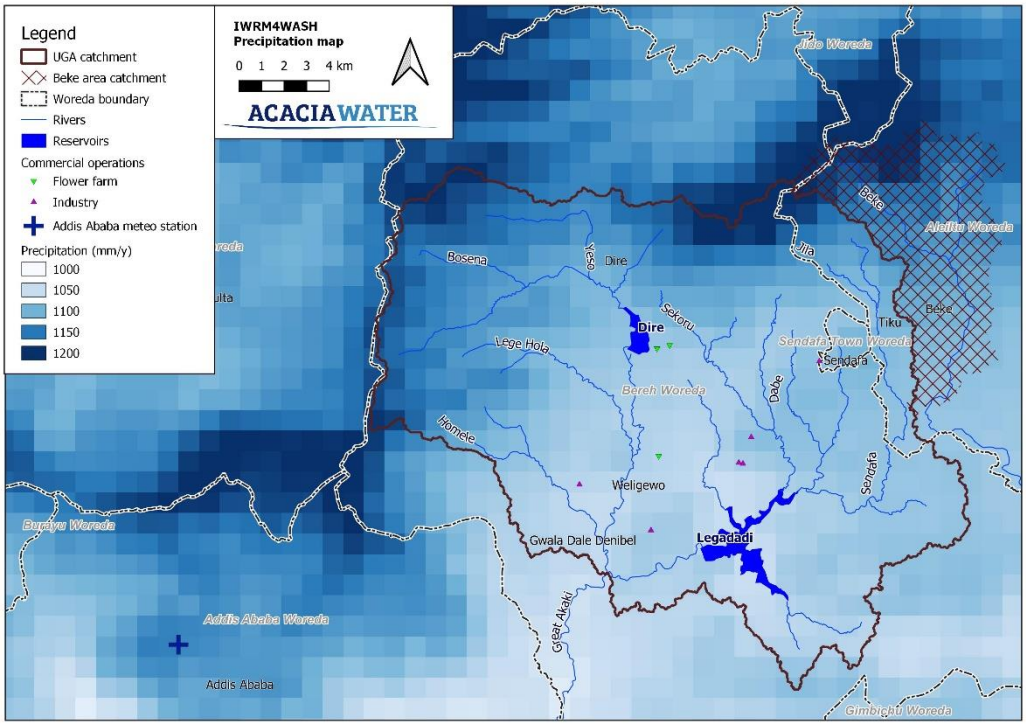


Figure 5. Average yearly precipitation in UGA catchment, with location of Addis Ababa meteorological station shown (southwest corner) for reference (source: WorldClim2)

Evapotranspiration

In Figure 6, evapotranspiration is also shown across UGA catchment. Evapotranspiration is the combination of evaporation (water directly evaporated by the sun) and transpiration (water evaporated by plants through photosynthesis), together forming the component of the water balance of water returned to the atmosphere after precipitation. Evapotranspiration is quite

even across the catchment area, only ranging from 800 mm/y on average in the northeast to 850 mm/y on average in the southwest.

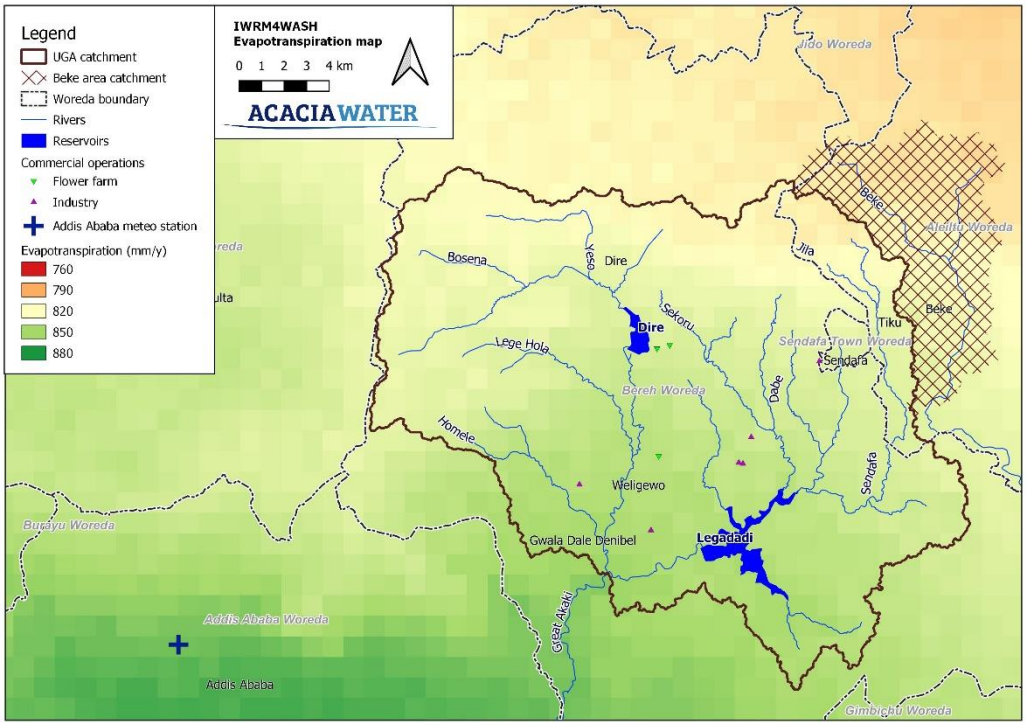


Figure 6. Average yearly evapotranspiration in UGA catchment (source: WorldClim2)

Temperature

The maximum mean monthly temperature of Akaki catchment ranges between 21.1 ˚C (wet season) to 29 ˚C (dry season), while the minimum falls between 7 ˚C – 12 ˚C (Belay et al, 2019).

3.2.1 Climate Change predictions

Using the Coupled Model Intercomparing Project Phase 5 (CMIP5), which compares 21 different climate change models, an analysis was made of expected future changes in the next 50 years for both rainfall and temperature. Two scenarios were examined, one with comprehensive measures combating climate change (RCP4.5) and one without comprehensive measures (RCP8.5).

Results for average precipitation, minimum temperature and maximum temperature are shown in Figure 7 on the next page, where results for all models are shown in a timeseries with average values and a 95% confidence interval in red lines. As is clearly illustrated in this figure, variation is high between models. Nevertheless, a significant trend is observed for all parameters in both scenarios, with quantitative results shown in Table 3. With comprehensive measures combating climate change, an average increase of 2.1 mm/y for precipitation and 0.026 ˚C/y for temperature is predicted; without comprehensive measures the average increase is 4.1 mm/y for precipitation and 0.038 ˚C/y for temperature.

A similar analysis was done for extreme events, which showed significant increases for temperature in both scenarios, while increase for precipitation was only significant in the RCP8.5 scenario.

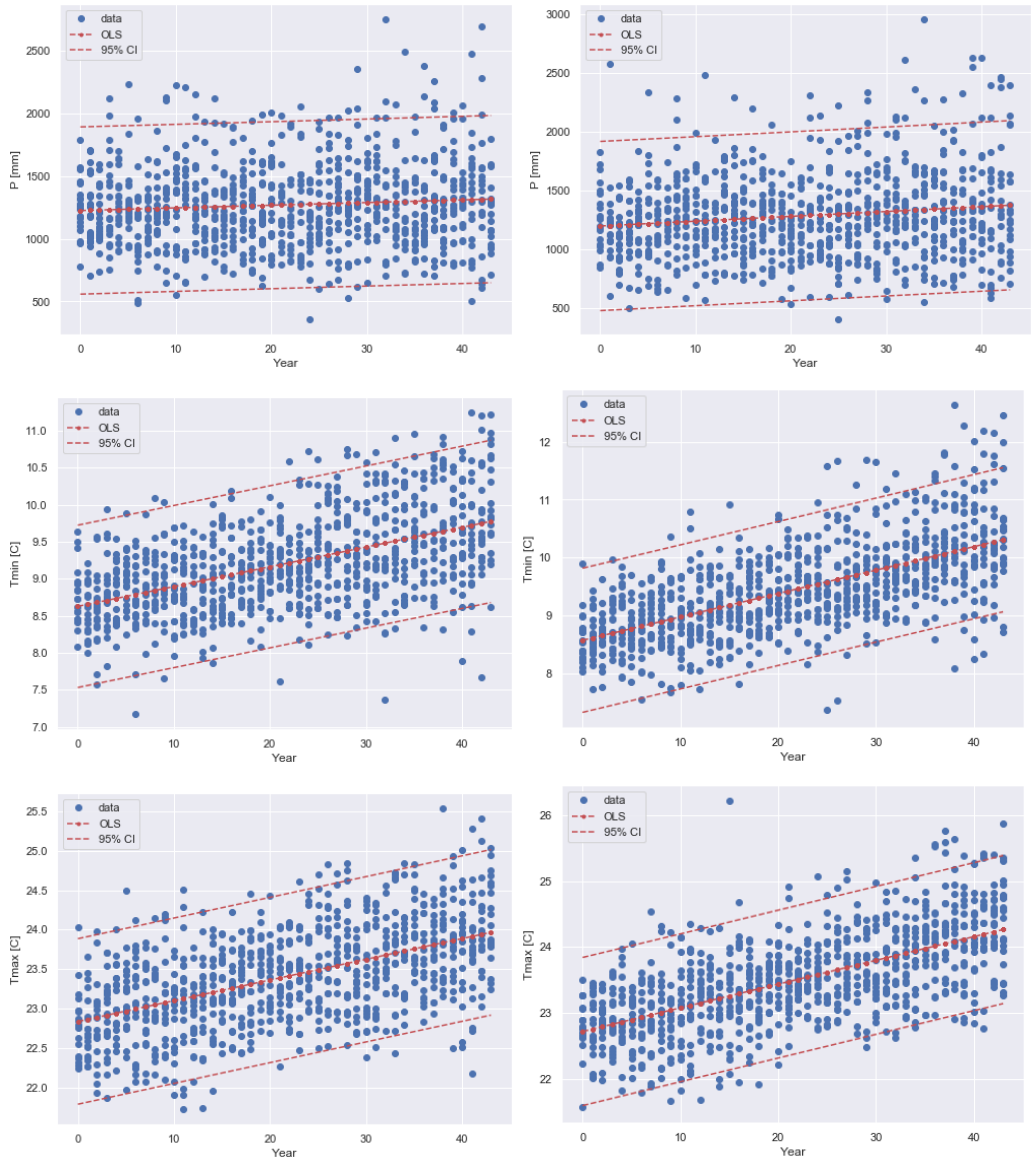


Figure 7. CMIP5 climate prediction results, showing results of both RCP4.5 (left figures) and RCP8.5 (right figures) over all models for precipitation (top figures), minimum temperature (middle figures) and maximum temperatures (bottom figures), with blue dots showing the yearly results of all different models, thick red line showing the average trend of all models and thin red lines showing the 95% confidence interval

Table 3. CMIP5 statistics for yearly climate prediction data, significant values (ns= not significant)

Predicted annual increase	RCP4.5	RCP8.5
Average precipitation (mm/y)	+2.1	+4.1
Average minimum temperature (°C/y)	+0.027	+0.040
Average maximum temperature (°C/y)	+0.026	+0.036
Extreme precipitation event (mm/y)	NS	+0.23
Extreme minimum temperature (°C/y)	+0.026	+0.042
Extreme maximum temperature (°C/y)	+0.032	+0.041

Looking at these changes for each month (
Table 4 below), it becomes apparent that precipitation is predicted to significantly increase specifically in the wet season (June to August) and peak dry season (December and January). Moreover, in the RCP8.5 scenario precipitation is actually predicted to decrease in November.

Table 4. CMIP5 statistics for monthly climate prediction data, significant values (ns= not significant)

	Predicted yearly change in precipitation (mm/y)		Predicted yearly change in temperature (˚C/y)	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5
January	+0.18	+0.17	+0.031	+0.047
February	NS	NS	+0.029	+0.040
March	NS	NS	+0.028	+0.043
April	NS	NS	+0.030	+0.042
May	NS	NS	+0.030	+0.041
June	+0.56	+0.85	+0.024	+0.033
July	NS	+0.92	+0.027	+0.037
August	+0.78	+1.17	+0.026	+0.036
September	NS	NS	+0.022	+0.033
October	NS	NS	+0.025	+0.035
November	NS	-0.13	+0.023	+0.036
December	+0.16	+0.17	+0.030	+0.044

Concluding remarks

CMIP5 examined two scenarios for the UGA sub-catchment: 1) RCP4.5 which considers comprehensive worldwide measures combating climate change and 2) RCP8.5 which is without comprehensive measures. Despite a high variation between models, in general a significant upward trend is observed for both precipitation and temperature.

With comprehensive measures combating climate change (RCP4.5), an average increase of 2.1 mm/y for precipitation and 0.026 ˚C/y for temperature is predicted. This seems little, but in 30 years, so in 2050, it means a likely precipitation increase of 63mm and temperature increase of 0.8 ˚C. Without comprehensive measures, so scenario RCP8.5, the average increase is 4.1 mm/y for precipitation and 0.038 ˚C/y for temperature. This would mean a precipitation increase of 123 mm and a temperature increase of 1.14 ˚C in the UGA catchment by 2050.

Without comprehensive measures combating climate change there will be a precipitation increase of 123mm and a temperature increase of 1.14˚C in the UGA catchment by 2050

But what impact does this have? At first glance, the increase in precipitation appears to be beneficial for water availability, and this is true to a certain extent. However, it is more likely that with precipitation increases, the intensity of rainfall will also increase; so more rainfall in a shorter time, also known as peak showers. In conjunction with degraded and compacted soils, this phenomenon causes that the soil does not have the infiltration capacity and enough time to absorb the large amounts of precipitation, hence water running off superficially. In combination with changing and bad land use, this increases the risk of destructive and life-threatening flash floods, which will take a lot of sediment with them.
In addition to the higher and accelerated chance of sedimentation of the reservoirs, they will no longer always be able to cope with the peak flows as a result of increased rainfall in the rivers and will discharge a lot of water downstream. In the case of the AAWSA and Akaki catchment management area, this does not necessarily have to be a negative effect since there are several downstream dams as well as communities that could collect and benefit from the surplus water.

3.3 Land use

The existing land use of the Dire and Legedadi sub catchments are characterized mainly with farmland, horticulture farming, towns (Sendafa, Dire and Gwale Dale Denibel) and scattered as well as clustered rural residential areas. See also Figure 8 below.

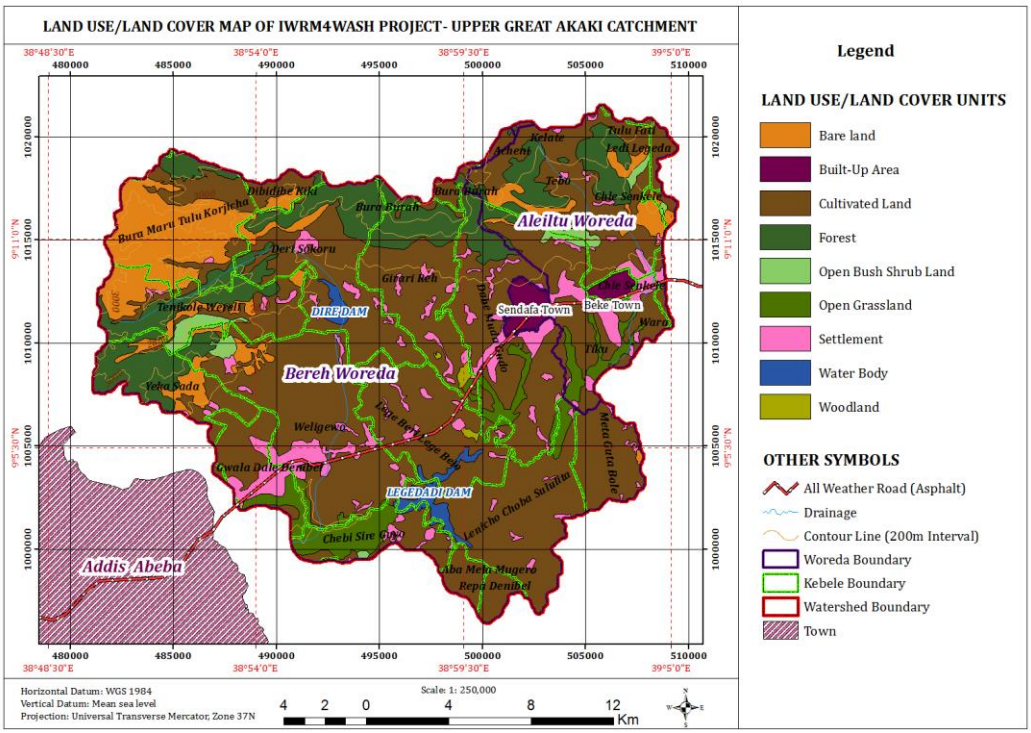


Figure 8. Land use/Land Cover map of Upper Great Akaki catchment (Source: Belay et al., 2019)

The main crop commonly grown in farming households include barley, wheat, bean and lentil. The former Montana forest areas have been subject to major deforestation and turned into farmlands. Most of the deforestation has occurred decades ago, but deforestation is still ongoing with clear examples from the last few years, most notably in the northern and northwestern highland parts in Upper Dire. See also Figure 9 on the next page. The existing patches of forest cover is dominantly Eucalyptus, which is planted by community members for commercial and timber purposes.

3.4 Soil

From literature review and satellite data analysis, a basic soil map of the area was made. See also Figure 10 on the next page. Here, three major soil units are illustrated. In the upper catchment, two major units are identified: luvisols and cambisols/leptosols. Cambisols and leptosols represent underdeveloped and very shallow soils respectively, and are related to sloping areas in UGA catchment. Luvisols are characterized by a well-developed clay layer and are present in the upper catchment where slopes are lower and thus soils have had more time to develop. In the middle and lower catchment, the area is dominated by vertisols, which are extremely clayey to the point that they can form large cracks during dry periods. The boundary between luvisols and vertisols is related to the mother material. More description of the soil types are given after Figure 10.

Locally, four types of soil are reported in the catchment on which crops grow annually. Theses soils are Koticha (Black soil), Dalecha (Grey soil), Gembore (Light soil) and Key (Red soil). Koticha and Dalecha are likely more related to vertisols while Gembore and Key are likely related to luvisols, although this would need to be confirmed in the field.

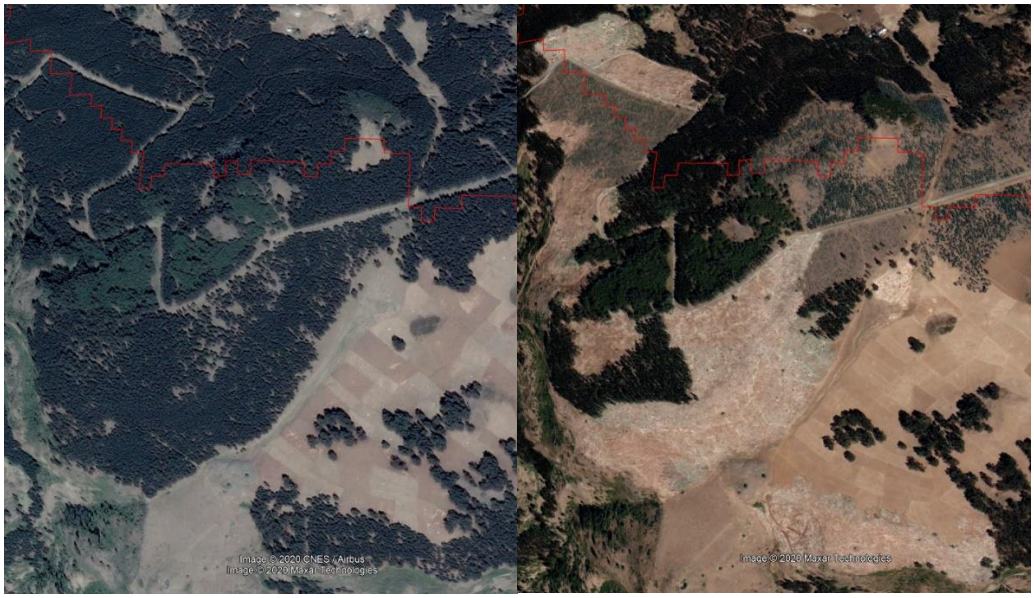


Figure 9. Google Earth images illustrating deforestation in the upper catchment (N9.2,E38.963), images from January 2017 (left) and February 2019 (right)

Vertisols are deep and have a clay texture throughout the profile which causes soil cracking and shrinking during the dry season. They are very poorly drained and have a hard, solid consistency when dry and very sticky and plastic when wet, making it hard for tillage. Due to the low permeability of the soil, areas are inundated during the rainy season and also irrigation may result in waterlogging unless adequate artificial drainage is applied. Vertisols can be well suited for farming if there is plenty of rainfall or irrigation water and suitable management practices.

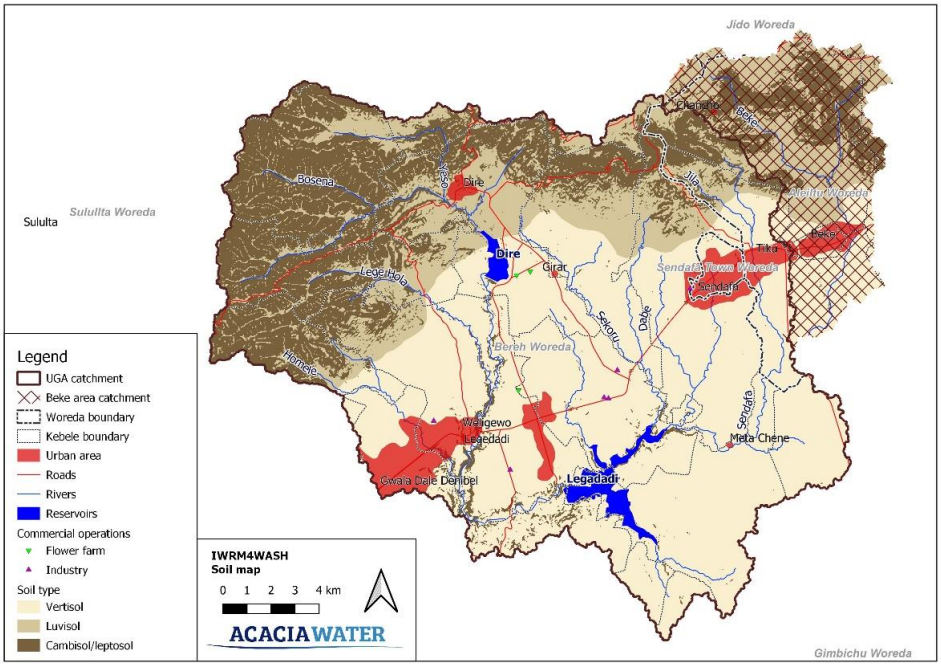


Figure 10. Soil map of UGA catchment

Luvisols are deep soils and have a heavy clay content making their consistency hard when dry, friable to firm when moist and sticky and slightly plastic when wet. This type of soil is well-drained, has a good permeability and high base saturation which makes it suitable for a wide range of agricultural use. Also, they can have a high soil fertility if the land is not eroded. Since exposure to raindrop impact and direct sunlight leads to surface crusting, runoff and severe erosion.

Leptosols are very young and shallow soils with a thickness of 10 to 50 cm, limited in depth by the continuous weathered bedrocks. They develop from variable parent materials such as intrusive rocks, volcanic rocks and meta volcanic rocks and laterite. Leptosols are characterized as rocky and stony with coarse fragments that increase with depth. They are excessively drained, prone to severe erosion and drought because of the shallow depth. Due to the inability to conserve enough moister and lack of dept for roots crops do not perform well in these soils.

Cambisols are soils with a beginning of soil formation. They generally contain medium to fine-textured materials and are well-drained. Most of these soils make good agricultural land, although the connection to leptosols means this potential is likely limited within the project area.

3.4.1 Soil erosion and gully formation

Land degradation is one of the critical issue of the UGA sub-catchment, most notably the upstream and mountainous part of the Dire dam reservoir is heavily degraded and serves as the main source of reservoir siltation. The area is being farmed and cultivated for years and years without any soil and water conservation (SWC) works. Due to steep nature and intensive rain fall in the area, the top fertile soil has been eroded. As a result, the productivity of the area is very low.

There are gullies and landslides experienced, especially in the Upper Dire sub-catchment, which aggravate the soil erosion as well as surface water run-off and eventually siltation of the downstream reservoirs. Examples of landslides are pictured in Figure 12 on the next page.

Figure 11. Degraded upper catchment of Dire reservoir, photo taken standing at GPS location of 37P: 491730; 1017589 at altitude of 2932 m asl

Figure 12. Landslide at the upper catchment of Dire reservoir at GPS location of 37P: 491239; 1018097 at the altitude of 2888 m asl.

Siltation of water reservoirs has a considerable impact on the reservoir functions. Silt deposits in water supply reservoirs reduce their live storage capacity. This reduction results in less water harvesting capacity, which contributes to the water shortage problems faced in the

rapidly increasing urban areas of Addis Ababa and its suburban areas. Buildup of suspended solids in Legedadi reservoir affects the raw water quality, increases the turbidity and has led to increased costs of water treatment.

To get a better understanding of erosion vulnerability across the catchment, an erosion sensitivity map has been made based on satellite data analysis (Figure 13). The most important factors here are slope and landcover. From this analysis it is evident that the most erosion vulnerable area is the northwest part of the catchment. Here, slopes are steep (up to 60%) and the bare landcover allows runoff and erosion to occur extensively. This area has been identified as prone to landslides in the fields study as well. The risk of erosion and degradation is high here and measures should be taken to increase the resilience of the area.

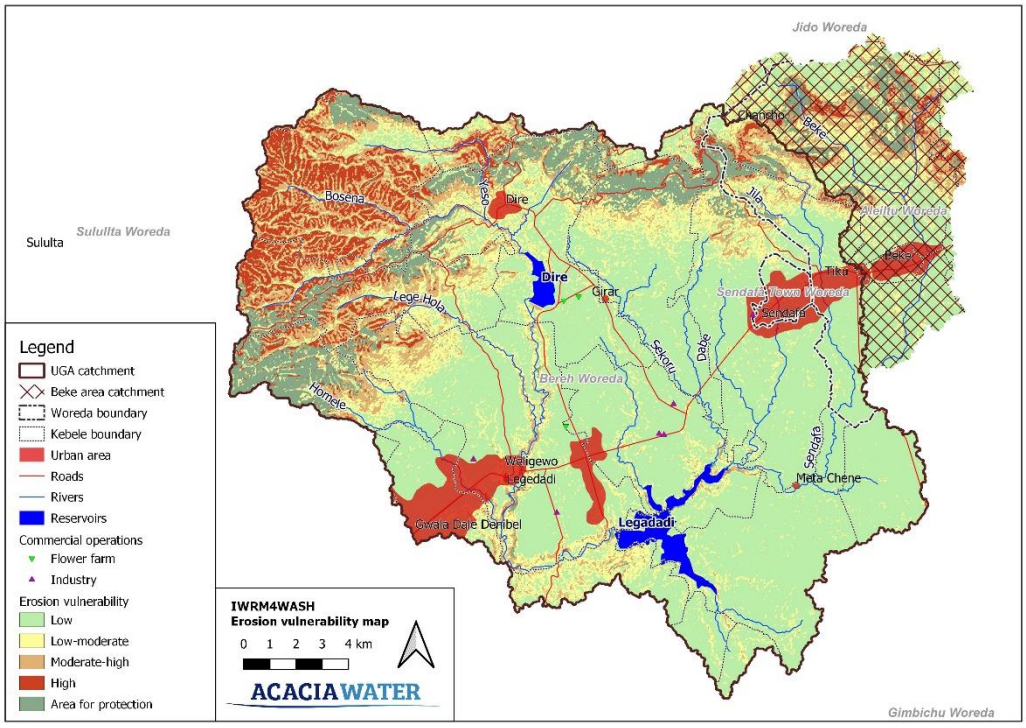


Figure 13. Erosion vulnerability in UGA catchment

A few small pockets of high-risk area occur all over the upper catchment, but most of the lower and middle catchment the vulnerability is low to moderate. In these areas, erosion is not an immediate concern, although agriculture is intensive in these areas. With continued agricultural exploitation, these areas are still at risk of degradation; implementation to sustainable agricultural practices is recommended.

Also highlighted in the map are **areas for protection**. Here, slopes are steep and as such have high potential for erosion but are still forested which prevents erosion currently. Protection of these areas from deforestation is vital for prevention of erosion in these areas.

Table 5 on the next page shows for each erosion vulnerability class how many hectares this concerns per identified class. In particular, the areas designated as 'Moderate-high' and 'High' sensitive to erosion should be addressed within the IWRM4WASH project. In total, these areas cover more than 6,400 ha, which are mainly concentrated in the northwest corner of the Upper Dire catchment.

Table 5. Erosion vulnerability classes by hectares

Erosion vulnerability class	Area (ha)
Low	21430
Low-moderate	6671
Moderate-high	4107
High	2322
Area for protection	2971

3.4.2 Development goals

The Consultants advice that the IWRM4WASH project should aim to restore a minimum of 10% or about 750 ha of the 6,400 ha of highly erosion vulnerable and heavily degraded lands with soil water conservation (SWC) measures. SWC measures or techniques include:

1) crop and vegetation management (i.e. cover crops, mulching, grass buffer strips, strip cropping and exclosure);
2) soil management (i.e. no-tillage, reduced tillage, contour tillage, deep tillage, drainage and soil amendment); and
3) mechanical methods (i.e. terraces, contour bunds and geotextiles).

Erosion comparison studies of croplands with and without SWC technique applications are showing that the soil loss is on average 20% lower[2] on plots where SWC techniques are applied (Maetens, Poesen and Vanmaercke, 2012), while with a good combined approach and in favorable cases on steep slopes, soil loss reduction of even more than 50% can be achieved (Chen et al., 2020, Tauro et al., 2018, Zhao, Yang and Govers, 2018). IWRM4WASH should therefore aim to reduce erosion and sediment discharge from the to be selected micro-watersheds in the Upper Dire catchment into the Dire dam reservoir by at least 20%.

Part of the nearly 3,000 ha of (still) wooded and forested areas on steep slopes must also be designated as protection areas. When zooming in on the Upper Dire catchment around Dire town, protection of 5% of this area – or about 150 ha – is a feasible target for the IWRM4WASH project.

3.4.3 Concluding remarks

Unless soil and water conservation (SWC) and sustainable land management (SLM) practices and measures are implemented in the short-term, the level of land degradation and soil erosion will accelerate in the foreseen future and could adversely affect the sustainability and productiveness of the Dire and Legedadi dam reservoirs, as well as the agricultural productivity and the livelihoods of people in the UGA sub-catchment who depend on healthy farmlands, landscape and ecosystem. This is especially the case for the Upper Dire catchment and sedimentation of the Dire dam reservoir.

[2] Based on conservative numbers from various studies, amongst others Maetens, Poesen and Vanmaercke (2012)

3.5 Hydrology

The UGA sub-catchment consists of two major streams with many tributaries and sub-catchments, see also Figure 14 below.

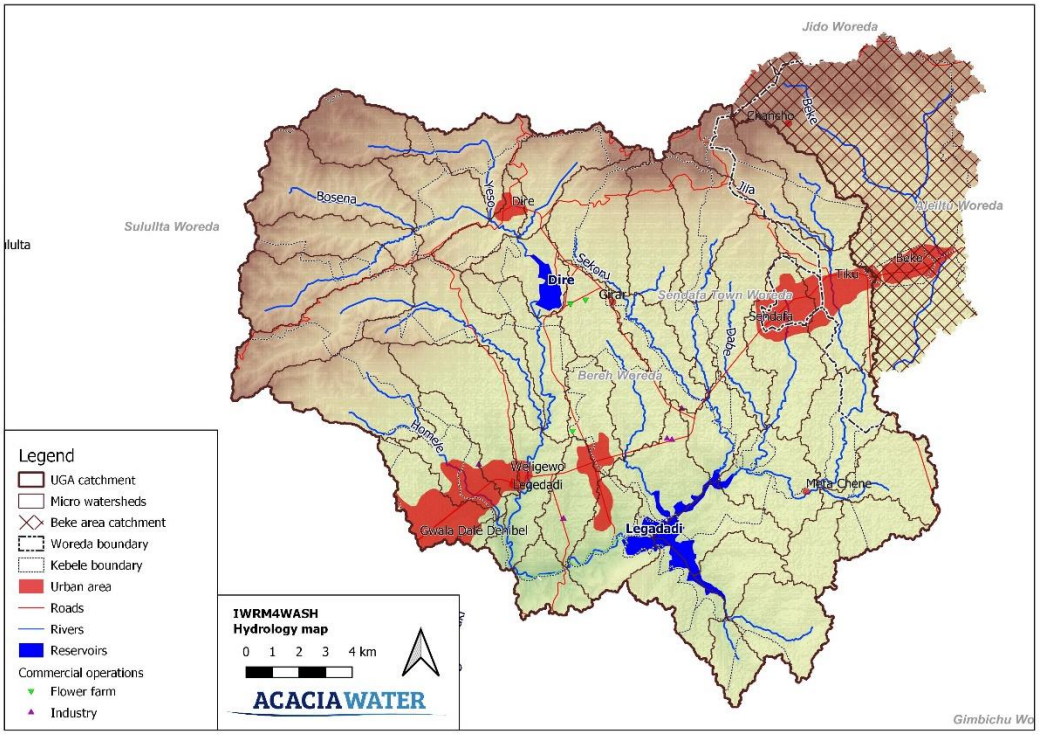


Figure 14. Upper Great Akaki catchment indicating hydrological boundaries, tributaries of Dire and Legedadi reservoirs, borehole points and major settlement areas

Figure 15. Wetlands just south of Sendafa (source: Google Earth)

The Legedadi stream drains the western half of the catchment and into the Dire reservoir while the Great Akaki River drains the eastern half of the catchment and Legedadi reservoir. Note that the Legadadi river is not directly connected to Legadadi reservoir; rather, they seem connected only by their proximity to Legadadi town. Main streams draining to the Legedadi reservoir include Lege Beri, Lege Sekoru, Lege Fule, Lege Belo, Lege Sendafa and some other southeastern tributaries. Main streams draining into Dire reservoir include Lege Yeso, Lege Bosena and Lege Meti.

In the upper catchment, the rivers incise the landscape quite deeply, especially in the northwest where forests have been cleared excessively. In the middle and lower catchment parts, rivers meander slightly and show some signs of occasional flooding of the riverbanks but overall the rivers seem quite stable. In some areas, the rivers are connected to some larger wetlands, specifically the area just south of Sendafa. See also Figure 15 on the left.

3.5.1 Micro-watershed delineation

The Consultant suggests the delineation of micro-watersheds for the UGA sub-catchment. The most important factor for determination of each micro-watershed is hydrology, where areas are defined by drainage of a specific stream or subset of a river.

The second factor is area. The target area for each micro-watershed was 1,000 ha, on which the sub-selection between drainage areas was determined. In a few cases, the selected area was larger than 1,000 ha (up to 1,400 ha), where hydrologically it made more sense to have larger areas instead of further subdivision into tiny micro-watershed and management areas.

The last factor which is only partially considered is infrastructure and land use. From a management perspective, there are some cases where considerations like infrastructure and land use trump the hydrological considerations. One clear example is Legadadi reservoir. There are many different streams and rivers drained by the reservoir which many different micro watersheds assigned to them. Yet it makes little sense for each of these micro catchments to manage only a part of the reservoir; rather, it makes more sense to have designated (micro watershed) management unit for the Legadadi reservoir as a whole (as can be seen in Figure 14). Other instances can be named where separated management of micro-watersheds has practical limits, like towns or protected areas divided across different micro watershed units. To optimally consider such limitations and make an ideal delineation of micro watershed management units, a discussion with a hydrologist and someone with thorough understanding of the local management units should occur and decide on final delineation jointly.

3.5.2 Selection of focus micro-watershed

Zoomed in on the Upper Dire part of the UGA sub-catchment, a total of 9 micro-watersheds are suggested. Micro-watershed 1, 2, 3 and 9 contain the drainage area of a single stream each, micro basin 4 and 5 contain the drainage area of Yeso stream (upper and lower catchment area respectively). Moreover, micro-watershed 7 and 8 are focused on stream segments of rivers also receiving input from higher lying drainage areas (from 1, 2, 3 and from 1, 2, 3, 4, 5, 6 & 7 respectively), culminating in micro watershed 9 which drains micro-watersheds 1 until 8 and containing the Dire dam reservoir. See also Figure 16 and a brief description of each of the 9 suggested micro-watersheds provided in Table 7 on the next page. Table 6 below gives the guidance notes for micro-watershed selection criteria.

Table 6. Guidance note for micro-watershed selection criteria

No	Criteria	Score points	Description of score points
1	Slope	0	Low, <20%
		1	Medium, 20 – 50%
		2	High, >50%
2	Land use/land cover	0	Low (covered by forest)
		1	Medium (grazing)
		2	High (farming activities)
3	Level of land degradation	0	Low
		1	Moderate
		2	Severe
4	Population size	0	Low
		1	Medium
		2	High

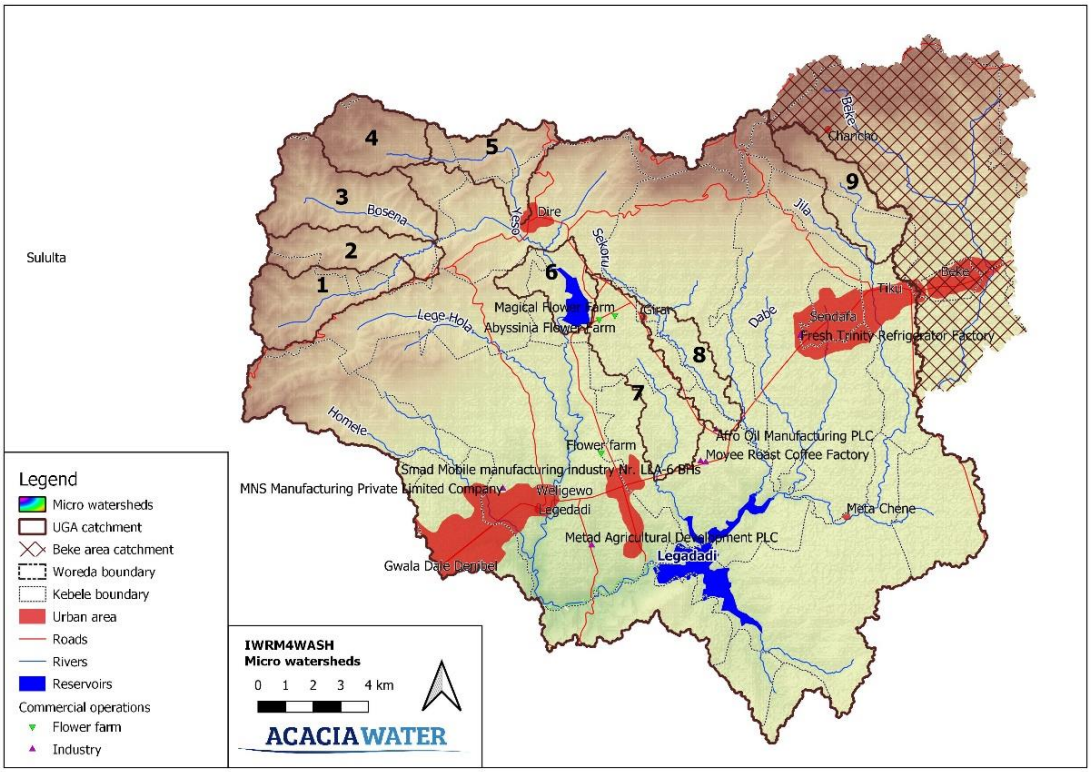


Figure 16. Zoom in on the 9 suggested micro-watersheds for the Upper Dire part of UGA sub-catchment

Table 7. Brief description of the 9 selected micro-watersheds

Micro-watershed (MW) no.	Description
mw1 – mw4	mw1 until mw4 jointly cover the largest part of the 'high degradation risk area', with worst erosion and sediment run-off taking place here due to steep slopes. All severely degraded micro-watersheds showing high potential for landscape restoration. Of these four, mw3 is the most indisputable considering it is largely deforested (small piece of forest excluded) and having a high/steep slope area, while mw2 is fairly comparable but degradation is to a slightly lesser extent as mw3. In mw4 there is a piece of land still forested, while there is also a relatively flat area with agriculture on it.
mw5	mw5 shares aspects with mw1 – mw4, but has deeper cut valleys (not necessarily gullies), which makes it a bit harder to accomplish restoration activities, while in addition it has a micro-watershed upstream (mw4) for which it is dependent on. In other words: if you want to tackle and restore mw5, you will also have to take on mw4 as well. Interesting advantage is that it also encompasses part of Dire town, including its water supply.
mw6	mw6 is interesting since the Dire dam reservoir is entirely located in this micro-watershed, if the IWRM4WASH project wishes to undertake specific activities here. Consider, for example, imposing a '100m no-activity buffer zone' around the lake. For the prevention of sedimentation in the lake, however, you are again dependent on the prevention of land degradation and erosion activities in the upstream micro-watersheds 1 to 5. Again, this preferably should go hand-in-hand.
mw7	mw7 holds the two largest flower farms of the UGA sub-catchment. Active environmental pollution seems under control and limited, but can nevertheless be an interesting case, also because of their proximity to the Dire dam. However, the land here is already a lot flatter, so that the problems in the field of land degradation and erosion are a lot less compared to the Upper Dire watersheds (mw1 - mw5).
mw8	Contains the reported largest polluter: Afro Oil manufacturing PLC. Is practically on the sub-watershed boundary; unsure where the pollution exactly goes.

mw9	Again related to degradation, here erosion appears to be a more active process at the moment than in 1-5 (assessed by means of satellite images). So possibly slightly different dynamics than at 1-5 and therefore interesting. Located upstream of Sendafa town, while the IWRM4WASH has a preference of focus on Upper Dire area may make this option less preferable.

Based on the micro-watershed selection criteria as indicated in Table 6 and by assigning weight numbers to the different criteria, a selection of micro-watershed could be determined on the basis of a calculated method. A minimum total score of 75% has been used for selection. As can be seen from Table 8 below, on this basis only micro-watershed 5 (mw5) meets the requirement. Additional advantage of mw5 is that it also encompasses part of Dire town, including its water supply sources.

Table 8. Final selection criteria and status

Woreda	Micro-watersheds	Slope (35%)	Land Use (20%)	Level of Land Degradation (30%)	Population Size (15%)	Slope (0-2)	Land Use (0-2)	Level of Land Degradation (0-2)	Population Size (0-3)	Total Score (100%)	Selection Status
Berek	**MW1**	2	1	2	1	1.0	0.5	0.5	0.5	68	NOT SELECTED
	MW2	2	1	2	1	1.0	0.5	0.5	0.5	68	NOT SELECTED
	MW3	2	1	2	1	1.0	0.5	0.5	0.5	68	NOT SELECTED
	MW4	2	1	2	1	1.0	0.5	0.5	0.5	68	NOT SELECTED
	MW5	2	2	2	2	1.0	1.0	0.5	1.0	85	SELECTED
	MW6	1	2	1	2	0.5	1.0	-	1.0	53	NOT SELECTED
	MW7	1	2	1	2	0.5	1.0	-	1.0	53	NOT SELECTED
	MW8	1	2	1	2	0.5	1.0	-	1.0	53	NOT SELECTED
	MW9	1	2	2	2	0.5	1.0	0.5	1.0	68	NOT SELECTED

Nevertheless, given the integral IWRM focus of the IWRM4WASH project, the impact and scale it seeks to achieve, as well as geographic and biophysical integrality and interdependence of a number of micro-watersheds, the Consultant recommends to involve 1 or 2 other micro-watersheds in mw5. The best candidates for this are mw4 and mw6 for the following reasons:

- **Micro-watershed 6 (mw6) in combination with mw4 and mw5**: Choosing this option can address both direct sedimentation and pollution around and into the Dire dam reservoir (mw6), while choosing mw4 and mw5 as upstream micro-watersheds can also directly address the root causes of land degradation, erosion and sedimentation. Ultimately, this should increase the water availability in the Dire dam, thereby directly providing for the improvement of the water demand and supply in the city of Addis Ababa;
- Micro-watersheds mw4 and mw5 share similar aspects, with mw5 having deeper cut valleys and encompassing part of Dire town. This can make it harder to set up effective restoration activities, but given the dependence on and combination with an upstream approach including mw4, a truly integrated IWRM approach can be applied.

3.6 Geology

Addis Ababa city and surrounding areas including the Great Akaki catchment is found at the edge of the main Ethiopian Rift Valley. The area is dominantly covered by volcanic rocks form different time periods (Oligocene-Pliocene Miocene and Quaternary) with chemistry ranging from basic to acidic (Fanuel, 2007). The dominant volcanic rock types in the area are basalts, ignimbrites, rhyolites and scoria. The overburden covering the bed rocks includes lacustrine & alluvial deposits. The geological map shown in Figure 17 on the next page and in Annex A of this report indicates that a large portion of the project area in the north and northwestern highlands of the catchment and the south adjacent to the Legedadi dam as well as the southeastern extension areas are made of Teramber basalts (Miocene Volcanic formation *Tv3;* Olivine-pyroxene pyric basalts of Tertiary age). These are highly to moderately weathered and fractured rocks from shield volcanoes with light to greyish dark color. Intense fracturing, columnar jointing and spheroidal weathering are very common features (Matebie etal., 2015). The unit is well observed at sections exposed at several locations during the field survey and covers about 66 % of the catchment area.

The surface geology of the central and relatively plain area of the catchment extending in the northeast to southwest direction across the Legedadi dam and reservoir area and Sendafa town and surrounding areas is the geological unit classified as Nazareth Group (lower) of Pliocene volcanics. These are welded pyroclastic flows, ash flows, tuffs and ignimbrites (*Nn*). It covers about 24 % of the catchment area. This unit is covered by thin soil development at the surface over the flat lands and gentle slope areas serving as farmlands or grazing fields. Currently, extensive operations of quarry works are underway by the local community over this unit. See also Figure 18 on the next page.
The unit mapped as Middle plateau Basalts (*Tv2*) covering about 6 % of the catchment area is a fractured and jointed type of basalt rock occupying the southeastern UGA sub-catchment boundary area and is characterized to have compositions of: olivine-plagioclase, plagioclase olivine, olivine, pyroxene-plagioclase phyric basalts and minor aphanitic basalts.

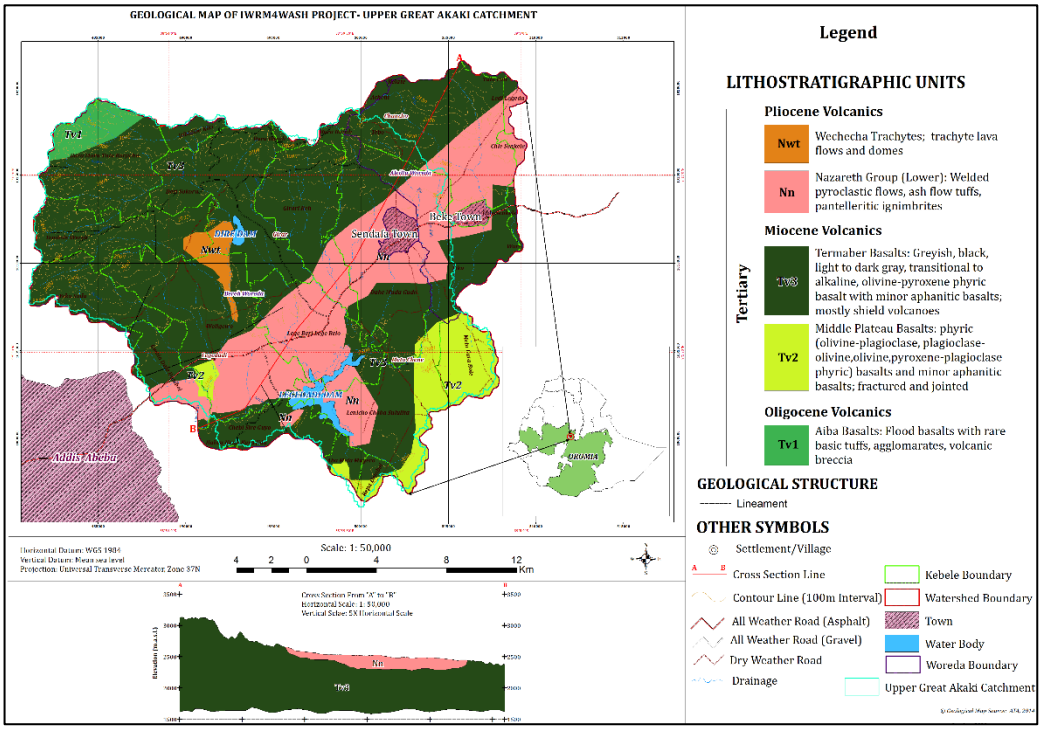


Figure 17. Geological map of UGA catchment

Figure 18. View of the stone quarry sites

The oldest exposed rock unit in the area is the Oligocene age volcanic known as Aiba Basalts (*Tv1*). It is mapped at the northwestern corner of the study area over the high ground along the watershed boundary occupying about 2 % of the catchment area. These are flood basalts with rare basaltic tuffs, agglomerate and volcanic breccia.

3.7 Hydrogeology

The geological setting of the study area is a variety of volcanic rocks as described in the previous geology section. Groundwater circulation and storage in these rocks depend on the type of porosity and permeability formed during and after formation such as fault, fractures and fissures produced as a result of tectonic activities. Process like weathering of fracturing may result in a secondary permeability. Hence, the most important features that control the groundwater flow and storage in volcanic rocks like the project area are vertical permeability due to primary and secondary fractures, horizontal permeability due to horizons containing opening due to the lava flows. The aquifers of the project area are largely formed due to weathered and fractured or scoraceous volcanic rocks with minor sediments deposited between different series of lava flows (*Tv2* and *Tv3*). According to the hydrogeological map of Addis Ababa map sheet (NC-3710) prepared by The Geological Survey of Ethiopia - GSE (2010), the volcanic rocks forming aquifers are classified as extensive moderate to high productive fissured aquifers.

The Hydrogeological map of the UGA sub-catchment is shown in Figure 19 below and in Annex B to this report, while an accompanying Aquifer Unit description is presented in Table 9 on the next page.

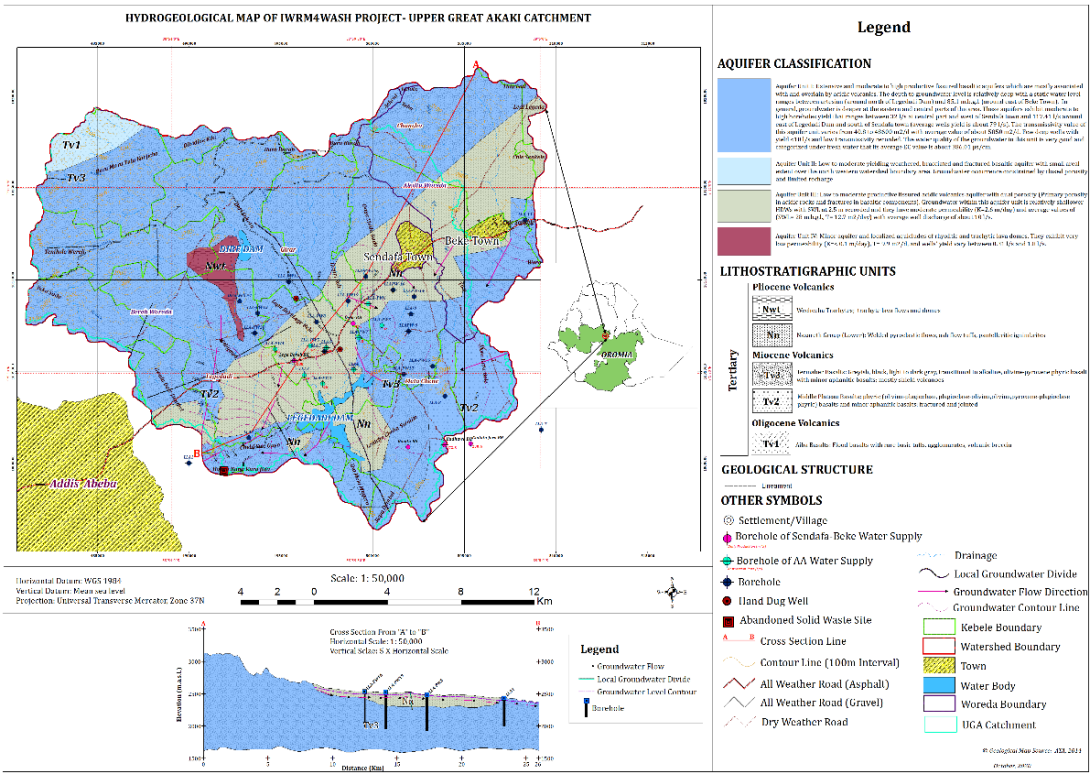


Figure 19. Hydrogeological map of the Upper Great Akaki sub-catchment (adapted from: Hydrogeological map of Addis Ababa, map sheet NC-3710, prepared by GSE, 2010)

3.7.1 Aquifer system

In general, in the project area the wells drilled to characterize the aquifers concentrate mainly in the central part of the catchment area. Apart from this, the groundwater flow system and the nature of the aquifer can be also be inferred from regional studies and surface lithostratigraphic, structural and geomorphological observations as well as the results of recently drilled wells.

The aquifers from Aquifer Unit I (Figure 19) are semi-confined to confined, where, the shallow, intermediate and deeper aquifer systems are inferred to be hydraulically connected. The rocks are intensively fractured and weathered, and due to the general tectonic effects, the nature of the underground conditions creates interconnections of groundwater flow systems. This is evidenced by the reported drying of the hand dug wells excavated by the local community for their general-purpose use as well as small scale irrigation practices initiated by Agricultural Transformation Agency (ATA) as a result of pumping of the recently drilled deep wells. Aquifer Unit III on the other hand, where volcanic pyroclastic flow aquifers are interlayered with local unconsolidated sediments, form a shallow and unconfined aquifer system underlain by basaltic aquifers.

Table 9. Accompanying Aquifer Unit Classification and Description to the Hydrogeological Map

Aquifer Classification	Description
Aquifer Unit I (*Tv2* and *Tv3*)	- Extensive and moderate to high productive fissured basaltic aquifer within mainly lower Basalt and Tarmaber basalts covering a wide area of the UGA sub-catchment. - Thickness of this aquifer unit is more than 90m. - The depth to groundwater level is relatively deep with a static water level ranges between artesian (around north of Legedadi Dam) and 85.1 m (around east of Beke Town). In general, groundwater is deeper at the

		eastern and central parts of the area. - Moderate to high boreholes yield that ranges between 32 l/s at central part and west of Sendafa town and 117.41 l/s around east of Legedadi Dam and south of Sendafa town (average wells yield is about 79 l/s). - The transmissivity value of this aquifer unit varies from 40.8 to 48600 m^2/d with average value of about 5850 m^2/d. - Few deep wells with yield <10 l/s and low transmissivity recorded. - The water quality of the groundwater in this unit is very good and categorized under freshwater with average EC value around 390 µs/cm.
Aquifer Unit II (*Tv1*)	-	Low to moderate yielding weathered, bracciated and fractured basaltic aquifer with small areal extent over the north western watershed boundary area. Groundwater occurrence constrained by closed porosity and limited recharge
Aquifer Unit III (*Nn*)	-	Composed of mainly Lower Nazareth Group of ash flows and tuff, this aquifer is relatively extensive but classified as low to moderate productive fissured acidic volcanics aquifer with dual porosity. Found at central eastern parts running from northeast to southwest through Sendafa town. - The thickness ranges from 90 m to more than 200 m. - Groundwater occurs in fractures. Storage and yield are reduced because of the welding or bonding of rock material, limiting the flow of water. Individual aquifer zones are less extensive. - Depth to water table varies from place to place between 6.8 m and 46 m. The groundwater in this aquifer unit is shallower around south of Legedadi Dam, whereas it is deeper around south of Sendafa town. - The transmissivity value of this aquifer unit varies from 3.7 to 37.1 m^2/day. - Yield of wells drilled in these aquifer units within the project area ranges between 5 L/sec to 15 L/sec. It may reach locally 20 L/sec around south of Legedadi Dam.
Aquifer Unit IV (*Nwt*)	-	This hydrogeological unit is very limited in its areal extent and are localized which is composed of mainly Wechecha trachytic lava domes and flows found and exposed at west of Dire Dam. - Lower permeability but sometimes they can transmit water to the underlying basaltic aquifers. In most places they can act as a local aquiclude (barrier) to the groundwater flow. - Water depth table varies between from 10.7m to 137m bgl. - The transmissivity value of this aquifer unit is less than 4.6 m^2/day. The transmissivity of this aquifer reaches locally to 15.3 m^2/day. - Yield of wells drilled in these aquifer units is very low ranges between 0.12 L/sec to 0.5 L/sec. It may reach locally from 13.1 to 41 L/sec at the western regions out of the study area.

The thickness and lateral extent of the unconsolidated sediments (mainly alluvial) is limited. In general, the aquifers in the area can be categorized as shallow and deep:

- **Shallow Aquifers**– These are aquifers which are very shallow that extends up to 40 to 90 meters below ground level (m bgl). As compared with the deeper systems the shallow aquifers are moderately fractured and weathered, and have low to moderate transmissivity values.
- **Deeper aquifers** –Deeper aquifers represent the hard and fractured lower fractured and scoraceous basaltic rocks. In real sense, deeper aquifers include both intermediate (90 – 200 m bgl) and deep depths (>200 m bgl). It is expected that with depth the permeability significantly decreases. In these aquifers groundwater flows dominantly in fracture systems as primary permeability is very low or nonexistent and its recharge sources are from regional systems. At some spots the deep groundwater systems forms artesian conditions such as in the area north of Dire dam (boreholes LLA3 &LLA4).

3.7.2 Aquifer properties

There is no well-organized aquifer parameter from drilled wells pump test data to characterize the entire study area. However, the transmissivity data from the recently drilled boreholes within the central portion of the area and visual observations of degree of fracturing and weathering, it displays it can be understood that the area has wide variations in aquifer hydraulic parameters. Estimates of transmissivity value of the aquifers in the project area ranges from about 3.7 m^2/d (slow), for pyroclastic deposits to more than 48,000 m^2/d (rapid) for basaltic rocks. The transmissivity value increases from central parts to eastern parts of the study area.

The only exception probably is the trachytic rocks that form domes or small hills are also less fractured. These rocks rather form local groundwater divides and act as barriers to local and sub-regional groundwater flows.

The evaluation of the limited pumping test data indicates that Tarmaber basalt with minor association of acidic volcanic aquifers have the highest transmissivity values, whereas, the acidic volcanic of ignimbrite, rhyolite and trachyte rocks, lava flows and domes, pyroclastic deposits and falls have moderate to very low transmissivity values. This wide range of transmissivity values characterizes the heterogeneity of the aquifer system in the study area. In general, the yield of wells is expected to be highly variable from place to place depending on the nature of fracturing, presence of the porous scoraceous/scoria horizons and connections to recharge sources.

From the pumping test discharge data obtained, the following is observed:

- Among the records of 29 wells, 24 wells have yield of >10 L/sec while 16 wells are with yields of >50 L/sec.
- The minimum and maximum recorded discharges during pumping test are 5 L/sec and 117 L/sec respectively with an average of 64 L/sec.
- The average recorded drawdown is 47m with a range from 1.7m to 201m.
- The depth of drilling ranges from 175m to 590m and the depth to static water levels in these wells range from 7 to 85m bgl and with two wells of artesian conditions.
- The main aquifer units intercepted in these wells is fractured and scoraceous basalt and rarely ignimbrite formation.
- The variability of geological formation with respect to extent, textures, structure and other factors in the area give rise to a heterogeneous hydraulic property resulting in drilling of variable productivity wells as indicated above.

3.7.3 Groundwater flow system

The groundwater flow pattern of the UGA catchment is produced for intermediate to deeper groundwater system. Therefore, the water level of the deep boreholes having more than 80m of depth found around central western are considered to map and determine the intermediate and deeper groundwater system flow of the catchment.

The groundwater flow pattern in general is discrete and the flow direction is not continuous in all direction. This indicates the groundwater flows through fractured bed rocks of volcanics in most cases. The groundwater's in western, north eastern, and eastern regions of the catchment flow in discrete manner from all directions towards the low lying. In this region, all the groundwater is converging into the area around south of Sendafa town in general, whereas the groundwater's found at south of Sendafa town from all direction flows towards the low lying area around south west of Legedadi Dam. Between these groundwater flowing regions, around

north of Legedadi Dam, there is an inferred local barrier or groundwater divide following the surface topographic highs running NW-SE direction.

3.7.4 Groundwater resources

Groundwater resources evaluations needs detailed assessments and specialized studies on recharge sources, mechanisms, quantifications of the amount, studies on the storage mediums/aquifers and characteristics etc. Recently, several wells have been drilled within UGA catchment for the purpose of Addis Ababa and surrounding community water supply which is under construction. For indications of the borehole locations see Figure 19.

4 Water Supply Analysis

In this section a review will be made of AAWSA's water production in general, we zoom in on its water production in the UGA sub-catchment, make an analysis of rural water supplies outside AAWSA's mandate, assess the overall water quality of sources in the catchment, and concludes with an analysis of the sanitation and hygiene standards in the project area.

4.1 AAWSA water production

Before looking at AAWSA's water production facilities in the Upper Great Akaki sub-catchment it would be good to first have a closer look at AAWSA's main water sources supplying water to the city of Addis Ababa. See therefore also Figure 20 below.

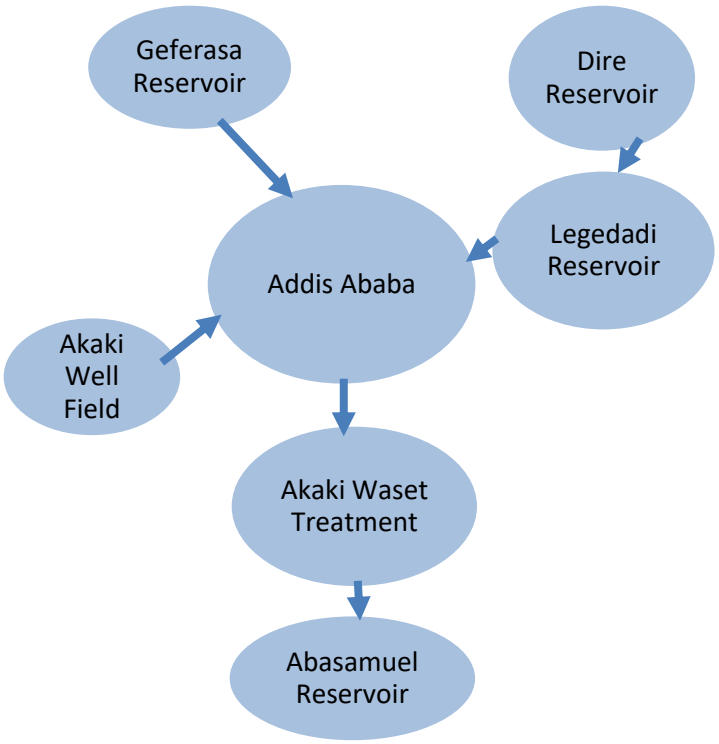


Figure 20. Simplified sketch showing main water sources of Addis Ababa City

Addis Ababa receives water from Legedadi and Dire Reservoirs (commissioned in 1967 and 1999, respectively) located at the east of the city, and from Geffersa reservoir located west of the city and which was constructed in 1943. In addition, Addis Ababa receives water from numerous groundwater sources abstracted from the Akaki well fields and a number of loose boreholes. For a complete overview of all AAWSAs water sources see Table 10 on the next page.

Table 10. Overview of AAWSA water production sources, per source type, estimated production and cover rate (%)

AAWSA water sources	Estimated production [m³/day]	Cover rate [%]
Surface water sources		
Legedadi & Dire dam reservoir (combined)	174,000	32.10%
Geferssa reservoir	30,000	5.54%
Groundwater sources		
Legedadi deep well	40,000	7.38%
Akaki old well field	8,000	1.48%
Akaki Phase II	66,000	12.18%
Akaki Phase 3A	36,000	6.64%
Akaki Phase 3B	68,000	12.55%
Akaki Koye Feche	30,000	5.54%
Pocket area wells	90,000	16.61%
	542,000	**100%**

The total production of 542,000 m³/day is before the non-revenue water (NRW) losses have been included. There are no accurate NRW percentage numbers available, but it is currently approximately 40% out of which 17 to 20% is considered as technical loss. This means that of the total of 542,000 m³/day produced, only 325,200 m³/day actually comes out of the tap of AAWSA's customers. Add that on top of this almost half (~50%) of the water produced goes mainly to commercial customers, it becomes clear that only a very small amount ends up at households for domestic use and daily human needs. If you compare the actual estimated water supply of 325,000 m³/day by AAWSA with the current (2020) estimated water demand of 1 million m³/day in Addis Ababa City, it becomes apparent that there is still a huge gap between supply and demand to bridge. So there is roughly a deficit of 675,000 m³ per day.

The other side of the story is that there are several water source development and exploration plans by AAWSA to increase its total water production. An overview of these plans is given in the table below with an indication of the daily expected water production.

Table 11. Overview of future water source development plans by AAWSA

No.	Water source development plan	Estimated daily water production [m³/day]
1.	25 boreholes at pocket areas in Addis Ababa	30,000
2.	21 boreholes at South Hayat North Fanta	68,000
3.	20 boreholes, Legedadi Phase II	86,000
4.	Gerbi dam construction (projected to start in 2021, $150 million USD loan secured from Exim Bank)	73,000
5.	Sibulu dam construction	428,000
6.	NRW reduction plan, level of reduction not indicated	unknown
		685,000

Concluding remarks

As can be seen from the Table 11, with a combined additional water volume of 685,000 m³/day these future water exploration plans could close the current gap between supply and demand. However, there are a few caveats here:

1. By the time these water development projects are completed, the total water demand in Addis Ababa has already increased further;
    a. For the realization of new well fields with boreholes, a minimum of two to three years must be expected for successful completion, possibly longer;
    b. The construction of a dam reservoir from feasibility studies to design and actual implementation will take much longer, and should even be assumed to be 15 to 20 years;
2. In the Consultant's experience, the estimates and projections of potential abstraction volumes are consistently overestimated and without risk margin, and in particular the abstraction rates that could be obtained from aquifers. It would be better to use more conservative numbers (say 50% -75% of current indications) so that the actual outcome will probably be better, instead of the other way around. If we take the target 20 boreholes at Legedadi Phase II with a projected production of 86,000 m^3/day, for example, then an individual production per borehole of 54 L/s (or 195 m^3/hr) is expected. These are very productive boreholes that are rare and it, therefore, seems very unlikely that a total production of 86,000 m^3/day with just 20 boreholes will be achieved;
3. A heavy focus on NRW reduction is a significantly more cost-efficient investment that can be implemented in the shorter term and can have a longer-lasting result as long as it is linked to good coordination, implementation, maintenance and management.

AAWSA's water production in the UGA sub-catchment from Legedadi and Dire dam reservoirs (174,000 m^3/day) as well as the Legedadi deep well (40,000 m^3/day), amount currently to a daily estimated production of 214,000 m^3/day thereby covering 39.5% of AAWSA's total daily production. According to figures from AAWSA, its water sources in the UGA sub-catchment supply an estimated 2.6 million people in Addis Ababa with water.

AAWSA's water production in the UGA sub-catchment from Legedadi and Dire dam reservoirs […] amount currently to a daily estimated production of 214,000 m3/day thereby covering 39.5% of AAWSA's total daily production

4.2 Legedadi and Dire dam reservoirs

Legedadi reservoir is the first water supply reservoir constructed in the Upper Great Akaki sub-catchment. Later on, Dire reservoir was constructed to supplement the Legedadi reservoir and to curb water shortage problems of the Addis Ababa city. The Dire Reservoir has a volume capacity of approximately 19 million m^3 (Mm^3), a crest length of 1,980 meters and spillway capacity (Q) of 500 m^3/s. Additional technical specifications of both dams can be found in Table 12 below, followed by overview photos of the dams in Figure 21 and Figure 22 on the next page.

Table 12. Technical specifications of Legedadi and Dire Reservoirs. (Source: Water supply dams in Ethiopia and sustainability, Estifanos, Ketsela M,. 2019)

Name of the water supply dam	Catchment area (km^2)	Reservoir Capacity (Mm^3)	Dam height(m)
Legedadi	225	47	44
Dire	77.7	19	46

Figure 21. Overview of Dire reservoir and its catchment

Figure 22. Partial view of Legedadi Reservoir

After the construction of Dire dam, surface water stored in this reservoir is transferred into the Legedadi reservoir through a 10km underground pipeline and mixed with Legedadi water. From here the raw water is transferred to the Legedadi treatment plant which treats the water from both reservoirs where after it is distributed to Addis Ababa. A simplified sketch of AAWSA's supply system is shown in Figure 20. Combined the two dam reservoirs have an average daily water production of 174,000 m^3/day (32% of total supply to Addis Ababa) of which an estimated 2.6 million residents of Addis Ababa City are supplied with water.

Siltation of the two water reservoirs has a considerable impact on the reservoir functions. Silt deposits in water supply reservoirs reduce their live storage capacity. This reduction results in less water harvesting capacity, which contributes to the water shortage problems faced in the rapidly increasing urban areas of Addis Ababa. Build-up of suspended solids in Legedadi reservoir affects the raw water quality, increases the turbidity and has led to increased costs of water treatment (Aliand Tsega, 2018). The expected increase in precipitation of more than 11% towards 2050 as a result of climate change will only exacerbate this problem.

Ali and Tsega (2018) recommended to collect regularly primary data. The data collection includes bathymetry, flow into the reservoir, sediment transport rate and sediment gradation. The bathymetric surveys undertaken for the Legedadi reservoir during the period 1979-1998 indicated that sediment accumulate at a rate of 0.11 Mm^3/year for the intervening period (Andualem and Yonas, 2008).

4.3 Rural water supply

The rural water supply provision can be classified as insufficient with unsafe facilities that cannot meet the water demand year-round. According to the socioeconomic data from Berek district, the potable water coverage in rural areas is 63.8%. The Water Mineral & Energy office of the district provided an overview of known water supply schemes as shown in Table 13 on the next page showing the type and number of (communal) water supply schemes in the district. It shows that most communities mainly rely on hand dug and shallow wells reaching the shallow groundwater aquifer, which react very sensitively to lack or delay of rainfall.

From the household (HH) survey conducted by the Consultant, showed that 100% of the respondents (426 households) are not satisfied with the quantity and quality of the water they have access to, judging the quality of water as being very poor. The HH survey furthermore has provided insight into the water sources used at household level. An overview of this in Table 14 on the next page.

Table 13. Type & number of water supply schemes

Water work	2017	2018
Deep wells	14	18
Shallow wells	50	53
Hand dug wells	236	240
Spring development	40	42
Total no. of schemes	340	345

Table 14. Main source of water at household level

Description	Frequency	Percentage (%)
Protected hand dug well	90	21.1
Borehole	53	12.4
Unprotected ring well	46	10.8
Unprotected hand dug well	32	7.5
Community or public water point	85	20.0
Tap connection inside the house	43	10.1
Surface water (river, dam, lake, pond, stream canal, irrigation channels)	31	7.3
Rainwater harvesting with improper technique	5	1.2
Rainwater harvesting with proper technique	2	0.5
Protected pond	4	0.9
Other	35	8.2
Total	**426**	100.0

Source: Household Survey, 2020

This shows that the majority of the interviewed households depend on groundwater (~ 52% via borehole or well, protected or unprotected), so protection and replenishment of shallow aquifers should become a top priority within the UGA sub-catchment. Then about 30% of the respondents make use of either a public or private water tap point. Remarkably, less than 2% of the respondents make use of rainwater harvesting techniques. Given the predicted sensitivity to climate change in the area, the local authorities and the IWRM4WASH project should focus more on disseminating the benefits of rainwater harvesting techniques and provide support to implement them.

Development goals:

- With more than 50% of UGA sub-catchment's inhabitants dependent on (shallow) groundwater, make protection and replenishment of this a political top priority;
- Develop an awareness and dissemination campaign on resilient rainwater harvesting and buffering techniques (3R), and provide implementation support to showcase such techniques as alternative domestic water source.

4.3.1 Women and water collection

For the 8.2% of respondents who answered 'Other' in the previous Table 14, physically walking to a public water source to collect water with jerry cans is the daily standard. This percentage is very likely much higher in the most remote highland areas of the UGA sub-catchment. According to UNIDO, women are usually the ones responsible for the fetching water for household purposes as well as for rearing of small livestock and subsistence backyard agriculture (UNIDO, 2015). Similar to other developing countries, the HH survey confirmed that also in the UGA sub-catchment 73% of the women and girls have the responsibility for water collection. Of the total respondents 53 % carry water jerrycans themselves, 29 % uses donkey cart to transport water, and 18% uses other modes of transport.

The HH survey also revealed that on average a household consumes 85 liters of water for domestic use on a daily basis. Women collect water with 20 Liter jerrycans twice in the morning and twice in the late afternoon (total: 4 trips), taking on average 19 minutes per roundtrip. However, FGD and KII participants from the community stated that one trip takes as much as 30 minutes on average during rainy season. Nevertheless, water collection will take more time during the dry season due to long queues as alternative water sources when available sources start to run out. Accordingly, on a daily basis 2 hours on average will be spent for water collection. Residents in more remote kebeles spend even more time fetching water and may take 4 hours a day to find water during the dry season. The time required to collect water is of course at the expense of women's household duties, but also time for self-development, engagement of in income-generating activities and engagement in social, political and other activities (UNIDO, 2015) which are essential in achieving gender equality.

4.3.2 Sendafa – Beke Water Supply Service Enterprise scheme

The towns of Sendafa and Beke (and Tuki in-between) have their own drinking water supply system that is operated by the Sendafa-Beke Water Supply Service Enterprise (SBWSSE). Unfortunately, accurate census data is lacking, but based on 2012 census data and a population growth of about 3% per year, the population of Sendafa by the end of 2020 is likely to be around 15,000 inhabitants. If you add the smaller Beke and Tuki towns to this, the population is probably around 25,000 inhabitants. Assuming an average urban water demand of 50 L/c/d, the current water demand for Sendafa-Beke would be slightly below 1,500 m^3/d. If we extend this to 2050 with a higher water demand per capita up to 100 L/c/d, the daily water demand will likely exceed 6,000 m^3/d.

SBWSSE makes use of 8 functional production boreholes, out of which three new boreholes are connected to the system recently. Although operating under one company and system, the water supply from the production boreholes has been split; two of the 8 boreholes deliver to Beke town, while the other 6 boreholes serve Sendafa town. The most productive borehole, the Dabe borehole, is highly productive and provides approximately 36 m^3/hr or 576 m^3/day, considering 16 hours of pumping per day. The other seven boreholes have an estimated capacity of 10 L/sec or less, totaling to a production of an estimated 1,150 m^3/day. The total daily production by the SBWSSE ends up at around 1,700 m^3/day. Which would mean that the current production by SBWSSE could just meet the current water demand, although the very likely NRW and leakage losses in the network are yet included.

Key-informant interviews (KIIs) held at municipal level in Sendafa and Beke towns report, however, that current production is inadequate and there is a water shortage from time to time, especially in Beke town that depends on two old boreholes from 1993. Some of the reasons mentioned as problem are:

1. Budget problem to run the existing electrometrical installations working with diesel;
2. Decline in yield of the old boreholes which needs investigations and rehabilitation works.

A new project, locally known as the '4BHs project' and includes the commissioning of 4 new production boreholes, is nearing completion and is expected to solve the water shortage problems. It concerns the four boreholes presented in Table 15 below.

Table 15. Technical specifications of new drilled boreholes under 4BHs project

Naming by SBWSSE	Drilled depth (m bgl)	Estimated yield (L/sec)	Estimated yield (m3/hr)
Gomata BH1	470	60	216

Gomata BH2	472	80	288
Muda BH	200	20	72
Legedadi area BH	400?	50	180
Total contribution		**210**	**756**

Indicated borehole yields are first estimates. The sustainable extraction capacity still has to be determined by means of long-term test pumping (minimum of 48 hours) and could possibly be (much) lower than indicated here. With the commissioning of the 4 new production boreholes and based on 16 hours of pumping per day, the daily production of SBWSSE could increase more than tenfold to more than 10,000 m³/day, which probably means that the local water demand can be met and obsolete and unsanitary boreholes could be decommissioned.

The Consultant has, however, strong doubts whether the estimated yields indicated will also remain feasible in the long term from a groundwater sustainability point of view. It is probably better to assume a more conservative expectation of 300 m³/hr to 500 m³/hr (or 4,800 to 8,000 m³/day), which would still mean a triple to fivefold improvement of the current production.

4.4 Water Quality

Legedadi and Dire Reservoirs are providing significant portion (>32%) of the household water supply to Addis Ababa City. However, its water quality deteriorates repeatedly during the year. For several years, the reservoir has grieved from irregular massive algae blooms, increased turbidity and undesirable odor and taste (Ali and Tsega, 2018). Regarding the algae bloom, it should be confirmed if this concerns *Blue greens* or *Cyanos*, since these algae types are potentially toxic to humans and other life forms. The maximum concentrations were recorded during the dry season with intermittent rains of the year (March to June) which may be due to runoff from the dry agricultural fields and atmospheric deposition. Nitrate level is generally remarkably high in reservoirs, Ammonium significantly varied both temporally and spatially.

Soluble reactive phosphate (SRP) varied significantly both seasonally and spatially with maximum values recorded during the short and long rainy months of the year. The remarkably high concentrations of SRP seem to be associated with the intensive human activities carried out in the catchment area such as agricultural activities involving the use of fertilizers. Ali and Tsega (2018) concluded that the most important water quality parameters in Legedadi reservoir plant nutrients and phytoplankton biomass were found to be high throughout the year and varied both seasonally and spatially. The year-round elevated turbidity selectively favored the most nuisance cyanobacteria (Microcystis and Anabaena) to dominate throughout the year. The levels of growth limiting plant nutrients (ammonium, nitrate, soluble reactive phosphate and silica) were high enough to cause surface bloom of algae and water hyacinth in the reservoir throughout the year. In addition to the elevated levels of turbidity and nutrients, the seasonal variability of these conditions also offered additional factor to selectively favor cyanobacterial blooms in the reservoir.

4.4.1 Historic water quality analysis of reservoir water

In 2015, Getachew *et al.* conducted a physico-chemical water quality analysis of water supply reservoirs of Addis Ababa City. According to the report, the test results of Legedadi reservoir exceeded both the WHO/EU and the Ethiopia drinking-water quality standards (Table 16 on the next page).

The Dire water supply reservoir has three tributaries, Legsilmicha, Legdamo, and Legmiti. According to the researchers, the composite sample taken from the three tributaries indicated

that level of biological oxygen demand (BOD_5), exceeded the limits permitted by either the WHO/EU or the Ethiopia drinking-water quality standards (Table 17 below).

Table 16. Results of water quality analysis of Legedadi Reservoir (before treatment) (Source: Getachew et al., 2015).

Water quality parameter	Analyzed value of physio-chemical parameter	WHO/EU quality standard
Turbidity (NTU)	**9**	**5**
Nitrate (mg/l)	**63.12**	**50**
Nitrite (mg/l)	**6.53**	**3**
Ammonia(mg/l)	**3.07**	**2.0**
Phosphate(mg/l)	**7.78**	**0.54**
BOD (mg/l)	**10.74**	**<5**

On the other hand the raw water quality data displayed at Legedadi water treatment office indicated that, except the turbidity of the water (expressed in NTU) and the total iron concentrations, the measured parameters are below the WHO and Ethiopian drinking water quality standard (Table 18 below).

Table 17. Results of water quality analysis of Dire Reservoir (Source: Getachew et al., 2015).

Water quality parameter	Analyzed value of physio-chemical parameter	WHO/EU quality standard
TDS (ppm)	197	500
Temperature(°C)	24.9	25
Alkalinity(mg/1)	173	
Phosphate (mg/1)	0.775	
Sulphate (mg/1)	18.2	250
BOD (mg/1)	10.5	<5
COD (mg/1)	29	40

Table 18. Raw water quality data of Legedadi reservoir

Parameters	Concentration	Ethiopian Drinking Water Quality Standard
Turbidity (NTU)	150-1400	<5
Oder	None objectionable	None objectionable
Taste	None objectionable	None objectionable
pH	7.12	6.5-8.0
TDS mg/l	61	600
Ammonia-N mg/l	0.04	1.5
Nitrate-N mg/l	0.011	11
Nitrite-N mg/l	0.012	1.0
SO4 mg/l	41.4	250
F mg/l	0.15	1.5
Total Fe mg/l	3.32	0.3
Mn mg/l	0.343	0.5
Cl mg/l	8.4	250
E.Coli MPN/100ml	N.A	N.A

Source: Taken from the Legedadi water treatment office board

The treated water quality data displayed in the treatment plant office board indicated that all the parameters including coliform test are within WHO and Ethiopian drinking water quality

standards (Table 19 on the next page). It is because, water treatment process helped to improve the level of Iron in the treated water, which was higher than the WHO guideline value in untreated water.

Table 19. Treated water quality data of Legedadi reservoir

Parameters	Concentration	Ethiopian Drinking Water Quality Standard
Turbidity (NTU)	0.284	<5
Oder	None objectionable	None objectionable
Taste	None objectionable	None objectionable
pH	7.51	6.5-8.0
TDS mg/l	65	600
Ammonia-N mg/l	0.021	1.5
Nitrate-N mg/l	0.4	11
Nitrite-N mg/l	0.003	1.0
SO4 mg/l	0.6	250
F mg/l	Not detectable	1.5
Total Fe mg/l	0.142	0.3
Mn mg/l	0.015	0.5
Cl mg/l	4.9	250
E.Coli MPN/100 ml	0	0
Total coliform MPN/100 ml	0	0

Source: Taken from the Legedadi water treatment office board

4.4.2 Targeted water quality testing 2020

At the request of the Client, the Consultant initiated a water quality testing campaign, in which 10 strategic locations in the UGA sub-catchment were determined. On October 7 and 8, 2020, the ten water samples have been taken from the UGA sub-catchment and around the Dire and Legedadi reservoirs. It concerns 8 surface water locations (UGA-S1 until UGA-S6, UGA-S9 and UGA-S10), one from a borehole (UGA-S7) and one from a hand dug well (UGA-S8). The sampling sites are shown in Figure 23 below.

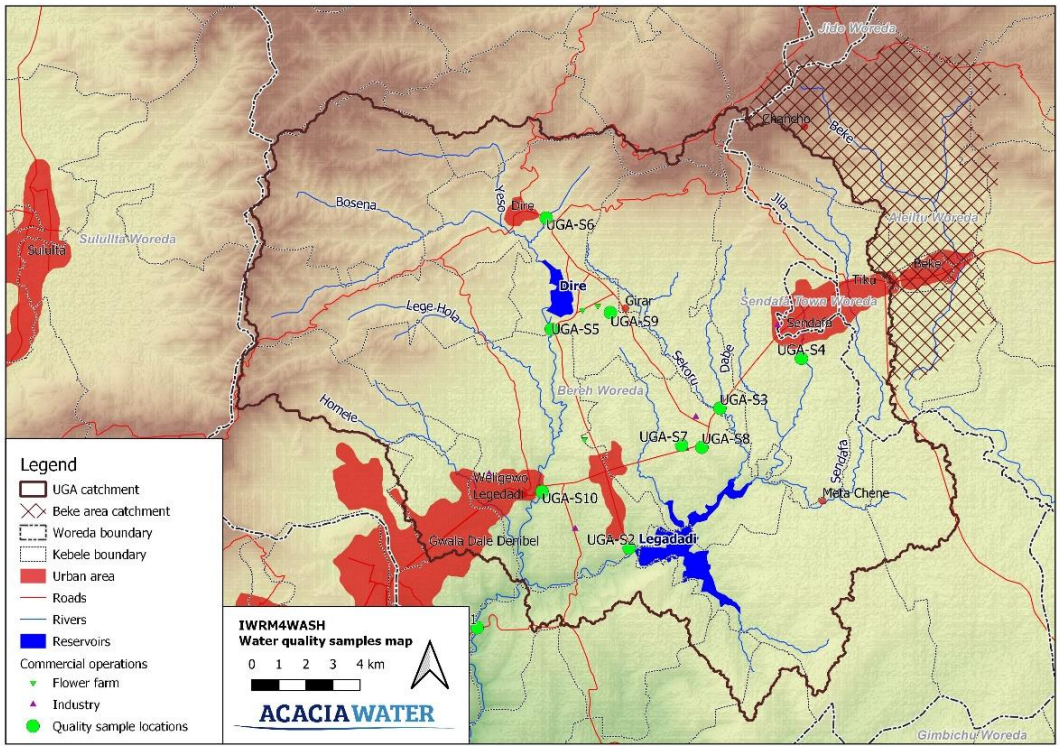


Figure 23. Selected water quality sampling locations in the UGA sub-catchment

The samples have been analyzed on physico-chemical parameters by the AAWSA laboratory and on heavy metals (As, Cd, Co, Cu, Ni, Pb, Zn, Cr, Hg, Mn and Fe) by the Horticoop Ethiopia PLC, soil and water laboratory from Debre Zeit. Heavy metals were analyzed on the groundwater sample from the hand dug well (UGA-S8) and four river water samples (UGA-S3, UGA-S4, UGA-S9, UGA-S10).

Table 20. Sampling locations related to Figure 23

Code	Location
UGA-S1	Outlet UGA sub-catchment of"Akaki" stream
UGA-S2	Downstream intake of Legedadi reservoir
UGA-S3	Tributary to Legedadi reservoir, close to Oil Manufacturer
UGA-S4	River upstream of Legedadi reservoir Sendafa town, Kultibi stream
UGA-S5	Downstream intake of Dire dam reservoir
UGA-S6	River upstream of Dire Reservoir, on Lege Bereh
UGA-S7	Borehole mobile manufacturing industry Nr. LLA-6 BHs
UGA-S8	Dug well Afro Oil Manufacturing PLC, Ejeri HDW
UGA-S9	river near Abyssinia& Magic Flower Farms, Lege Beri river
UGA-S1O	River downstream Dire rervoir (crossing of the pipeline on Legedadi river)

Results

The analyses have been summarized in Table 21 on the next page. The analytical lab method and examination standards applied by Horticoop Ethiopia PLC laboratory was 1) acid digestion and 2) ICP-OES measurement.. The samples have been analyzed on major chemical components except for sodium. Water samples are slightly acid (pH < 7), have a low salinity (Electrical conductivity < 500 µS/cm) and is moderately hard (Hardness as CaCO3 < 180 mg/l).

Comparing the sum of the cations in meq/l, the sum of anions in meq/l and the electrical conductivity (NB: EC/100 is about equal to sum of kations or anions) learns that the missing sodium concentrations cannot explain the difference in charge balance. Most probably the analyses of chloride, bicarbonate and hardness have relatively large errors. Therefore calculations of saturation of calcium carbonate and other minerals have not been carried out, though we think water is slightly undersaturated with respect to calcium carbonate.

All samples show sign of anthropogenic influence based on nitrate contents. For UGA-S6 nitrate has not been determined. Nitrate in UGA-S8 (hand dug well) reached the permissible limit of the WHO standard and Ethiopian standard (CES-58). The samples analyzed on heavy metals all surpass the acceptable limits of one or more metals, notably cadmium, lead, mercury and arsenic.

The groundwater samples from the hand dug well downstream of the Afro Oil Manufacturing PLC is highly polluted. The water is muddy (high turbidity), anoxic (high iron content), has high levels of nutrients (nitrate) and very high concentration of heavy metals. It seems not much water is drawn from the hand dug well (stagnant conditions) and waste has accumulated in the well.

Conclusions

The number of ten analyses is limited for such a large area with diverse agricultural land use and many villages, towns and industries. A rationale for the sampling strategy is not provided. Therefore, these analyses probably does not present a representative overview of the water quality of surface and groundwater in the UGA sub-catchment. Also the accuracy of the analyses is questioned.

Table 21. Analyses of water samples from UGA sub-catchment. Values in red are concentrations of parameters exceeding the WHO (WHO, 2017) or Ethiopian (CSA, 2017) drinking water standards. Values in blue are concentrations of parameters exceeding background values and therefore indicating anthropogenic influence.

Parameter		Unit	Samples										Standards		Natural
			UGA-S1	UGA-S2	UGA-S3	UGA-S4	UGA-S5	UGA-S6	UGA-S7	UGA-S8	UGA-S9	UGA-S10	WHO (2017)	Eth. CES-58 (2013)	values
Turbidity		NTU	28.9	190	25.8	15.9	24.1	3.61	0.54	220	5.35	5.31			
	pH	-	6.29	6.59	6.51	6.84	6.74	6.81	6.99	7.01	6.8	7.06		6.5 - 8.5	
Tot Diss sol.	TDS	mg/l	124	55	90	173	94	116	226	104	213	112	1000	1000	
Electr. Cond.	EC	µS/cm	262	116	188	364	196	244	470	219	446	235	1500		
Total HD	as CaCO3	mg/l	101	95	80	182	124	154	122	126	163	115		300	
Calcium HD	as CaCO3	mg/l	94	69.2	69.2	107.6	99.4	87.2	94	78.4	65.6	96.2		75 (as Ca)	
Magnesium HD	as CaCO3	mg/l	7.8	25.37	10.81	74.6	25	67.2	27.8	47.8	97.4	18.8		50 (as Mg)	
Ammonia	$NH4^+$	mg/l	0.90	3.12	0.41	0.50	0.71	0.10	0.49	4.09	0.48	0.09	-	1.5	< 0.2
Nitrite	$NO2^-$	mg/l	0.13	0.47	0.08	0.07	0.72	0.11	0.07	0.03	0.19	0.05	3	3	< 0.5
Nitrate	$NO3^-$	mg/l	8.9	35.9	2.7	11.1	6.2		4.0	50.0	32.3	3.5	50	50	< 3
Sulphate	$SO4^{2-}$	mg/l	8	25	4	7	4	1	7	36	27	2	-	250	
Phosphate	$PO4^{3-}$	mg/l	0.6	1.2	0.3	0.7	0.7	0.3	0.8	1.8	3.7	0.7			< 0.25
Fluoride	F^-	mg/l	0.07	0.08	0.09	0.02	0.03	0.02	0.39	0.01	0.28	0.02	1.5	1.5	
Iron total	Fe^{2+} ($+Fe^{3+}$)	mg/l	1.4	4.6	0.7	1.2	0.6	0.1	0.1	4.5	0.4	0.1		0.3	
Manganese	Mn^{2+}	mgll	0.13	0.55	0.09	0.83	0.09	0.05	0.10	0.74	0.19	0.05		0.5	
Silica	SiO2	mgll	13	128	133	136	80	213	68	19	183	178			
Chloride	Cl^-	mg/l	17.4	2.9	0.7	5.3	1.0	0.8	5.2	1.9	4.2	1.1	250	250	
Bicarb. Alk..	$HCO3^-$	mg/l	101	8	93	159	96	126	196	105	117	107			
Σanions		meq/l	2.47	1.35	1.69	3.10	1.81	2.11	3.61	3.39	3.26	1.90			
Σkations		meq/l	2.14	2.25	1.65	3.74	2.55	3.10	2.47	2.94	3.31	2.31			
Σanions - Σkations		meq/l	0.33	-0.90	0.04	-0.64	-0.74	-0.98	1.15	0.45	-0.05	-0.41			
EC/100 (= Σan or Σkat)		meq/l	2.62	1.16	1.88	3.64	1.96	2.44	4.70	2.19	4.46	2.35			
	As	µg/l			< 1	19				302	173	5	10	10	
	Cd	µg/l			38	94				211	84	65	3	3	
	Co	µg/l			<24	37				40	29	21	-		< 1
	Cu	µg/l			0	16				43	19	10	2000	2000	< 100
	Ni	µg/l			< 1	61				56	48	35	70		< 25
Heavy metals	Pb	µg/l			41	217				363	239	132	10	10	
	Zn	µg/l			< 13	< 13				881	31	14	no	5000	< 50
	Cr	µg/l			< 1	69				70	39	21	50	50	10
	Hg	µg/l			54	89				326	128	134	6	1	
	Mn	µg/l			6	1336				157	471	< 8	-		
	Fe	µg/l			14	< 13				16288	< 13	< 13	-		

Nevertheless, the nutrients and very high concentrations of heavy metals indicate strong influence of anthropogenic activities. If the heavy metal analyses are correct, most water in the UGA sub-catchment is not fit to be used as a source for drinking water. Uncontrolled household wastewater discharges, but more likely those from chemical users in the manufacturing and horticulture industries, are the cause of the high heavy metal concentrations in the water.

Some of these largest industries located in the UGA sub-catchment are further highlighted in sections 7.5 and 7.6 of this report. The alarmingly high concentrations in heavy metals in this study are consistent with concentrations in the Awash river downstream of the Akaki river, reported by Eliku & Leta (2018).

Recommendations

The current water analysis of 10 samples has been a good start to gain a first insight into the water quality of various water sources in the UGA sub-catchment. Nevertheless, before final conclusions can be drawn it is recommended to sample and analyze different water sources, as a first batch, from 50 locations followed by more detailed sampling. For a good sampling strategy locations must be selected based on an overlay of (micro)catchments and the pattern of agricultural practices (land use), housing and industries (effluents).

It should also be ensured that sampling points are included of pristine waters, such as upstream catchments and deep boreholes. Regarding the analytical package, analysis on heavy metals must be carried out on all samples. Given the suspected influence of industrial and agricultural activities the package should also include organic parameters like commonly used pesticides, volatile organic compounds like the BTEX group and halogenated compounds of the VOH group.

5 Institutional Framework Analysis

In the subsequent Chapters the outcomes and analysis results of the Data Collection phase (Phase B) are presented. This is done on the basis of four main themes, of which each forms a new section in this chapter, namely: Institutional Framework analysis (Chapter 5), Socio-economic analysis (Chapter 6), Environmental analysis (Chapter 7) and Gender & Youth analysis (Chapter 8).

5.1 Introduction

The institutional framework in Ethiopia and the UGA sub-catchment specifically has already been extensively discussed in the Inception Report (submission date: September 15, 2020). In this section we focus on the main findings regarding the institutional set-up surrounding land and water management in the UGA sub-catchment.

Despite the fact that a thorough institutional study could be conducted based on literature, field observations, household (HH) surveys, focus group discussions (FDGs) and key-informant interviews (KIIs), it is regrettable that due to lack of time qualitative in-depth interviews were not possible with a number of Addis Ababa based organizations such as AAWSA and Oromia Water Mineral and Energy Bureau (OWMEB). Therefore, this section is prepared without considering these institutions.

5.2 Contextual background

The Ethiopian government promotes good economic, environmental and social governance as fundamental for stimulating inclusiveness of the catchment areas growth. With regard to the water resources, the Ethiopian water resources management policy emphasizes on institutional development at every aspect in the water sector and fosters in particular the development of the agriculture and WASH sector. Institutional instability is avoided by enabling important linkages between communities, governmental bodies, private sector and other support agencies. Furthermore, coherent institutional framework are set up allowing an integrated and comprehensive management of water resources as well as the necessary flexibility while accommodating continuity in terms of change and development.

Reviews had been made on the existing policies, strategies, legal and institutional framework, and concepts that embrace the idea of having the transparent governance system that needs to respond to citizens' preferences and wellbeing. Moreover, reviews had been made on the strength and capacity of institutions in terms of institutional governance, compliance to national policies, strategies and legislations, facilities, human resources and financial and information management system.

5.3 Approach and methodologies

The baseline survey was conducted in a systematic approach by using household survey, key informant interview, focused group discussion and physical observations. In connection to this, the IWRM4WASH project is designed to measure performance by employing eight result

areas of which institutional study is one part of these result areas. These results are become a greater tool for assessing the WASH movement in light of creating access to water, sanitation and exercising healthy hygienic practices and related facilities at community level in the project areas. The approach and methodology begins from data collection tools and methodologies, data recording and analysis and interpretation to ultimately provide the meaningful results in the survey.

5.4 Institutional Policies, Strategies and legal status

Ethiopia has laws, policies, strategies and frameworks which incorporate natural resources management. These are necessary for the project to navigate maneuvering space while designing and implementing activities. This section gives brief description of the most relevant applicable policies, strategies and legislations desirable to the improved water resources management for WASH in the Upper Great Akaki catchment. For this particular project, sector policies and strategies are reviewed and made part of this baseline survey document.

The policies reviewed so far includes: Ethiopian Water Resource Policy, Health Policy, and Environmental Protection Policy and policy documents on Climate Change, WASH and Public Health in Ethiopia.

5.4.1 Ethiopian Water Resources Policy

It is good and encouraging to have such a comprehensive water resources management policy in place. In the review process, it was found out that the policy is so detailed and comprehensive to use it for WASH sector development. However, it was also possible to identify the key policy gaps which some of these are outlined below.

- It is quite known that the climate change has a direct influence on water supply services at all levels. However, the policy gives less attention to the variability of climate change on water resources. In the policy, climate change has not yet been a priority in ensuring sustainable water supply services and the policy needs to perceive climate resilient water supply services with consideration;
- Although the stakeholders' participation is pointed out as important mechanism for water resources management in the country, the policy could not identify the key stakeholders that are desirable for WASH sector development in a clearer sense;
- The water policy gives more emphasis for water and its management. Although it is mentioned in the policy it is not clear about the ownership and who the relevant stakeholders are to realize the improved sanitation system;
- Water, Sanitation and Hygiene are inseparable for the health and wellbeing of the society. However, the water policy could not point out the desired linkages between these three important components of WASH.

5.4.2 Ethiopian Water Resources Management Proclamation

This proclamation is identified as proclamation number 197/2000 that was issued for water resources management, protection and utilization so as to put the water resources of Ethiopia to the highest and social and economic benefit for its people through appropriate protection and due management modalities. On top of the identification of the powers and duties of the supervising body, the law also gives an order of rectification of water works which are incompatible or inconsistent with the Ethiopian water resources policy document.

5.4.3 Health Policy and Strategy

On the review of policy documents on climate change, WASH and public health in Ethiopia that was developed in 2015, it was noted that the reviewers used the power and interest grid matrix for the identification of key stakeholders in the document. The high power and high interest grid is an acceptable option above the rest of the grids in the matrix. The stakeholders analysis

includes the most relevant Government sectors that need to be assigned to lead climate change related issues and donors including UN agencies interested to finance the climate change and WASH. From the wider list of stakeholders put in the analysis, the relevant government sector ministries are identified as: Ministry of Agriculture (MoA), Ministry of Water, Irrigation & Energy (MoWIE), Ministry of Health (MoH) and Ministry of Education (MoE), whereas, Government sectors assigned to lead climate change related issues are named as Ministry of Finance and Economic Development (MoFED) and the National Meteorology Agency (NMA).

The national sanitation and hygiene strategy developed by the Ministry of Health is more compressive and easy to apply. The strategy puts responsibility matrix that begins from Kebele level to the national level which involves key actors in WASH. In its strategic framework, the strategy outlined the hygiene and sanitation pillars as Pillar 1: Enabling Environment, Pillar 2: Sanitation and Hygiene promotion and Pillar 3: Access to hardware. All of the three pillars have their own specific details each set to support poverty reduction, disease prevention and improved sanitation and hygiene.

In the final analysis, the strategy clearly indicated the roadmap, roles and responsibilities for each stakeholder and identified the National Coordinating Forum which includes Ministries of Health, Water Resources, Education and Agriculture as well as NGOs, Academic Institutions, Privet Sector and donors. However, from the result of the household survey, focus group discussion and interviews, it was realized that there is no functional coordination forum on the ground to lead the WASH in the area.

5.4.4 Ethiopian Environmental and Climate Change Policy

This policy was approved in 1997 and largely focuses on environmentally sustainable development through healthy environmental protection that ensures climate resilient economy adaptation of sectorial, regional and local community level. It promotes the mainstreaming of environmental issues among development sectors including WASH without considering the important of institutional framework and coordination role in the sector.

5.5 WASH Sector Participants

There are a number of government agencies in the UGA sub-catchment area that are directly or indirectly involved in the water, sanitation and hygiene development sector. The roles and responsibilities of various agencies in relation to the water, sanitation and hygiene program are identified by the desk review and KII. From the general observations and analysis, the following institutions and programmes at federal and regional levels have taken into consideration for the assessment:

- Ministry of Water Resources, Irrigation and Energy (MoWIE)
- Federal Basin Development Authority (BDA)
- Ministry of Health (MoH)
- ONE WASH National Programme, National WASH Coordination Office (NWCO)
- Oromia Water and Energy Resources Development Bureau (OWERDB)
- Addis Ababa Water and Sewerage Authority (AAWSA)
- National Meteorology Agency (NMA)
- Berek Woreda Environmental Protection Office
- Berek Woreda Finance and Economy office
- Oromia Bureau of Agriculture
- Berek Woreda water resources, health and education offices
- Sendafa Town Water Supply and Sanitation Services, health and education offices
- Rural community water and sanitation committees
- Communities and private sector participants

In rural areas community water and sanitation committees operate water systems and promote sanitation. Not all the local committees are registered, which is a prerequisite to open a bank account to hold funds collected from users. In Berek woreda there are 174 rural water committees

5.5.1 WASH sector partners' assessments

Sector coordination, service delivery arrangement, regulations and accountability are required to ensure alignment and harmonization with the WASH sector agencies. Coordination mechanisms for the WASH sector can establish the basis for improved stakeholders' collaboration and lays the basic ground for the shared vision among the group of partners that have the direct stake in the development of WASH sector.

All of the above institutions reviewed in the survey are found to be relevant for WASH sector, the management of climate change and environmental protection including the management of water sources. Desk reviews focus group discussions, key informant interviews, household survey and observations were used as data collection tools to understand the existing situations on the ground. In concluding the assessments from reasoning, it was realized that there is no strong sectoral linkages among these WASH actors. No one bear the responsibility of coordinating the WASH sector, while in effect leaving everyone to move in isolation. There is weak capacity in WASH and environmental management and enforcement are key challenges of the sector in general and project areas in particular. There is a lack of skilled human resources in key sectors and prioritized initiatives. There is a need to strengthen capacity in terms of technical skills and knowhow, analytical skills, monitoring, reporting and verification at all level and requires to invest in human resources development if the objectives of WASH and environmental and water source protection is to be met. Financial constraint is another area of concern. According to the data obtained from the field sites, the budget or finance for the development of WASH sector and environmental protection is unsatisfactorily small. These all limitations contribute to the occurrence of severe scarcity of water supply, poor sanitation and undesirable hygiene management in the area. It was observed that sanitation and hygiene in the towns, in the community and in schools are very poor. Sector development policies, development programs and strategies are not well understood among institution leaders and professional staffs and communities at woreda and kebele levels. Almost all of the government offices in the woreda and town are poorly maintained and inferior in quality. This makes the workforce obviously feel physically uncomfortable and unhappy and ultimately undermines the productivity.

5.5.2 Assessment of Perceptions and findings

Community perceptions: The great majority of the rural community relies on groundwater from shallow wells. According to HH survey FGD assessments with some of these communities indicate that at the end of the dry season groundwater levels can have depleted to such an extent that they cannot make use of these sources for some weeks to months, and have to look for alternative water sources that take unnecessary time and energy at the expense of (labor) productivity. Access to improved water sources is typically far away from the upland rural communities (> 1km away) making them dependent on unsafe waterholes, such as unprotected ponds and river streams.

Household survey: The household survey was conducted to assess and visualize the status of drinking water; sanitation and hygiene (WASH) service conditions for the communities living in UGA catchment areas. From the aspect of institutional framework, the survey contains information on the availability of quality of WASH services and survey instrument covered a range of information for the calculation of household welfare status, access to water, sanitation and hygienic services and at this point respondents were asked if they knew that

there existed the "responsible body for the coordination of WASH in the study area". The rate of occurrence or frequency of respondents for this particular question is 390. From the total respondents, 19% responded that they knew the coordinating body, whereas 76% answered that there is no such body and 5% said that they don't know about it at all. In another question on "Who is responsible for educating people about clean water, sanitation and hygiene in your area?" none of them responded about the availability of responsible body for enlightening people about safe WASH at all.

76% of respondents indicated that there is no local responsible body for the coordination for WASH in the study area.

The household survey also includes the question to know if the "communities have ability to maintain WASH facilities". On this particular question 399 respondents were participated. While 12% responded positively, the remaining 88% responded that they communities have no capacity to maintain WASH facilities. In connection to this, the respondents were asked if the privet sector support community in WASH services. A total of 383 people were involved to respond to this question. Out of this number only 3% responded positively and the remaining 97% responded that there is no privet sector support for WASH in the study area.

Focus Group Discussion: Based on this basic conceptual framework, the focus group discussions (FGD) were conducted with people from similar backgrounds or experiences that were brought together to discuss about specific topics related to water, sanitation, hygiene, water sources and environmental protection. Key responses from the focus group discussants were the following:

- There is an acute water shortage in the area. Because of water and sanitation problems, communal latrines in the town and toilets in schools are found in a very bad situation;
- There is lack of coordination in the WASH sector in the area which is thought to be highly desirable for the people to get essential and comprehensive WASH services;
- Communities have no technical capacity to manage water schemes and they often go to woreda water offices for repair and maintenance supports.
- People involved in FGD responded that they have little knowledge about policies and strategies and have had no more orientation or enlightenment about these important documents;
- The waste management (liquid and solid waste) is not well developed, there is no single vacuum truck for the town and waste disposal place is full at a moment;
- One group responded that there is collaboration with Agriculture office to develop nursery sites and engaged in plantation of trees as one of the environmental protection and climate change management efforts in the area.

Key informants interviews: People working in water supply and sanitation sector, project partners, school administrators and teachers, health care workers, environmentalists and others were interviewed to assess WASH-related knowledge, attitude and related practices. Interviews were also made to assess the capacity and readiness of every project partners to carry out sophisticated program such as WASH programs in the area. Another dimension of the KII is to assess the institutional framework and enabling environment and level of the engagement of the partners on WASH movement (Inter-sectorial coordination). From the interview respondents, the following points were captured:

- There is no responsible body in the area to coordinate WASH and the situation seems to be fragmented and tends to move in isolation;

- There is severe water shortage which in turn becomes difficult to keep improved sanitation and hygiene very well;
- Most of the respondents do not have adequate knowledge about the national policies, development programs and strategies at woreda level;
- There is no consistent program set to advocate for safe water, sanitation and hygienic practices;
- There are huge capacity limitations in the sector, specifically at lower level with respect of human power, physical facilities, financial resources (budget), technologies and operating system.

Observations: Observations were carried out for all impact indicators to assess the physical characteristics and conditions of sanitation and hygiene facilities. In physical observations, attempts were made to see the availability of fairly adequate infrastructure that supports the main functions of the partner organizations and institutions that are dealing with WASH program. To this point, it was observed that there have been very poor and old office buildings, badly built and near to collapsing toilets, water scarcities, no transportation facilities, limited technical knowledge, poor office equipment, office furniture and fixture in almost all offices visited for the survey.

5.6 Key Indicators

Four indicators are employed to measure the performances of water, sanitation and hygiene facilities and used to assess the capacity of partners such as government agents, local administrations and communities and the intensity of the collaboration and networking existing among these groups for the management of WASH climate change and environmental protection by focusing on the conservation of water sources:

1. **Outcome Indicator 1:** The consistent progress in capacity of national, regional and local agencies in managing the water, sanitation and hygiene facilities;
2. **Outcome Indicator 2:** Knowledge of institutions' contribution to the mitigation of climate change has a measurable impact on environmental protection including the protection of water sources;
3. **Outcome Indicator 3:** Hand washing knowledge and practice exists and institutions have a strong advocacy system in place to realize this impact (School WASH);
4. **Outcome Indicator 4:** Adequacy of the integration and collaboration exists between the WASH sector actors and this coordination is based on systematic management approach.

5.7 Conclusions and Recommendation

5.7.1 Conclusions

The sector ministries at a national level already have clear policies, strategies and accountability and monitoring system that are used to measure the effectiveness of these policies and strategies set to guide the WASH service deliveries. The national water resources policy and strategy, the health policy and strategy and environmental policy are good examples of the WASH sector policies that are reviewed for this particular survey. There are also legal proclamations endorsed by national councils set to support the functionalities of these policies and strategies. Although certain limitations are observed in some of the policy documents during the review, the existing policies and strategy documents sufficiently adequate and purposeful to apply for improved integrated water resources management (IWRM) in the UGA sub-catchment.

Sectoral challenges

As it was observed from the HH, FGD and KII surveys done, the biggest problem in the sector is poor sector coordination with both proper inter-institutional and intersectoral linkages lacking. Furthermore, there is:

- low perception of the water management sector policy and strategy at the grassroot (i.e. community) level;
- severe human resources capacity limitations for management and compliance with water, land and environmental quality standards (e.g. district governments are on average understaffed at over 46%);
- poor infrastructure; and
- lack of budget required to expand services in various fields, such as: WASH services, the development of water supply infrastructure, improved sanitation and hygiene facilities, protection of the environment and water sources, advocating for safe hygiene, and the management of climate change impacts in the project area.

Accountability in the WASH sector should be the fundamental principle whereby the sector champions are in charge of providing access to sustainable water supply, improved sanitation services and maintaining safe hygiene to the people they serve in the project area. This requires that the stakeholders need to come together and form a strong coordination body that should be guided by joint planning and implementation framework and proven monitoring and evaluation model. To realize this basic principle, the WASH sector partners have to build their own and sector capacities in every dimension, work on solving water scarcities and promote safe sanitation and hygiene to ensure the health and wellbeing of the people in UGA catchment areas.

5.7.2 Recommendations

- Promote appropriate linkage mechanisms for both the coordination of water resources, sanitation and hygiene management activities between the federal and regional Government agencies;
- Strengthen water resources management, health, environmental protection and agricultural development institutions, for sustainable development and management of the WASH sector;
- It is highly desirable to form joint planning, implementation and monitoring mechanism for the WASH sector and smooth information sharing among the partners of the sector;
- The sector management needs to follow workable form of coordination approaches which has to include useful elements of periodic dialog, communication and feedback mechanisms which can obviously satisfy the interest of all in the sector;
- The regional government needs to allocate adequate budget for infrastructure development, program delivery, human resources development, advocacy and education targeting safe water, sanitation, hygiene, healthy and safe environment, the impact of climate change and on mitigating environmental degradation and on ensuring ground water source and food security;
- Improve hygiene facilities such as toilets in schools and communities considering safe space for girls that includes separate toilets and washrooms.

6 Socio-economic analysis

The Consultants' socio-economic expert brought visit to and had focus on the Berek Woreda (*i.e. district*) in the Upper Great Akaki (UGA) sub-catchment. The district has a total area of 77,223 hectares or 772.2 km^2, which is almost twice as large than the UGA sub-catchment which encompasses approximately 393 km^2 (39,300 ha).

The purpose of this socio-economic analysis of the UGA sub-catchment is to give an overview of the socio-economic baseline assessment which includes current settlement patterns and development intervention that largely impacted sustainability of the Dire and Legedadi dam reservoirs. This section presents the prevailing situation for reviewing socioeconomic situation and mitigation measure and how the UGA sub-catchment area can be used for the benefit all stakeholders.

6.1 Methodology for socio-economic study

The study involves the use of both quantitative and qualitative methods of data gathering and analysis. Quantitative study was conducted to gather quantitative information from households, local government and from concerned district government offices. Qualitative study, on the other hand was conducted to gather information from different sources including secondary information from previous study.

6.2 Population & household characteristics

Population characteristic refers to the present population and expected change, ethnic and religious diversity and influxes and outflows of temporary residents as well as the arrival of seasonal or leisure residents. The total population of Berek Woreda was established at 86,458 in 2018, out of whom 43,690 are male and 42,768 are female.

6.2.1 Household size and age distribution

The household survey reveal that an average household size of 6. The survey result for the population is high because of the preference of family to have many children. Depending on the report of household survey result, the age distribution of the study population by age groups is given in Table 22 below.

Table 22. Age distribution

Age group	Total	Percentage (%)
< 18 years old	719	34
> 18 years old	1,412	66
Total	2,131	100

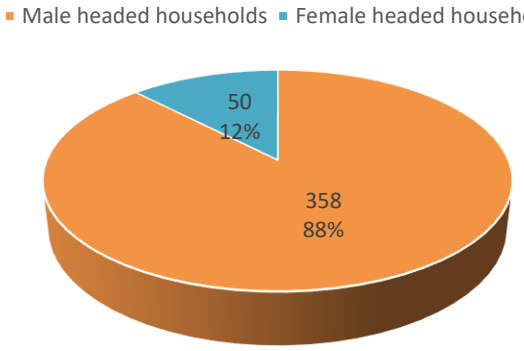
Source: Household survey, 2020

The household survey results illustrated that 34% of the surveyed household is less than 18 years, 66% of the population are greater than 18 years and the dependency ration is less than one. This shows that the productive age population is higher than dependent population.

6.2.2 Sex of the Respondents

The composition of the household heads commonly dominated by male as marriage and begetting children is highly valued, where the husband is considered as 'shed' head to protect family from any impairment. This shows that, consistent with other parts of Ethiopia, female headship is by far lower than male heads mainly due to socio-economic circumstances, cultural and social factors that shaped the position of women in the society. The following table shows the sex composition of respondents in the study sub cities.

Table 23. Sex composition of respondents[3]

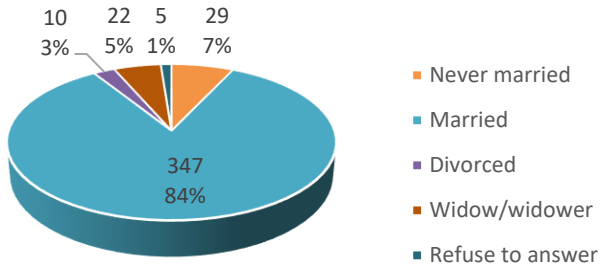


Source: Household survey, 2020

6.2.3 Marital Status of the Respondent

Among the respondents, married represents were 85% in the town while divorced are 2% as shown in Table 24 below. Most of them have children, and are therefore heads of households

Table 24. Marital status in the respondents



Source: Household survey, 2020

6.2.4 Housing Characteristics and Ownership

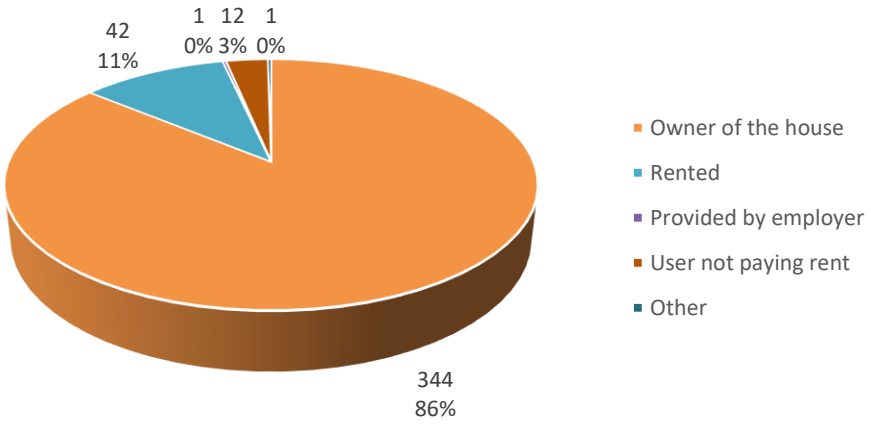
Housing is one of the social problems of the study area. For instance, as observed during the field survey the far majority (86%) of households is the owner of the house they life in, while 11% of them are living in a rented house. Table 25 on the next page depicts dowelling houses ownership.

Most houses in study area covered with corrugated iron and walled by wood. The household survey also reveals that 89% of the houses are made up of wood & corrugated iron.

[3] N.B.: For all pie-charts: the full figure (e.g. '50') indicates the actual number of respondents who gave a certain answer, the percentage number (e.g. '12%') represents the percentage of the total respondents to a specific question

Furthermore, scaling up economic capacity of the individual household and awareness creation are required to improve the current poor housing condition gradually.

Table 25. Ownership status of your house



Source: Household survey, 2020

Table 26. Main building material

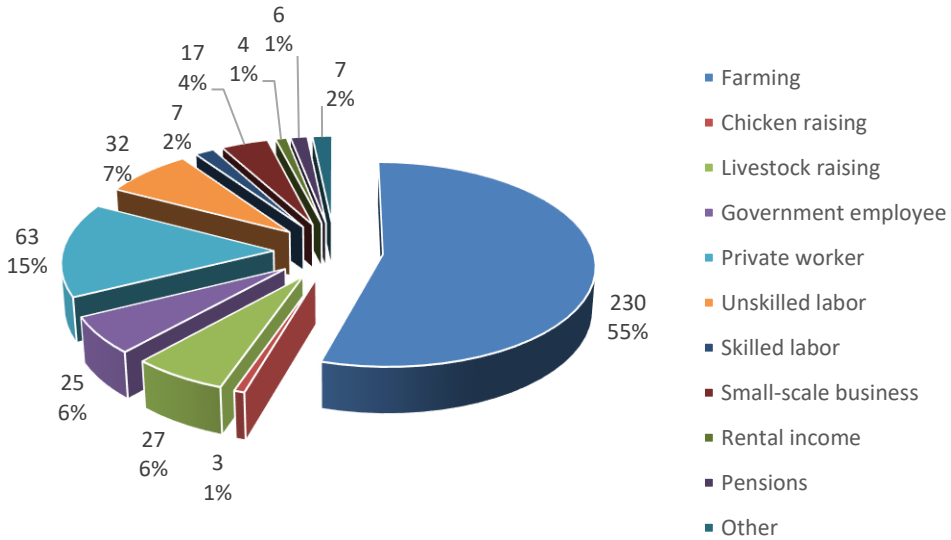
Age group	Total	Percentage (%)
House made of brick	35	9
House made of wood & corrugated iron	370	89
House made of stone	7	2

Source: Household survey, 2020

6.2.5 Households source of income

With regard to income related issues, detailed up-to-date information of Berek woreda specific income data is not available in national census and other statistical bulletins. There are several ways to identify income levels including surveys. However, experiences show that people are usually unwilling to give income and this has been proved during the sample household survey when the annual productivity and land holding is not correlated.

Table 27. Main source of income



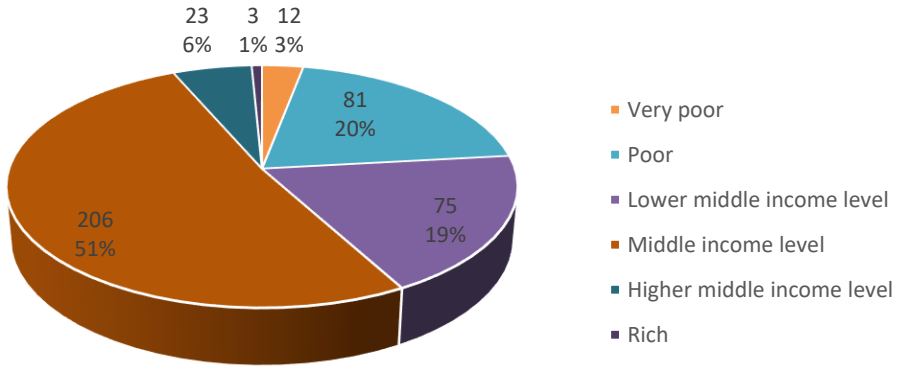
Source: Household survey, 2020

The consultant has made an attempt to incorporate the income and expenditure of the sample households the result is as follows. Table 27 on the previous page highlights the main source of income of the households.

6.2.6 Wealth Ranking

Wealth is a household characteristic that often has a large effect on living standards. The local wealth classification is estimated depending on ownership of selected assets, such as: income, number of livestock, size of cultivable & grazing land and annual harvest, materials used for housing construction; and possession of different household amenities. According to local classification, the wealth guide places individual households on a continuous scale of relative wealth. Accordingly, sample household fill themselves that they plunge in the following wealth category as indicated in table below.

Table 28. Wealth Ranking



Source: Household survey, 2020

From this exercise it can be concluded that 51% of the respondents rank themselves at middle income level, but that of the other respondents the far majority (42%; very poor, poor and lower middle income level) rank themselves on a poorer income scale. For the IWRM4WASH project, this baseline outcome can be used to assess whether households have moved from a lower income level towards the middle-income level or higher at the end of its 4-year program.

6.3 Agriculture

The study kebeles populations largely rely on rainfed agriculture. In recent years wheat is the most dominant cultivated crop, while barley and teff are two other crops regularly grown on relative large scale. Oxen plough and hoe cultivation is the technology prevailing in the area for field clearing and tilling. Most of the crops such as teff, wheat, lentils, horse beans, oats, fenugreek and field peas are produced during the main rainy season *Meher* (June-September), whereas tow and cereal crops, such as commonly grown barley, are produced in the *Belg* season which is the short rainy season from March to April.

6.3.1 Crop production

Regarding agricultural crop production in Berek Woreda, wheat was the most grown crop in the years 2017 and 2018 on, on average, just under 11,000 ha and a production of 52,000 to 55,000 quintals (1 quintal is equal to 100kg or one-tenth of a ton). Teff is annually cultivated on 6,500 to 7,500 ha reaching a production of 180,000 to over 200,000 quintals. Barley is typically cultivated on around 4,000 ha in Berek Woreda reaching a production of about

140,000 quintals per season. Other widely cultivated crops include pulses (~20,000 ha), field peas (4,000 ha) and lentils (<3,000 ha), although production yield figures lack or are not known. In Table 29 and Table 30 on the next page the average and maximum productivity of wheat and teff is shown, showing a clear difference between farmers and crops benefitting from farmer-extension packages (Table 29) and those wo do not (Table 30).

Table 29. Productivity of crops under full extension package

Type of Crops	Productivity (quintals*/Ha)	
	Average	Maxima
Wheat	44	54
Teff	25	34.7
Barley[4]	35	N/A

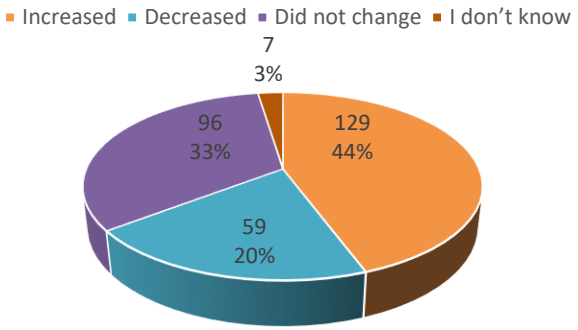
* 1 quintal is equal to 100kg or one-tenth of a ton (source: Berek Woreda Agricultural office)

Table 30. productivity of crops under non-extension package (source: Woreda Agricultural office)

Type of Crops	Productivity (quintals/Ha)	
	Average	Maxima
Wheat	44	38
Teff	21	23

Respondents of the HH survey were also asked whether in their perception the agricultural production on their fields has increased, decreased or remained the same over the past 5 years. Results are shown in Table 31. Most of the respondents (44%) answer that in their perception the harvest has increased or otherwise remained the same (33%). An unambiguous explanation for this could not be given. One of the explanations given is that before 2015 a protracted drought has occurred, as a result of which there has been an increase in crop productivity in the past 5 years, both actual and perception wise.

Table 31. Trends of crop production for the last 5 years (2015 – 2020)



Source: Household survey, 2020

6.3.2 Nutrition

FGD discussant voiced that, on average, they are food insecure for 3 to 12 months of the year. They cover their food deficit from Government aid and by purchasing from the market using the money they earned from sale of livestock and forest products such as firewood.

[4] due to the lack of complete data, differentiation between average and maximum of Barley crop production and under full extension package and non-extension package was not possible

6.3.3 Access to irrigation water and role of women

Out of 797 interviewed farmers during the Data Collection Phase (HH survey and FGDs) who engage in backyard vegetable agriculture, 90% of them are women. However, access to productive use of water is limited for both women and men due to lack of irrigation schemes in the district. There are only small private initiatives to use water sources for irrigation purpose. Compared to men, women have little access to water for productive use as they have little participation in irrigation user associations. For instance, there are 26 irrigation user associations in Berek Woreda with a total of 209 members, of which women constitute 30%. Women FGD participants in Girar Berh kebele mentioned that women engaging in subsistence vegetable farming in their backyard usually use fetched water for irrigation. They also described that individuals who have financial capacity use private pumps for irrigation purposes. According to the irrigation experts from the Agricultural Bureau of Berek woreda, women are kept out of the participation and use of irrigation tools. This is often because of an attitude and mentality problem of men in leadership positions towards fellow female members. This is informal, but pure discrimination.

6.3.4 Agricultural productivity & inputs

Basically, in the study area there are two ways for farmers to gain access to agricultural inputs:

1. **Package system**, which is the supply of improved seeds and chemical fertilizers by the agricultural office with very involvement of Development Agents stationed in the kebeles. According to Berek woreda Agricultural and Rural Development Office, the agricultural experts and Development Agents (DA) also often visit the farmers for practical advice;
2. **Preferential.** Here the farmer's access is limited to chemical fertilizers. This depends upon the need of the farmers and his decision, for which crops he should apply chemical fertilizers.

Other important inputs to which farmer need access include herbicides and pesticides. Nevertheless, these are still only occasionally used. Besides, even though agricultural extension officers have made efforts in recent years to familiarize the farmer in Berek woreda with contemporary agricultural input options there is, for example, little use of improved fertilizers and seeds This is mainly due to a lack of financial capacity, however the uncertainty about starting with tillage and planting due to erratic rainfall was also mentioned by some respondents.

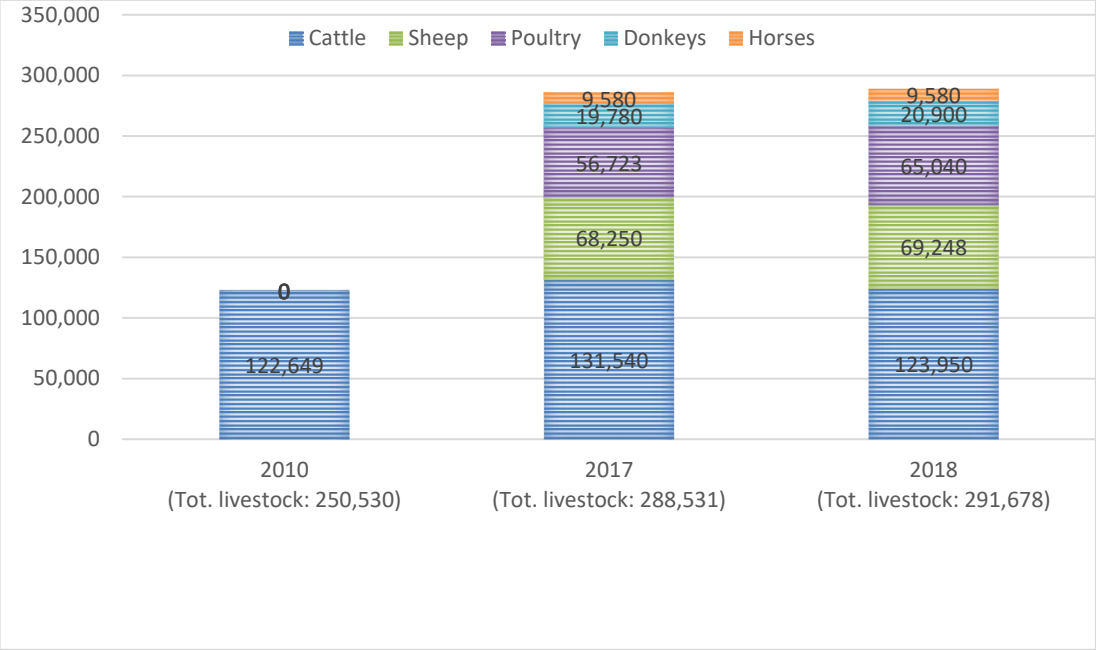
Despite the fact that agriculture is the main livelihood within the UGA sub-catchment, users and communities are unable to link up with improved agricultural practices as it is interwoven with multiple and complex societal issues. Crop and livestock production has seriously been affected due to unpredictable nature of rainfall upon which the Kebeles agriculture depends as a major source of moisture. In addition, there is a great lack of alternative sources of income, especially in times when crop and livestock income is disappointing. Other frequently heard limiting factors and constraints to sector development are: high population growth and the associated land fragmentation, limited provision of new technologies, lack of product diversification, inadequate agricultural market system and limited access to credit facilities.

6.4 Livestock and poultry

In addition to crop cultivation the community raises the cattle, sheep, goats and donkey as the major livestock. Livestock production has multifaceted problems such as constant animal diseases, lack of medical service, and absence of improved breeds and shortage of feed as they mainly rely on grazing and crop residue that is not enough to sustain the livestock throughout the year.

In Table 32 below numbers of the main types of livestock in Berek woreda are provided. What can be observed is that the total number of livestock has increased by 16.4% between 2010 and 2020. Cattle is the favorite piece of livestock to keep, but its share is falling from almost 49% in 2010 back to just over 42.5% in 2018. The decline in cattle numbers is more a case of disease and drought than a conscious farming choice. In other types of livestock, we see a slight to greater increase, especially in poultry.

Table 32. Number of livestock



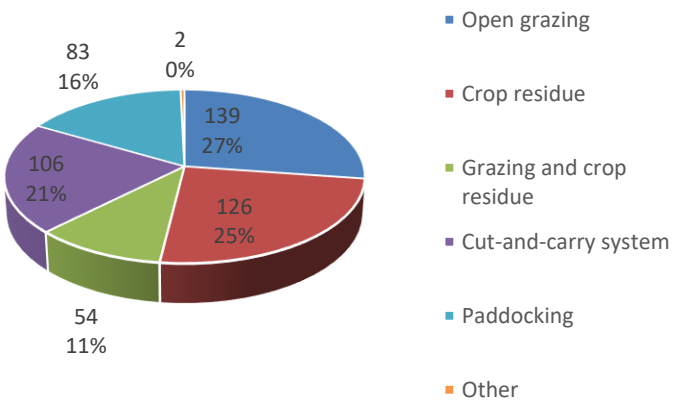
Source: District Livestock & Fishery Development office

6.4.1 Livestock diseases

The five major livestock diseases that have circulated in recent years that affect the welfare of livestock and livestock owners are: black leg (cattle/bovine), *Pastureolosis* (cattle/bovine and sheep/ovine), sheep box (ovine), lumpy skin disease (LSD; bovine) and Foot-and-Mouth disease (FMD; bovine & ovine). In Berek Woreda there is only one animal health institution and seven (7) veterinarian posts.

6.4.2 Livestock grazing

Table 33. Source of Feed for Livestock



Source: Household survey, 2020

From Table 33 on the previous page it can be observed that the majority of farmers let their livestock rely on open grazing and feeding from crop residues. Keeping stable livestock, also called *paddocking*, possibly supplemented with hay and other crop feed through a cut-and-carry system, is increasing but still somewhat limited as a result of shortage of crops, low income output and animal diseases such as anthrax, blackleg, foot-and-mouth (FMD) diseases.

6.4.3 Bee keeping

Finally, and although this is seen by socio-economists as a promising local source of income. Table 34 below shows the development of beekeeping in the region, which has experienced very slight growth in recent years.

Table 34. Bee keeping

No	Type distributed	Number of bee hives in	Number of bee hives in
		2017	**2018**
1	Traditional	2233	2500
2	Modern	788	790
3	Transitional mud hive	88	90

6.5 Social Services

6.5.1 Education

In 2018 the district has 45 primary schools within its boundaries, of which 10 are governmental and 35 are non-governmental (i.e. private) and the far majority of schools offering education on level 1 to 8. The total number of enrolled students on these schools amount to 19,298 students of which 9,356 boys and 9,942 girls. Looking at the average number of students at each type of school a clear offset already becomes apparent. See also Table 35 below. 1,200 students go on average to a governmental school, of which 636 girls and 564 boy students. These average 1,200 students have 28 teachers (13.3 female and 15.1 male teachers) at their disposal.

Table 35. Average number of students and teachers at the 45 primary schools in Berek Woreda

Type of school	All	Girls	Boys	Teachers	Students per teacher	Female teachers	Male teachers
Governmental	1200	636	564	28.4	42.3	13.3	15.1
Private	208.4	102.3	106.1	13.8	15.1	7.3	6.5
Combined	428.8	220.9	207.9	18.6	23.0	8.7	9.9

At private schools the total average students is 208.4, of which 102.3 girls and 106.1 boys, where an average of 13.8 teachers work (7.3 female and 6.5 male). On a positive note, private schools employ on average more female teachers than men. Looking at the workload of teachers this corresponds to 15.1 students per teacher on average on private schools, opposite to 42.3 students per teacher at a governmental school. Their access to sanitary facilities will be discussed in the next paragraph.

From the registration list of all enrolled students per grade it can be observed that there is a significant drop out of students after grade 5 and 6 when student numbers drop from 1,929 and 2,368 students respectively, to just around 1,400 in grade 7. This drop out continues into grade 8, leaving only about 900 students. A similar trend and figures can be observed in the previous year 2017. According to KII response of experts at the woreda's Education Bureau and the Women & Youth Affair office, people tend to take their children from school mainly due to financial-domestic issues. When they face such problems and having to choose between

sending a son or daughter to school, they prefer to send their son to school and to make their daughter do domestic chores.

Adult education

Regarding adult education, out of 3,210 attendants, 48% of them are women. However, the Women & Youth Affair office of Berek Woreda stated that actual engagement of adult women in this program is low due to their high domestic work responsibilities.

6.5.2 School water and sanitation

In the previous section it has already been shown that there are large differences between numbers and the quality of the education offered in the field of study. In this section we will also see the difference between access to water and sanitary facilities, both between type of school and availability depending on your gender.

First of all, almost none of the primary schools, most notably the rural ones, have a piped water connection. And the mainly urban schools that do have a connection receive only sporadically water because of persistent water shortages and production lagging behind, among others by Sendafa-Beke Water Supply Services Enterprise (SBWSSE). An overview of the other results are shown in the table below.

Table 36. Average number of students and teachers having access to sanitary facilities on primary schools

Type of school	Average # of latrine/ toilet seat per school	Average # of girls per latrine/ toilet seat	Average # of boys per latrine/ urinal	Average # of hand wash points	Average # of drink water tap points	Average # of Female teachers per latrine	Average # of Male teachers per latrine
Governmental	15	77.7	69.1	7.1	5.4	5.7	4.9
Private	6.5	31.8	34.6	5.2	1.6	7.0	8.7
Combined	8.4	42.0	42.3	5.6	2.3	6.7	5.8
Minimum	2	6.0	5.0	1	1	1	0
Maximum	32	137.8	111.5	20	13	23	18

A number of things stand out:

- The number and availability of latrines to girls or boys is almost the same; there is hardly any difference, regardless of whether you attend a governmental or private school;
- In a public school, two to 2.5 times as many girls and boys have to use and share 1 latrine compared to private schools. In short: in private schools, many more latrines are available per X number of students;
- The total **number of students who have to use 1 latrine is high**:
  - Girl students: the number of girl students per latrine at governmental schools is with almost 78 girls per latrine more than 50% above the Ethiopian standard of a maximum of 50 girl students per latrine (MoE, 2017);
  - Boy students: the number of boy students having to share 1 latrine or urinal is with 35 boys at private schools and 69 boys at governmental schools (just) under the Ethiopian standard of maximum 75 boy students per latrine/urinal (MoE, 2017);
- Particularly in the rural areas it was observed that **many school toilets are poorly designed, constructed and managed**. Schools with non-separate toilet blocks for boys and girls have found that female students in particular tend to be absent, particularly during the period of menstruation, due to fear of being bullied and humiliation;
- The quality and cleanliness of the sanitation facilities was not assessed or included during this study, but with these numbers it seems impossible to guarantee tidiness and cleanliness of the facilities. According to KII with school supervisors, many primary **school students prefer open defecation as the school latrines are not clean and safe for usage**;

- The supply of faucets for hand washing and drinking water at schools appear to be higher at governmental schools (7.1 and 5.4 respectively) opposite that available at private schools (5.2 and 1.6 respectively). However, this number should be compared with the total number of students on a school. Knowing that there are an average of 1,200 students at a governmental school and at a private school 'only' 208, then you are in the end still better off at a private school (30.6 students per faucet versus 96);
- Remarkably, as a teacher you are better off at a governmental school than at a private school when it comes to the availability of latrines. Nevertheless, the supply is low and there are often no more than 1 or 2 latrines for female teachers and only 1 and sometimes none at all for male teachers;
- Of the 21 urban primary and secondary schools, only 5 of them have a separate Menstruation Hygiene management facility such as pad changing rooms and place for rest;
- Some schools have established girls and sanitation clubs which engage in awareness creation and advocacy works regarding menstruation, sanitation and hygiene. In addition to this, these clubs engage in distributing hygiene pads for girls who experience menstruation in schools or for those who cannot afford hygiene pads.

The number of girl students per latrine on governmental schools in Berek Woreda is well over the Ethiopian standard of maximum 50 girl students per latrine (MoE, 2017)

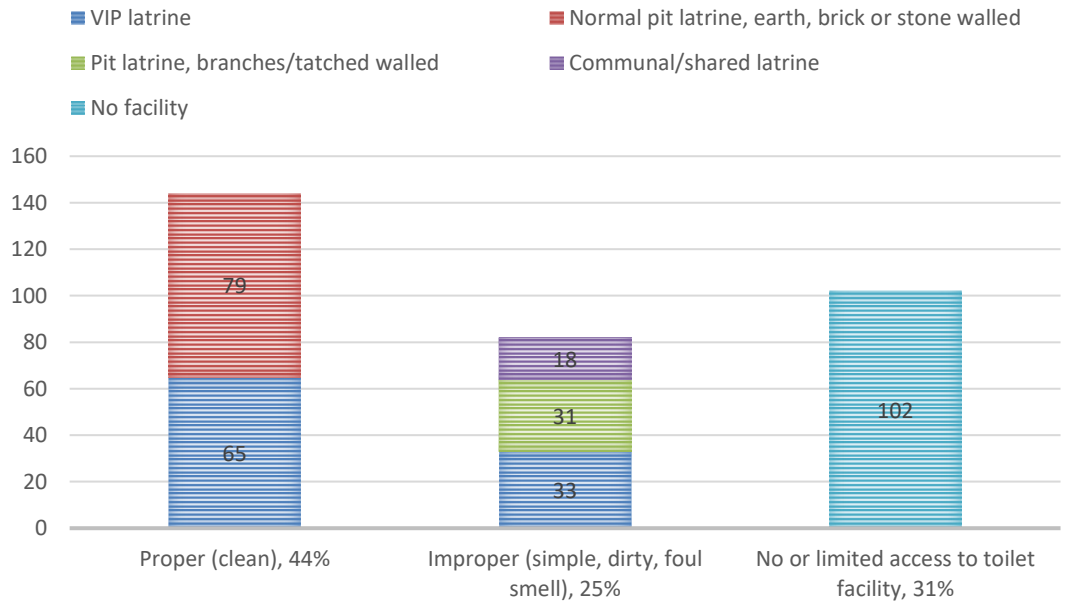
Development goals:

- Improved, safe, sanitary WASH facilities in schools will facilitate and sense of security as well as educational efficiency and progression, especially those of female students;
- The aim should be to double the construction of safe and improved latrines, faucets and menstruation hygiene management facilities per school to meet the Ethiopian standards set by the Ministry of Education (MoE, 2017), especially those at governmental schools;
- there must be training for both school management and students to deal with the available sanitation facilities with care and hygiene, and to bring the risks of unsanitary conditions needs more attention;
- a school or community-led caretaker program could be set up to keep the latrines clean and orderly, perhaps even inviting to use;
- Strengthen girl and sanitation clubs at schools and their advocacy work regarding menstruation, sanitation and hygiene.

6.5.3 Sanitation and hygiene in UGA sub-catchment

The sanitation system in the UGA sub-catchment, like in many other parts of Ethiopia, is poor. Table 37 on the next page illustrates the type of existing sanitation facilities of the surveyed households. According to 328 HH survey respondents 69% of the people have access to a form of sanitation, at household level or communal. Of these 328 respondents, 44% (144) have access to a proper clean latrine at household level, while 25% (82) has access to an improper (simple, dirty & foul smell) latrine facility, either privately or shared by the community. An example of an unsanitary public community latrine in Dire rural kebele is shown in Figure 24 below, while Figure 25 on the next page shows a public toilet at market place upstream of Dire reservoir in Dire town.

Table 37. Types of toilet facilities



Source: Household survey, 2020

Figure 24. Public latrine in Dire rural kebele (photo credit: AquaCon, 2020)

On the other hand, a large group of 31% (102) have no or limited access to sanitation or toilet facility at all. Hence, prevalence of open defecation is still significant and demands a thorough approach to this problem. Regarding the responsibility of cleaning latrine pits, of the respondents who have access to latrines 69% of them replied that adult women typically have the responsibility of cleaning the latrines.

Figure 25. Public toilet at market place upstream of Dire reservoir in Dire town

Concluding remarks

Thus, upgrading and cleaning up existing latrines, and constructing new latrines calls for sanitation marketing to facilitate the production and availability of slabs and other related industrial materials at affordable price at close distance. In addition, more attention should be paid to the safety and privacy of women, and innovative – and if possible, business-like - ways of cleaning and reusing latrine material should be considered. There is therefore an immediate opportunity for the *market-based approach* side of the IWRM4WASH project to create local entrepreneurship and employment through the support of training courses and access to small start-up capital.

In achieving health improvements, clear linkages exist between adequate safe water supply, improved sanitation and hygiene, and behavioral change (through awareness campaigns). Establishing these linkages require an integrated approach. In general, people are willing to contribute more in order to benefit from proper water supply than for sanitation services. This provides new potential for generating technical and economic benefits when linking water supply with the sewerage management, and becomes especially interesting if economic added value can be obtained from the residual flows of this 'waste', such as energy or fertilizer.

Development goals:

- Support renewed awareness campaigns about the importance of good sanitation facilities and their direct influence on essential issues such as improved education, health, work productivity and employment;
- Given the low latrine coverage, the IWRM4WASH project should support regional initiatives to increase the number of improved clean sanitation facilities in the catchment, with the aim of achieving a doubling of this number;
    - **Suggested OVI**: minimum construction of 250 improved clean sanitation facilities and a proper sanitation coverage from 35% to at least 75% in large parts of the UGA sub-catchment;
- Support local entrepreneurship and employment through education training and small start-up capital to facilitate the immediate material production and possibility of latrine construction at medium to large scale.

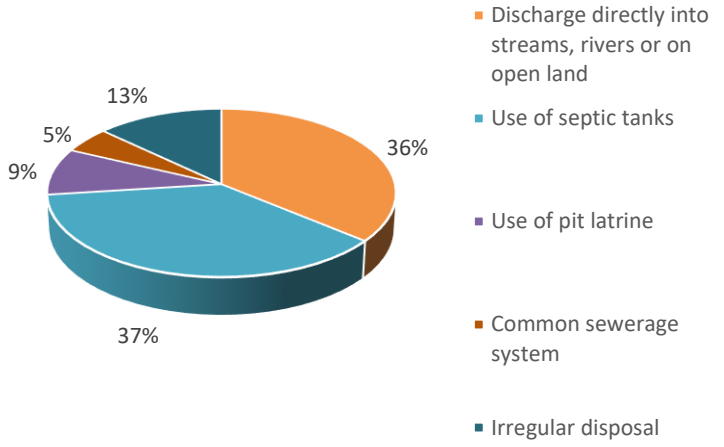
6.5.4 Waste disposal and management

Similarly to the poor sanitation system in the UGA sub-catchment, there is no well-organized solid and liquid waste disposal mechanisms. Private and communal septic tanks are being used to collect liquid waste. Since the Sendafa and Dire towns are located in the upper part of the Legedadi and Dire reservoirs, any contaminated discharge would end up to the reservoirs. Therefore, improving the solid and liquid waste disposal mechanism of the towns would be important.

Also any unsafe discharge of waste from flower farms and industries could adversely affect the quality of surface and ground water of the area. Hence, the sanitation situation of towns in the upper catchment of the reservoirs and industrial discharges should be taken into account in the IWRM.

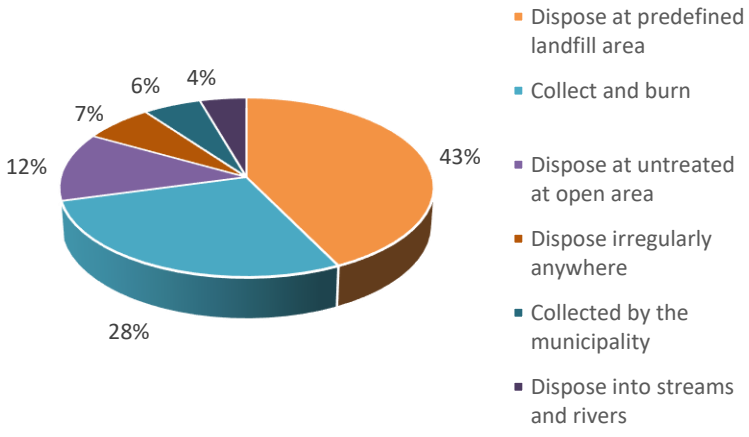
HH surveys were conducted to understand the system of liquid and solid waste disposal mechanism in the project area and what their own behavior is in this regard. 355 residents of the UGA sub-catchment replied and the results of this survey are shown in Table 38 and Table 39 below.

Table 38. Used system for liquid waste disposal % out of 355 respondents



Source: Household survey, 2020

Table 39. Used system for solid waste disposal in % out of 355 respondents



Source: Household survey, 2020

The household survey revealed that there is no well-organized liquid and solid waste collection and disposal mechanism in the project area. Improper way of collecting and disposal of domestic wastes coupled with irresponsible way of industrial waste disposal would adversely affect the soil, surface and groundwater quality of the catchment and would cause adverse health impact on the people. It would also adversely affect aesthetic view of the area and reduce attractiveness of the area.

In particular with regard to liquid waste disposal and despite the fact that 37% of the respondents indicate that they use a septic tank, 36% of the respondents dispose their liquid waste directly into streams, rivers and open land remain significant, while of the 11% irregular disposal it remains unclear where the waste water going. In addition, it is generally known that the waste residues in septic tanks (37%) and pit latrines (9%) continue to infiltrate and 'leak' to the underlying aquifer, where it can contaminate the groundwater. In addition, of solid waste 4% is discharged into river and streams, and up to 23%, is dumped untreated in the public.

6.5.5 Health

Berek Woreda does not house a hospital. In 2018 one new health center was opened, bringing the current total to four health centers in the district. Besides, there are twenty-two (22) health posts present in Berek. These health facilities together employ 79 health professionals, ranging from nurses and health officers to lab technicians and sanitarians, but officially there is not one single doctor active in the area.

Also, the 22 health centers and health posts in the rural kebeles do not have any protected water supply in their premises, and therefore usually use a shared water source with the community. The sanitation and hygiene facilities at these health centers and posts are usually bad to appalling. Despite the presence of hand washing faucets, there is often no water from the tap and soap is absent. According to the children and communicable disease coordinator at Sendafa town, hand washing practice is low among health care providing professionals which also contributes to the transmission of various infections. According to him there is improvement of hand washing practice among health care professionals as a result of the COVID-19 pandemic. Nevertheless, it is estimated that 15% of patients, many of whom are women who come for giving birth, develop one or more infections during their hospital stay.

Current health data such as top ten diseases (general diseases, vector borne diseases, water borne diseases, sexual transmitted diseases and poverty related diseases) were identified by statistics of the Berek woreda Health Office (2020). The most frequently registered diseases were acute febrile illness (AFI; 1,398 cases in 2017 and 1,710 in 2018), acute upper respiratory tract infection (URTI; 1,621 cases in 2017, 2,349 in 2018 and 4,882 in 2020), *Tonsillitis* (acute *pharyngitis*, unspecified; 4,859 cases in 2020), Typhoid fever (3,125 cases in 2020), diarrhea (non-blood; 1,065 cases in 2018 and 3,035 in 2020), *Dyspepsia* (inability to swallow; 2,422 cases in 2020) and intestinal parasite (493 in 2017). More detailed figures of health data statistics of the Berek Woreda Health Office can be viewed in Annex C to this report.

If we take a closer look at these figures by age and sex, it is noticeable that especially with the diseases URTI, typhoid fever, diarrhea and *dyspepsia* the largest number of cases of illness are mainly in the age groups 5-14 and 14-29 years, i.e. among children and young adults. Within these groups it also appears that women are hit more often and harder than men; often women suffer 50% to 100% more from these aforementioned diseases than men. This could be an indication that women are performing heavier and more dangerous work in unsanitary conditions.

Development goals:

- Support the improvement of WASH facilities at health centers and posts to halt the spread of various infectious diseases, including COVID-19;
- The reduction of some of the most common diseases in the area are waterborne or caused by the lack of WASH knowledge, practices as well as improved facilities at household level or at school. Therefore very important to start addressing these WASH issues at the source;
- Identify the barriers to appointing experienced doctors and managers, and support their recruitment where possible.

6.6 Infrastructure and Services

6.6.1 Transportation

The study area kebele is hardly accessible from the junction of (Addis Ababa-Sendafa) asphalt road. There is no public transport from aforementioned kebeles to the market center (Sendafa town). As the result people of the area used back animals and carry by them to sell their product and to transport purchased agricultural inputs and other items from and to the market. Table 40 highlights issues of concern on transportation.

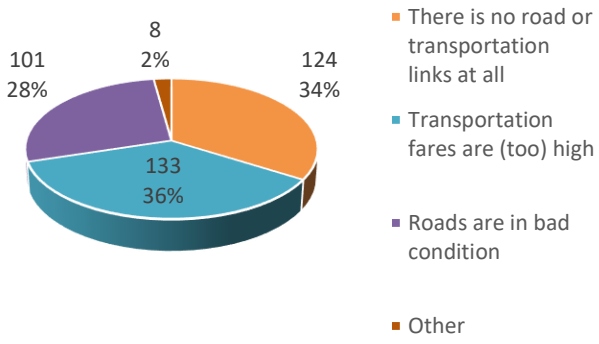
Table 40. Transportation issues of Households

Description	Frequency	Percentage (%)
Yes	213	52
No	186	45

Source: Household survey, 2020

The road connecting villages are in poor condition that aggravated during rainy season to move from place to place. Thus, it requires all weather roads for transportation system that creates linkage with market center. There is no navigable river or lake in the study area. Therefore, upgrading the existing road and planning for other means of transportation can alleviate the problem to somehow. Table 41 below illustrates this.

Table 41. Main problem related to Transport



Source: Household survey, 2020

6.6.2 Telecommunication

Telecom service is one of the major means by which people interact within and outside the kebeles for the different purpose. To this effect mobile telephone system is available in the Kebeles while member of the impacted community reported that there is frequent interruption of the telephone service. Hence the existing local and international communications is believed to facilitate the business and development activity that is carried out in the kebeles.

6.6.3 Electricity

The kebeles have no adequate electric power supply connection to national grid system. By way of illustration, only 45% of the HH survey respondents indicate that they have a home electricity connection. The district office of Ethiopian Electric Utility (EEU; formerly known as *Ethiopian Electric Power Corporation* or EEPCo) – responsible for electric power distribution and the operation of power transmission – has currently no plan to expand connections to the more remote and rural kebeles of Berek woreda as part of universal access plan. As the result people use firewood as source for cooking and energy.

6.6.4 Availability of Credit and Financial Institutions

The only financial institution accessible in the project area is Commercial Banks & Oromia Saving and Credit Association (Micro finance) with a branch office in Sendafa town. The Regional Government established micro-credit scheme that operate in the region to support vulnerable and poor households. Oromia Saving and Credit Association (Micro finance) planned to provide small loan to the poor through schemes especially designed to meet the poor particular needs and circumstances. The characteristic features of such schemes are:

- Procedures are designed to be helpful to the client and therefore user friendly: they are simple to understand, locally provided and easily and quickly accessible;
- The traditional lender requirement for physical collateral (land, house, productive assets) is usually replaced by a system of collective guarantee groups whose members are mutually responsible for ensuring that their individual loan are repaid;
- Loan amounts, at least in the first instance, are small, much smaller than traditional lenders would find it viable to provide and service;
- Borrowers are usually also required to be saver.

However, because of access limitations to micro-finance, we learned that household heads are forced to borrow money from traditional lender at an average interest rate of 10% per month. In general, small size loans and group collaterals can become already a hindrance to the member of the community to get maximum benefit out of the credit. This has the effect of that hardly any farmer is liable to credit, including the fear of group collateral and high interest rates. Some members of the community are forced to take out loans from traditional credit lenders at high interest rates. Thus, there is a need for appropriate financial and credit mechanisms and intuitions, which could include rent-to-own and community financing mechanisms. This must go along with adequate agri-business trainings that enable farmers to enhance productivity and diversify their means of livelihoods.

6.7 FGD findings

Participants of the FGDs voice their concern on more than 30 topics for which members of the study community perceive as challenges to earn means of livelihood and or to improve their living standard. This extensive list can be found in Annex D.

The FGD discussants reflected trends they observed on their socio-economic wellbeing in the last five years. Historical land use system is changed and there is critical shortage of land because of encroachment of different development activity such as water bodies, forest, different industry, housing and settlements, while adverse impacts of land degradation, excessive use of chemical fertilizer are all too common. These mainly by land shortages driven negative effects, have as consequence that there is a high reporting of unemployment and employment in the area. Other issues at play include: intensification of crop and animal diseases, project hosted community being devoid of having access to safe water, decent and reliable presence of roads and electricity in the major towns. The FGD participants also

highlighted their concern about high school dropout and quality of education because of shortage of income to cover education fee.

Concluding, the discussants highlight mainly dispossession of farm land by different development activities which they perceive as a threat to construct sustainable means of livelihood for dispossessed community members. One remarkable response that was mentioned by community members was that there are “Frequent baseline survey with no or little response to the community inquiries”, highlighting the necessity that tangible follow-up must be given to the stakeholder consultations for further implementation of the IWRM4WASH project in the coming years.

6.8 Conclusion and Recommendations

The socioeconomic assessment reveals that there is an encroachment of development interventions coupled with poor social & economic infrastructure that pave way for over-cultivation and shortage of land. Besides, existing sanitation facilities, such as liquid and solid waste disposal sites, are at rudimentary stage that calls urgent attention of stakeholders. All these factors also influence the availability and quality of water in the catchment. In the implementation of the IWRM4WASH project cycle it is advisable to:

- Promote impacted community involvement;
- Provide a framework (project cycle) for impacted community action;
- Encourage and coordinate the participation of other stakeholders, and build linkages among them;
- IWRM4WASH project must make strong efforts to better integrate water supply and sanitation and hygiene, including coordinated planning;
- Create enabling environment for private public partnership (PPP) particularly for sanitation marketing and business opportunities in this regard;
- Set standards and provide regulatory procedures;
- Promote participatory monitoring and evaluation (M&E) to ensure quality, equity, sustainability and accountability;
- Share and apply lessons learned.

7 Environmental analysis

Environmental site visits to the UGA sub-catchment were conducted on September 10, 14 and 17, 2020. The complete list of consulted organizations and persons is presented in Table 42 below. Site observations included:

- Assessment of existing environment;
- Identification of flora and fauna of the project area;
- Assessment of impacts from industries, stone quarries and flower farms;
- Assessment of land use, land degradation, soil erosion prone and gully formation in the upper catchment.

Table 42. List of consulted organizations & persons

Name	Organization and position	Telephone
Tesfaye Oda	Head of Berek district forest development and Utilization	0911989583
Abdisa Kebede	Berek Woreda environmental expert	0912905045
Mesay Mekoya	Head of Berek woreda Environment, Forest and Climate Change Office	0913060550
Getenet Damtew	Administration Department Head	0945909090
Wondosen Lakew	Abyssinia Flower farm Administration staff	0973839048
Mr Ronald	Manager of Abyssinia Flower Farm	0929908746
Hawi Tekelu	Environment and safety officer	

Consultation was conducted with Berek Woreda environment, forest and climate change office head and staff members focusing on existing environmental situation of the reservoirs catchment and climate change impacts and measures being carried out to adopt the climate change impacts.

Furthermore, consultation with Berek district forest and wildlife development enterprise head at Dire town was conducted, focusing on eucalyptus plantation and its management aspects and involvement of out growers in the plantation. Interviews with some industry owners/managers were conducted, including staff of Abyssinia Flower farm, mainly focusing on industrial waste collection and disposal management.

7.1 Flora

Site assessment revealed that Dire and Legedadi catchment areas are dominantly covered with Eucalyptus trees. The former montane forest has been replaced by Eucalyptus plantation and farm land. Very few patches of *juniperes procera* is found at the UGA sub-catchment of Dire dam inside the eucalyptus tree plantation. Other tree species found at some spots of the catchment include: *Ficus sycomorus*, *Acacia abysinica, Cordia africana* and *cupressus lusitanica*.

The commonly observed and dominant shrub in the open spaces under the eucalyptus plantation at the mountainous area is Aloe vera. It is a succulent plant species with jelly leaf. The gel is used traditionally by some people as skin lotion.

Figure 26. Eucalyptus tree plantation at the uper catchment of dire reservoir

Figure 27. Remenant Patch of *Juniperus procera* forest inside the eucalyptus tree plantation

Figure 28. *Acacia abysinica* near the Legedadi resrvoir

Figure 29. Patch of *Ficus vasta* along the road from Sendaf to Dire

Figure 30. Aloe vera shrub commonly observed at the mountainous area of the catchment

Another endemic shrub observed in the catchment is *Plectocephalus varians*. It has white to purplish flower usually appear in September like *Bidens macroptera*. However, it appears mostly in solitary form. *Plectocephalus varians* is endemic shrub to Ethiopia. See Figure 32 on the next page.

Figure 31. *Bidens macroptera* (Adey ababa in Amharic) an endemic shrub observed at the buffer zone of dire reservoir

Figure 32. *Plectocephalus varians* an endemic shrub

7.2 Fauna

Since the catchment is highly disturbed by human activities, there is no suitable habitat for wild fauna. Discussion with the environment, forest and climate change office experts of Berek woreda revealed that there is no protected area for wildlife in their woreda and no wildlife species that can be mentioned worth except hyena. Other species rarely found in the catchment are fox and rabbit.

Figure 33. Wattled Ibis observed near Dire dam

Figure 34. Cattle egret seen at wetland area in Legedadi sub catchment

During the site visit none of the above mentioned species were encountered. On the other hand there are some avifauna species in the catchment. Due to the existence of reservoirs, waterfowls such as duck, Egyptian goose and gray cormorant were observed. Other bird species observed during the site visit include Sacred ibis, Cattle egret , ring neck dove, speckled mouth bird, black crow and wattled Ibis.

7.3 Land use

The main land use of the catchment include eucalyptus tree plantation, farm land, grazing land, settlement area, industrial areas and water bodies. See also Figure 8 in section 3.3 of this report. The mountainous area is intensively planted with eucalyptus tree and managed by Berek woreda Forest and Wildlife Enterprise of Oromia Region.

Berek woreda Forest Development and Utilization Enterprise under Oromia Region Forest and Wildlife Enterprise is managing 9,000 ha of plantation found within three woredas namely: Berek, Aleltu and Jida woredas. Out of the total plantation area, 75% is found in Berek woreda, 15% in Aleltu woreda and the rest in Jida woreda. The main eucalyptus tree species planted by the enterprise is *Eucalyptus globulus*. Also, some model farmers owning more than 0.25 ha of land are involved as out growers of eucalyptus trees.

According to the head of Berek district forest and wildlife enterprise, plantation of eucalyptus tree is more profitable than annual crop production. The harvested trees use for various purposes including raw material for industries such as *chipud* manufacturing, as construction material, as timber and fire wood (source: Interview with Ato Tesfaye Oda, head of the Berek district Forest and Wildlife Enterprise).

As it was observed during the site visit, areas covered with eucalyptus tree plantation have little soil erosion as compared to unplanted areas and crop fields. This implies that eucalyptus plantation is serving to control soil erosion and siltation of reservoirs. Local communities are benefitting from the tree plantations by collecting fallen leaves, whereby the leaves are used for medicinal (homeopathic) and culinary purposes. Leave collection was especially observed Gidebe kebele near the water shed divide between Dire and Jema Rivers.
Collected leaves are packed in containers and transported to Addis Ababa by 4x4 vehicle. Collection job is mainly carried out by women. One pack of dried leaves sold at source for 20 birr and in Addis Ababa it can be sold for 40 birr.

Figure 35. Dried eucalyptus leaves stored near residential house and packed to transport to Addis Ababa

Figure 36. 4x4 vehicle is transporting the dried leaves to Addis Ababa for sale

The Eucalyptus plantation enterprise is supporting the community by allocating a fixed 5% of the total sale for projects for the benefit of the community. Each kebele has elected committee members who can monitor and follow up the harvest and sale. The proceeds of the fixed 5% of sales is placed in a bank account opened by the kebele committees to be used to fund community development activities per kebele.

Main crops grown in the Dire and Legedadi catchment are wheat, barley, bean, teff and lentils. The soil depth at the hilly and mountainous sections is very shallow and the productivity is relatively low at mountainous section.

Another land use type in the UGA sub-catchment that is increasing fairly fast but still to a limited extent is stone quarry. There are several stone quarry sites in the catchment. Farmland is being converted into quarry sites, particularly along existing road sides. Former crop fields

situated near the existing gravel roadsides are almost converted into quarry ground. Informal discussion made with individuals involved in stone production work revealed that the temporary income obtained from the quarrying is higher than the benefit obtained from crop production. For this reason land holders are converting their farm land into quarry site and extract stone for sale. One truck load of coble stone sold for 3,000 to 4,000 Ethiopian birr at source.

Figure 37. Bean and wheat grown side by side along the road from Sendafa to Dire

Figure 38. Teff crop at Legedadi sub catchment

Figure 39. Farmland being converted into stone quarry along the road to Dire dam reservoir

7.4 Land use change

The former Montane forest areas have been subjected to major deforestation and partly turned into farmlands and partly converted into eucalyptus tree plantation. Eucalyptus is planted by Berek District Forest and Wildlife Development Enterprise of Oromia Region. Eucalyptus is also planted by community members on portion of their landholding to satisfy their timber and fire wood demands.

Another major land use change occurred in the UGA sub-catchment is in the grazing land, which over time has been turned into cultivated land (Figure 40 on the next page). Recent land use change observed in the catchment is conversion of farm land and grazing land into quarry sites. Quarry extraction is intensively carried out to sale stone for coble stone road construction and house construction purposes. As per the informal communication with one of the quarry operators, extraction of stone and selling seems more beneficiary for the time

being. But the long term impact on the farm land would be devastating. It permanently damages the productivity of the land and degraded the environment.

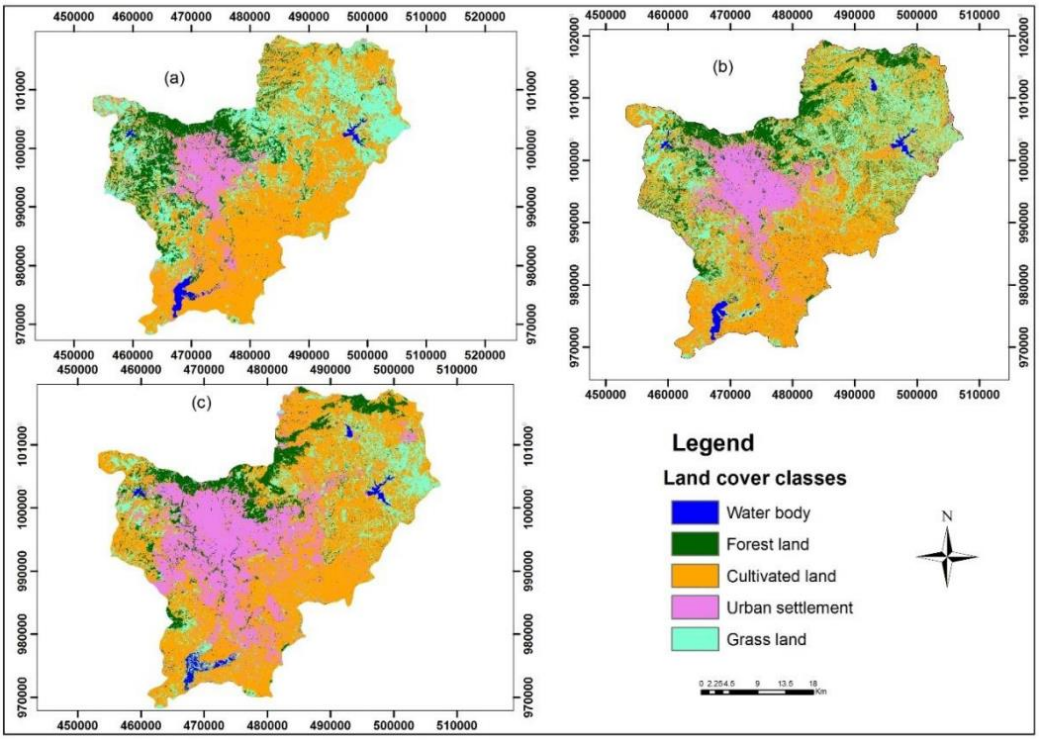


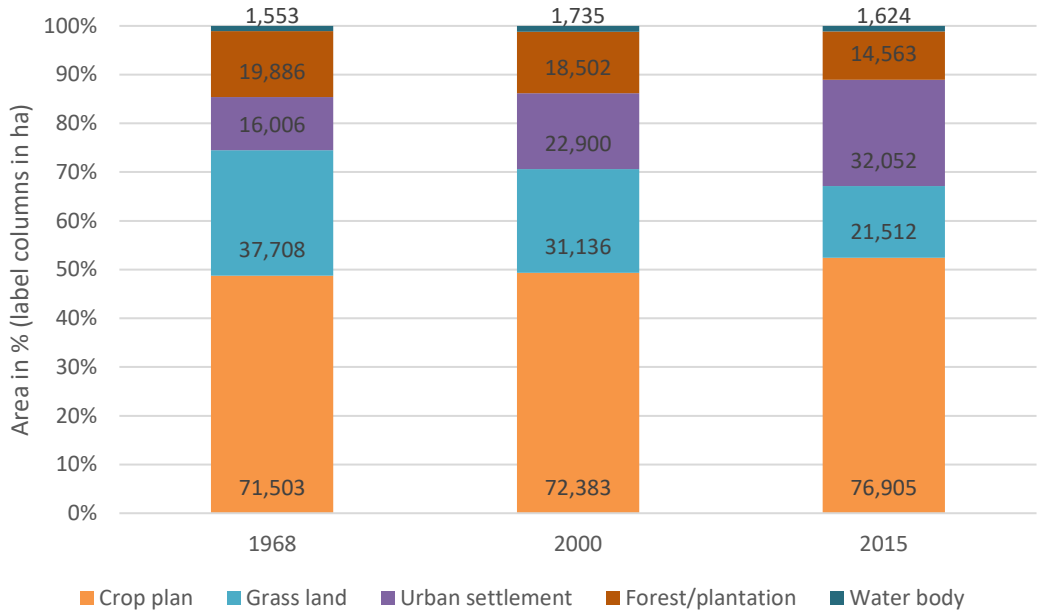
Figure 40. Land use map of the Akaki Catchment of the years 1986 (a), 2000 (b) and 2015 (c) (source: Belay et al., 2019)

Table 43 on the next page shows the spatial distribution of land-use/land-cover categories of the Akaki catchment area during the three years 1986, 2000 and 2015. For the year 1986, the land cover map is shown in Figure 40 (a). The percentage coverage of each class is shown in Table 43 and indicates that the highest area of the catchment is covered with cultivated land (48.97%), while forest, grass land, urban settlement and water covered 13.56%, 25.71%, 10.9% and 1.06%, respectively. For land-use/land-cover map of 2000 as shown in Figure 40 (b), the areal coverage of cultivated land, urban settlement and water body was increased to 49.36%, 15.61% and 1.18%, respectively, while the areal coverage of forest land and grass land was decreased to 12.62% and 21.23%, respectively. The land use map for 2015 of the UGA sub-catchment is presented in Figure 40 (c), in which the cultivated land is covered for about 52.44% of the areal extent of Akaki catchment. Whereas forest land, grass land, urban settlement and water body covered 9.9%, 14.67%, 21.86% and 1.1% of the areal coverage of the study area, respectively (Belay et al., 2019).

Concluding observations regarding land use change, it is very clear that crop land is the largest land use (currently >50%) and still growing. Another important observation is that grassland and urban settlement seem to be exchanging pennies with each other; grassland has decreased in acreage by 43%, while urban settlement has increased by exactly 100% in the past 50 years. At the same time, it is also known that livestock numbers have not decreased (fairly stable around 290,000 heads, see also section 6.4 ‘Livestock and poultry’ on page 57). This will inevitably lead to conflicts about land and land use, especially between livestock keepers and herders, agriculture as well as settlements.

61% of the respondents of the HH survey indicated there is a continuously decreasing of forest cover in their area. This is in line with observations on the ground. The former indigenous montane forest has been converted into crop land and eucalyptus tree plantation.

Table 43. Land use land cover categories in the UGA sub-catchment during 1986, 2000, 2015



Source: Belay et al 2019

From the soil conservation and silt reduction point of view, eucalyptus plantation have played a positive role as compared to the remaining crop land and bare ground. As it was observed at site, crop land areas, particularly at steep slope and hill sides have experienced more severe erosion and land degradation than areas covered by the eucalyptus trees. This indicates that even though many people do not support eucalyptus tree plantation for the soil conservation, practically it has contributed to reduce soil erosion at the Upper Dire catchment. However, its impact on SWC is not comparable with indigenous trees. Absence of undergrowth in the eucalyptus forest has negative impact on biodiversity. Its high consumption of water could also lead to less ground water recharge. But when compared to bare land where there is no tree cover, areas covered with eucalyptus trees is contributing positively for erosion protection and downstream reservoir siltation.

Conversion of farm and grazing lands into stone quarry sites

Conversion of farm and grazing land into stone quarry site has been witnessed during the site visit. Productive land have been converted to quarry sites by land owners as well as by companies engaged in construction industries to meet the building materials needs in ever-expanding Addis Ababa City. There is no reinstatement works after the extraction of stones, nor monitoring its mining and to what extent by regulatory bodies. The stone extracted areas are left or abandoned and will convert into natural born ponds or remain bare.

7.5 Manufacturing industries

Industrialization is one of the fast-growing activities in the UGA sub-catchment. There are several emerging industries producing various products. Some of these industries have started production while others are still under construction. Some of these industries discharge hazardous wastes into environment without proper treatment. Major industries which were observed during the site assessment are described in the subsequent paragraphs.

7.5.1 Oil processing industry

An oil processing industry was found in the Legedadi catchment. It produces motor oils and greases. It is located at GPS location of 37P497996; 1007443 at 2,518 m asl. The factory is disposing untreated industrial waste (residue of hydrocarbon) in its compound, on roadsides, on grazing land and on the side of pond. The following photographs shows how the waste disposal is being carried out by this specific enterprise.

Figure 41. Unregulated disposal of untreated industrial waste by the oil processing industry. At GPS 37P497996; 1007443

Figure 42. Waste disposed by the oil processing industry on side of pond, which is being used for livestock watering

Figure 43. Waste disposal on grazing land near the hand dug well at GPS location (37P: 497366; 1007771)

Figure 44. Waste from an oil processing company in between Sendafa town and Legedadi reservoir (Photo credit: Abebe Ketema, 2020)

7.5.2 Mobile phone Factory

A mobile phone assembly factory is located in the Legedadi sub catchment at GPS location of 37P 497444; 1006305 at altitude of 2506 m asl. The factory is located near water supply borehole LLA-6. There is no more than 5m distance between the center of the borehole and the fence of the factory. During the site visit, there was no responsible person to give information on type of waste and how it is disposed. However, local guards told us that the solid waste is collected and burned within the factory compound and liquid waste stored in septic tank. Visually, the compound was net.

Figure 45. A mobile assembly factory very close to borehole at GPS location of 37P: 497444; 1006305

7.5.3 Coffee processing

A Coffee processing and exporting company is located at GPS location of 37P497627; 1006263 at altitude of 2504 masl. Purpose of the factory is roasting, grinding, packing and exporting coffee. There is no waste that can threaten the environment. Any solid waste is being reused as firewood for roasting the coffee.

Figure 46. An impression of the Coffee processing company

7.5.4 Refrigerator Factory

A refrigerator manufacturing factory is located in Sendafa town at GPS location of 37P: 501024; 1010838 at the altitude of 2,529m asl. Solid wastes such as scrap metals, pieces of wood and cartoons sold to people who are reusing it. The waste generated from toilets is stored in septic tanks.

Figure 47. A refrigerator manufacturing factory at GPS location of 37P: 501024; 1010838

7.6 Horticulture and flower farms

Almost 100 ha of the UGA sub-catchment has been covered with horticulture farms. Three flower farms covering about 25 to 35 ha each have been established in the catchment. Two of these farms (Abyssinia flower and Magical flower farms) are located close to Dire reservoir, however outside the drainage system of the Dire reservoir but within Legedadi dam sub-catchment.

7.6.1 Abyssinia Flower Farm

Abyssinia flower farm is one of the big farms located in the Legedadi catchment. It is located at GPS location of 37P 493810; 1011413 at the altitude of 2554 masl. The size of the farm is about 34ha. The company has created job opportunity for more than 300 local people. The factory uses fertilizers and pesticides. As per the farm manager, the amount of fertilizer being used is low. To reduce the need of chemical fertilizer, the company is preparing compost from the leaves and stalks of the flower. See also Figure 48 and Figure 49 below.

Abyssinia flower farm besides creating job opportunities for local people particularly for women, it is supporting nearby community by distributing potable water and participating in other community development works such as constructing school for the community and tree planting to improve the surrounding environment.

Discussion with Abyssinia flower farm manager showed that the farm has an environmental management plan and has assigned a responsible expert to follow up day-to-day environmental management activities. Water quality tests are conducted twice per year. Global auditors known as ''Rain Forest Alliance Global'' conducted environmental management audit on the farm management and issued a silver level performance certificate. As per the company management, the woreda EFCC office also conduct environmental monitoring once a year.

Figure 48. View of Abyssinia flower farm

Figure 49. Compost made from remnant leaves and stalks after the harvest of flower

There are septic tanks for liquid waste, while solid waste mainly the containers of chemicals incinerated using the installed incinerator. However, the overflow of supernatant from the septic tanks is being discharged on the nearby wetland, which could adversely affect the ground and surface water of the area. Ground water sampling and testing water quality would help to identify the extent of pollution related to the flower farm. As per the farm manager, the groundwater samples which thus far have been taken and tested do not show any sign any pollution. This contradicts with the findings from the water quality testing by the Consultant, as presented in section 4.4.2 of this report.

However, drainage water quality data obtained from Abyssinia flower farm archive indicated that the drainage water has relatively high BOD, high number of Total dissolved solids (TDS) and high concentrations of fecal coliforms. See also Table 44 and Table 45 on the next page. Nevertheless, these concentrations for untreated drainage water for horticultural irrigation purposes is not bad. But since the farm is using chemicals such as insecticides, herbicides and fertilizers, focus of monitoring should be on heavy metals.

Table 44. Water quality test results of Abyssinia flower farm Drainage water phase 1

Parameter	Concentration
Date Analysis Conducted	10/10 2018
pH	7.47
Total suspended solid mg/l	108
Turbidity, NTU	33
Na mg/l	28
SO4 mg/l	65
BOD5 mg/l	45
Fecal coliform per 100 ml	100

Table 45. Water quality test results of Abyssinia flower farm Drainage water phase 2

Parameter	Concentration
Date analysis conducted	10/10 2018
pH	7.07
Total suspended solid mg/l	28
Turbidity, NTU	303
Na mg/l	28
SO4 mg/l	46
BOD5 mg/l	60
Fecal coliform per 100 ml	20

Source: Abyssinia flower farm Plc. Archive

Figure 50. Employees of the farm, most of them women

7.6.2 Magical Flower Farm

Magical flower farm is another farm growing flowers in green house. The farm is located near Abyssinia flower farm at GPS location 37P 493815; 1011416 at altitude of 2553. It has similar management plan with Abyssinia flower farm.

7.6.3 Discharge of untreated industrial waste into the environment

Industries are increasingly emerging in the upper Akaki catchment, particularly in Legedadi sub catchment. There are a number of industries already stablished and started manufacturing industrial products. Among the existing industries Afro Oil Manufacturing Plc is the one that is discharging its waste environmentally unfriendly. The company is producing lubricants and

greases and discharge the waste haphazardly inside the industry compound, on the road sides and even at sides of ponds.

Most of the manufacturing industries in the catchment do not have environmental management plan and there is no regular monitoring from responsible government offices.

7.6.4 Absence of environmental management plan for industries

Most of the manufacturing industries established in the Legedadi catchment do not have environmental and social management plan. They are discharging their waste into the environment without treating. One of the visible examples of such practices was at the oil processing industry, which is producing lubricants and greases for motors using raw material from hydrocarbon origin.

Low capacity of the district's environmental protection and climate change office give the industries freedom to discharge their industrial waste wherever they like to discharge. As it is mentioned above, lack of integration among sectorial offices and other responsible stakeholders is another gray area that needs to be improved to secure sustainable and safe environment that promotes healthy and inclusive economic growth.
In order to make sustainable growth, each industry should prepare industry specific environmental and social management plan and its implementation should be regularly monitored by the woreda environmental protection office.

7.7 Disaster preparedness & climate adaptation

Studies have shown that many of the WASH services in developing countries, including in Ethiopia, are not adapted and prepared to climate change (WHO/DFID, Vision 2030). Over the last five decades, the temperature in Ethiopia increased at about 0.37˚C per decade. Though annual average precipitation for the same period over much of the country remained stable, it showed a 15-20% decreasing trend in the eastern and south eastern semi-arid and arid regions of the country with increased frequency of drought. On the other hand, other areas of the country had experienced increased precipitation, causing an increase in the frequency of flush and river floods in different parts of the country.

According to the Climate risk management study (Bisrat Kifle et.al, 2017), Addis Ababa is expected to experience water supply stress as a result of complex interaction of urbanization and more erratic rainfall as a result of climate change. In combination with high population growth, scenarios on surface water supply (independent projections for 2023 and 2039) show that both the water levels and volumes at Legedadi, Dire as well as Gefersa reservoirs will experience decreased levels more frequently and increasingly. Subsequently, and without significant interventions or new alternative water sources, this will lead to severe water shortages in the city. This is in line with the concluding remarks on the climate change projections towards 2050 as described in section 3.2.1 on page 15. The rural population of the UGA sub-catchment relies on shallow groundwater sources, such as hand dug and shallow boreholes, that are highly vulnerable to effects like falling groundwater levels as a result of climate change impacts, including prolonged droughts and more erratic rain events.

Local perception

During the HH survey respondents were asked to know whether the community experience the climate change impact. Among the 402 respondents, 66% felt the impact of climate change, while the remaining respondents didn't recognize the presence of climate change in their area. About 63% of respondents confirmed the increase of temperature from year to year, while 35% said no change in temperature.

Regarding rainfall, 80% of the asked household heads responded that rainfall is increasing. This is in line with general rainfall prediction in the highlands of Ethiopia. Unlike the decreasing trend of precipitation in the eastern and south eastern semi-arid and arid regions of the country, highlands of Ethiopia including the project area is experiencing more intensive rainfall and rainfall variability (See section 3.2.1 on page 15). In general, the HH survey result revealed that most of the respondents understood that there is an increase in precipitation as well as of temperature in the UGA sub-catchment.

Discussion with Berek woreda Environmental protection, forest and climate change office head also revealed that there is drawdown of shallow ground water in the catchment and mentioned it as one of the consequences of more erratic rainfall and prolonged periods of drought. The discussion also revealed that there are new crop diseases and variability of rainfall in the catchment.

7.8 IWRM and economic growth

Over the last decades the Government of Ethiopia (GoE) achieved substantial progress in economic, social and human development. Ambitions are high and the GoE blueprint is to achieve a middle-income status by 2025 by foremost prioritization of agriculture with implementation of tools and technology. Currently about 1/3 of GDP is agriculture, the remainder construction and services and some manufacturing, while private consumption and public investment explain demand-side growth. The 2nd phase of GoE's Growth & Transformation Plan (GTP II) involves more on infrastructure and manufacturing including exploiting more the huge potential of improved irrigation schemes through focused and sustained investment and more yield.

The water resources management (WRM) policy from 1999, gives emphasis for the minimization and mitigation of negative environmental impacts associated with water resource development programs by promoting, planning and implementation on economically viable, socially equitable, technically efficient and environmentally sound basis. Building upon this WRM policy, the Ministry of Water, Irrigation and Energy (MoWIE) prepared in 2015 the "Climate Resilient Water Safety, strategic framework" with the aim to raise awareness and understanding of risk issues from catchment to mouth, and designate measures to be taken to provide safe drinking water in a systematic way throughout Ethiopia. In this document, it is stated that the Government of Ethiopia designed a Water Sector Policy and Water Sector Development Universal Access Plan (UAP) I and a revised UAP II, and hence, achieved significant progress in the provision of safe water supply both in the urban and the rural settings in the past 20 years. The policy was well-articulated in terms of water availability, quality, continuity and suitability including watershed management and prevention of water source pollution. However, though, good enabling policy environment is in place, the major challenges are the underserved one third of the population. The goal of the strategy framework is to guide the development and implementation of Water Safety Plans (WSP) aimed at improvements of each step of the water safety plans so as to enable provision of safe and adequate drinking water which has the trust of the consumers and meet health-based water quality target.

With a growing number of IWRM operational guidelines, trainings, handbooks and participation in the International Network of Basin Organizations (INBO), and leading networks and global partnerships such as GWP, IWRM has gained more and more interest in Ethiopia. The Ethiopian government recognizes that water issues touch all segments of society and all economic sectors. The government also recognized that population growth, rapid urbanization and industrialization, expansion of agriculture and tourism, and climate change all put water

under increasing stress. Given this growing pressure it is critical that this vital resource is properly planned, monitored and managed under IWRM together with stakeholder's participation and capacity building.

Integrated water resources management (IWRM), including soil and water conservation (SWC) and sustainable land management (SLM) practices in Legedadi and Dire sub catchments is relatively weak. The household survey result indicated that SWC measures are not to the expectation. Out of the 299 respondents asked whether they perform SWC works or not in their plots of land, 54% replied that they perform soil conservation works and 19% replied that they do not do soil and water conservation works.

As it was observed during field visits, there are no visible SWC measures in the catchment; no terraces, no check dams and no micro-basins have been seen in the catchment. This calls for implementing IWRM activities through mobilization of community.

7.9 Institutional and Demographic Findings

7.9.1 Population growth and land fragmentation

Land fragmentation induced by increasing population growth has put its contribution on land degradation and reduction of farm productivity. Dividing and re-dividing of the landholding of a family among their offspring reduces size of land per household. Increasing urbanization and emerging industries are also posing pressure on farming communities and their lands in the catchment. Being located close to Addis Ababa, the UGA sub-catchment is populating rapidly. Sendafa town, confined to a relatively small area a decade ago, has expanded and is expected to expand considerably in a few years, thereby further encroaching agriculture, grassland and forested lands.

Development goal:

- Supporting the development of a multi-year family as well as land use and zoning plan & approach at regional and district (woreda) level;
- Training and hiring of stakeholder (and environmental) managers at regional or district level who know the area well and are close to people, to prevent conflicts of interests and to arrive at widely supported solutions.

7.9.2 Lack of institutional capacity for environmental enforcement

A lack of institutional capacity was observed for enforcing and monitoring compliance with national environmental objectives. This mainly applies to the district (woreda) level where the main executive and monitoring responsibilities lie. Discussion with Berek woreda environmental protection and climate change office head revealed that only 50% of the allocated manpower is deployed and the remaining 50% of the job titles still remain vacant. This has imposed problems on the capacity of the office to discharge the responsibility vested up on the office.

Development goal: Knowledge and organizational strengthening of relevant district offices for the enforcement of water, land and environmental objectives.

7.9.3 Lack of inter-institutional cooperation

Another bottleneck in countering environmental threats and degradation in the UGA sub-catchment is the lack of inter-institutional cooperation and integration among different district (*woreda*) offices. Each office is almost working completely independent without planning in a coordinated manner with other offices regarding overlapping subjects.

Lack of coordination among environmental protection (EPA, EFCC), mining office and investment offices (FED, ATA, etc.) is significantly affecting the land use and environment of the sub-catchment. The observed uncontrolled opening of stone quarries on farmland without any environmental management plan is one of the phenomena that confirms poor coordination among the relevant sectoral offices and other stakeholders at woreda level. Mining office can issue mining license without requesting environmental impact assessment (EIA) document and without any permission from Environmental office. A general absence of coordination and integration among the sectoral offices at woreda level lies at the basis for the observed weak management of the resources and degradation of the environment.

There is also contradicting interest between investment policy and EIA proclamation. The Investment Proclamation seeks to vigorously promote economic transformation without any specific references to environmental safeguards. Instead, it states that the investment office "*shall, after issuing the investment permit, notify the concerned government institutions so that the latter could conduct the necessary follow up*". This situation may prove detrimental for overall pollution control prospects in Ethiopia as potentially polluting enterprises may obtain investment permits from investment office before EIA authorization.

Development goal: Promotion of inter-institutional cooperation and improved integration among sectorial district and regional offices by organizing multi-disciplinary practical water and land use planning workshops.

7.9.4 Encroachment of the dam reservoirs' buffer zones

As it was observed during the site visit, there are settlements and farming activities within the buffer zone of the Legedadi catchment. There is no delineated buffer zone or physical separation around the reservoir. Unlike Dire reservoir, there is no fence around Legedadi reservoir. Farming activities which is extended to the bank of the reservoir would increase reservoir siltation and pollution of water, by using fertilizers, pesticides as well as humans and animals that leave their feces directly in the lake water. Unless necessary measures are taken, life of the reservoir would be shortened, and water quality of the raw water would be deteriorated which in most cases also leads to a higher water treatment costs.

Development goals: Establishment of a 100m 'no-activity' buffer zones around Legedadi dam reservoir, including awareness raising of nearby living communities and other stakeholders.

7.9.5 Lack of sustainable land management practices in the highlands

The upper parts and highlands of the UGA sub-catchment (particularly areas between 2,600m asl and 3,000m asl) have been eroded due to continuous farming without the aid of soil and water conservation works. During extensive field visits, also in the Upper Dire sub-catchment, no terraces, no check dams or other form of soil and water conservation (SWC) works were observed. There is no terraces, no check dams or other form of soil conservation works, not even on the very steep slopes. Except areas covered with eucalyptus tree plantations, the open farmlands are severely eroded and have lost fertility and, thus, agricultural productivity. Soil erosion in areas covered by eucalyptus tree plantation are relatively better and there is no significant soil loss and no formation of gullies.

Development goals:

1. Setting up of a catchment management plan (CMP) including agroclimatic and soil suitability maps;
2. Awareness creation on and introduction of where which type of SWC measures is most effective, and support community-based implementation;

3. Diversification of livelihoods through support for promoting and setting up agroforestry, farmer managed natural regeneration (FMNR) farming, wood lots (*Eucalyptus* or other economic multipurpose trees) and other alternative forms of livelihood, such as: dairy farming, paddocking of livestock, cut-and-carry system and bee keeping;
4. Explore other ways of income sources and distribution. Think of farmers using tree plantation as out grower and sharing the benefit in their own conservation organization/union or share with the Berek woreda Forest and Wildlife Development Enterprise for conservation and reinvestment in the area.

7.9.6 Climate Change and Associated Impacts

Discussion made with the Berek Woreda Environment, Forest and Climate Change (EFCC) office head indicated that the impact of climate change is become visible in various aspects of the environment. As per the office head explanation, there is increase in temperature and high variability of rainfall including shifting the onset and end of rainy season. Moreover, there is emerging of new crop diseases which were not known in the past, although it is debatable whether this is (only) a result of climate change. Other impact of climate change as per the head of the EFCC is depletion of the groundwater table on which many people with a shallow hand dug well depend. Environmental expert of the woreda indicated that there are number of hand dug wells abandoned due to depleted aquifers.
Household survey also indicated that most of the community residing in the catchment feel that there is climate change in the area, which is explained by increasing temperature from time to time.

Expert judgement: From the previous narratives it can be concluded that there is ignorance about how climate change is caused, what its impact is, but also what other factors such as human actions influence the community-felt adverse impacts, such as water availability. From a land and water resources management expert judgment point of view, for example, depletion of groundwater tables is in many cases much more a cause of other factors such as: uncontrolled water use and abstractions, inefficient water use, land use change and degradation as well as creation of impermeable surfaces (e.g. roads, buildings) so that rainwater can no longer infiltrate. In this context, the impact of climate change is often only minor and much less decisive.

Development goal: Awareness campaign about the effects of human actions on land and water availability versus climate change, creation of water buffering and storage in the landscape for times of excess as well as lack of water.

7.10 Overall Environmental development goals and indicators

In the previous sections we described the current status and perception of the environmental condition in the UGA sub-catchment, including some development goals for specific subjects. We close this section with an overview of the main environmental development goals and indicators that have been observed in the UGA sub-catchment specifically and that the IWRM4WASH project should take into account.

- **Promotion of inter-institutional and inter-departmental cooperation**, for example by organizing practical water and land use planning workshops;
- **Training and appointing of stakeholder managers** at AAWSA, Berek woreda and/or Oromia Water and Energy Resource Development Bureau (OWMEB) who know the area well and are close to people, to prevent conflicts of interests and to arrive at widely supported solutions;

- **Prepare an integrated, multi-year catchment management plan (CMP)** – or else at least a land zoning or land use management plan – that involves all the relevant stakeholders and implement it with diligence;
- **Each industry has to prepare environmental and social impact assessment (ESIA)** and get approval from environmental protection office before starting the construction, production and/or exploitation on its premises. Site specific management plan should be in place and the responsible office at Woreda level should monitor its proper implementation and whenever there is unforeseen impacts, the environmental management plan must be updated to incorporate any unforeseen impacts. Industries with potential to pollute the environment need to have environmental experts among their manpower;
- **No industrial waste should be allowed to discharge in the environment** without adequate treatment. Industry owners should be promoted to reuse or recycle waste products as much as possible, and otherwise be fined if the Ethiopian environmental and waste disposal requirements are not met;
- **Establishment of a 100m 'no-activity' buffer zones around Legedadi dam** reservoir, including awareness raising of nearby living communities and other stakeholders;
- **Awareness creation on soil water conservation (SWC) and sustainable land management (SLM)**, introduction of where which type is most effective, and support community-based implementation;
- **Give priority for soil and water conservation (SWC) works** to improve the land productivity, to minimize reservoir siltation and to improve livelihood of the people residing in the catchment. More focus for the SWC measures should be given to steep slope areas and hill sides;
- **Crop farming should not be allowed on steep slopes above 50%,** preferably not on slopes steeper than 15%, and should only be eligible for wood lots for the plantation of indigenous trees or other multipurpose trees which could improve the economic return and minimize downstream siltation;
- **Build the capacity of the Woreda EFCC office** by manpower, laboratory equipment and transport facilities to enable them to properly discharge and enforce its own environmental management, monitoring and awareness creation responsibilities.
- **Stone quarrying activities should be closely monitored, properly managed and approved** by the Woreda Environment, Forest and Climate Change (EFCC) office. Site specific environmental management plan for each quarry site should be prepared and approved by the woreda EFCC. Each of the abandoned quarry sites should be progressively reinstated and responsible office at Woreda level should monitor its implementation;
- **Vocational training towards Creation of off-(farm)land jobs will be required to reduce land fragmentation** so that unemployed youth shifts from farming to restorative business sector on land and water. This will require: 1) attracting low-skilled, but sustainable and low-environmental impact industry to Berek Woreda, 2) offering short-term vocational (re-)trainings in the fields of: wood works, metal works, sustainable agriculture, dairy farming, small-scale business, middle and retail management, and 3) introduction of economic zoning for restorative business development, conservation as well as for mixed sector optimization.

8 Gender & Youth analysis

The issue of women role in water management was addressed by using various data collection tools, including FGDs, KIIs and site observations. The role of women in water management was first raised in the HH surveys and the further explored through KIIs and FGDs, and finally confirmed through information from district water bureau and Sendafa-Beke Water Supply Services Enterprise (SBWSSE).

8.1 Role of women in water management

As opposed to the over-representation of women and girls in, for example, fetching water as part of household chores, it is observed that there is little participation of women in the water management. This is well illustrated by a number of examples such as the few number of female employees in the water sector, no women community representative in the Sendafa town water board, and the fact that out of the existing 174 water committees not a single woman is in the chairperson position. In any case, women are in any case heavily underrepresented at the decision-making and strategic level, which means that their power influence is very limited formally and institutionally as well.

An important reason for this is the traditional domestic division of tasks, including taking care of food, cleaning the house, looking after the children and fetching water, which are almost exclusively performed by women. Experts at district water bureaus also claim, however, that women are less able to fulfill water management tasks, let alone to fulfill higher positioned water committee tasks.

Nevertheless, out of 227 total water committee members 43 (19%) of them were women. Most of these women members are also perceived as heads of households. However, the ministerial 'Health, Sanitation and Hygiene Strategy' (2005) recommends that more than 50 percent of these committee members should be women, whereby women should hold at least one of the executive functions as chair, secretary or treasurer. KII with a women member of a water committee also stated that there is no social exclusion of women that prevent women from participation in water management. The thing is that its customary (traditionally speaking) to choose men when community representation is requested.

8.2 Mindset of women in Upper Great Akaki sub-catchment

It is observed that women exhibit characteristics similar to most parts of the country particularly central Ethiopia (Shewa area). They behave as per the acceptable behavior standards of most part of the country. However, there are places mainly in east of the country where women are very much outgoing and independent. In sum, it can be concluded that women in Upper Great Akaki sub-catchment area are outspoken. They don't have problem of expressing themselves especially when they are communicated either by men or women as long it is by their language (Afan Oromo). This implies that it is not due to the proximity of the area to Addis Ababa rather it is because of the cultural orientation of the community. In addition, schoolgirls who are living in small rural towns like Dire are more expressive outgoing and independent.

8.3 District women empowerment

The Berek Woreda Women & Youth Affairs office has designed various women empowerment programs to enhance the status of women at all levels. Here is a list of the district's most prominent and visible women empowerment programs:

1. **Empowering women mentally and psychologically:** the Women & Youth Affairs office works to enhance the knowledge of women in different issues and to change their attitude of women towards themselves. Low education attainment of women is still the main cause that women experience deprivation and having a disadvantage in areas such as labor market participation and self-development. Which in turn has the consequence that women are more susceptible to poverty, domestic violence, low participation and representation in the affairs of the community including water management, amongst others. As it is found out from the survey result, 30% of the women respondents never attended any school. Hence, the woreda office works towards empowering women mentally and psychologically by providing various trainings in collaboration with other sector offices and NGOs to change their attitude towards themselves and training to improve their skills in the fields of: self-development, reproductive health, HIV Aids self-protection (e.g. against domestic violence), and the like;
2. **Empowering women economically:** to empower women economically, the bureau works towards income expansion of women. Accordingly, the office identifies which economic activities are suitable for each specific kebele. Then facilitate and supports women to forms associations and engage in the proposed activities such as poultry, dairy farming, backyard to small-scale horticulture farming of high-value crops, and honey making by beekeeping. In the area there are also loan facilities available for setting up small and medium enterprises (SMEs) established by women;
    a. Berek Woreda Women & Youth Affair office, in collaboration with Oromia Regional Government, supports in **providing high productive cows for poor women** that live in the district. Furthermore, it collaborates with the district Bureau of Agriculture to support and engage women in backyard farming;
    b. As a pilot, the office has deployed **distribution of fuel-efficient or improved cooking stoves to women** in collaboration with the districts' Bureau of Agriculture to relieve them from domestic workload and to reduce long-term health impacts. Access to renewable energy (also known as 'Safe Access to Fuel and Energy (SAFE), FAO, 2018') can lead to women's economic empowerment and have a greater impact on communities when energy projects adopt a gender lens that supports. FAO's SAFE approach in Ethiopia combines energy-efficient technologies with support to multi-purpose tree plantations;
3. **Social empowerment:** the women affair office also works towards increasing the women participation in every aspect of the social life including political participation. For instance, despite the fact that about 50% of district council representatives are women, female KII respondents indicate that they not feel sufficiently represented and that gender issues did not improve significantly over the past years.

Development goals:

- Continue the existing women empowerment training programs on attitudinal change, although awareness and behavioral change must also take place in men;
- Expand the training programs on women on various employable and entrepreneurship skills regardless of their educational background;
- Establish mechanism to increase the representation of women in employment ,and in various supply chain networks;

- Facilitate mechanism to empower women socially by encouraging them to become members of various committees in different sectors, engaging in political activities and strengthen school girls club to practice social skills such as assertiveness.

8.4 Youth & youth empowerment

Although no official figures are known, youth unemployment in Berek Woreda and the project area is dire. The municipality of Sendafa town has a plan to engage 2,000 youth on a yearly basis in various manufacturing activities by establishing small & medium enterprise (SME) associations and loans. Moreover, the town administration arranged youth friendly health care services.

According to the district Women & Youth Affair office the attitude of youth creates a challenge on the success of support programs set up by governments and agencies. Most youth have barely completed primary school and therefore have a development delay in the labor market in the areas of knowledge, self-development, entrepreneurship and social skills. Besides, youth and adolescents in the area have a poor work culture and ethic. This is besides the budget limitations of the district office to support and supervise the youth empowerment activities in a proper and effective manner. Due to the lack of financial support from the local authorities, young ambitious entrepreneurs face difficulties in accessing providing collateral for loan.

Development goals:

- Establishment of training centers or creating linkage with existing nearby Technical and Vocational Education and Training (TVET) colleges to provide various employable skill building trainings as well as trainings in entrepreneurship and competency in various economic activities;
- Contribute to pragmatic and applied curriculum development of TVET courses, such as climate smart farming, renewable energy, sustainable land and water management, and a number of economic high potential sectors;
- Provision of appropriate support, monitoring and supervision on the economic activities of youth since lack of supervision is the main cause of failure of SMEs;

9 Establish IWRM4WASH project indicators

After analyzing all findings and data results in the field of biophysical, institutional, socio-economic, environmental, and gender and youth aspects in the UGA sub-catchment project area, the Consultant was able to make a lot of observations. This resulted in more and less clear development goals as well as links with integrated water resources management and the IWRM4WASH project in a more general sense. In this last chapter, based on our findings, we suggest indicators we deem important for the execution and implementation of the IWRM4WASH project, which we have tried to link to the four (4) formulated Project Results. See Table 46 below.

Table 46. IWRM4WASH Project Results

Project Result	Project result description
R1	**Trans-regional dialogue** established and strengthened between Addis Ababa City Administration, AAWSA, OWERDB, MoWIE, BDA and other stakeholders in Upper Awash River Basin under the framework to promote IWRM and to foster trans-regional dialogue
R2	**Reservoirs protection**: Enhance the sustainability of the Legedadi and Dire dam reservoirs by improving the water quality and the rate of siltation
R3	**Market based livelihood improvement**: Sustainably enhance the livelihood/food security for people living upstream of Dire and Legedadi dam reservoirs by creating alternative opportunities as incentives to encourage conservation activities
R4	**WASH Development**: Inclusively improve WASH services for 100,000 people living in the catchment areas: 10,000 people (rural) dwellers and 90,000 people living in the cities of Akaki, Burayu, Gelan, Salulta and Sendafa

The end result is a long list of 28 potential project **objectively verifiable indicators (OVIs)**, which we have related to the IWRM4WASH Project Results through indicating a numbering (R1, R2, R3 and R4) as to indicate which OVI contributes to which Project Result. Client VEI and contributing partners such as AAWSA and OWMEB - whether or not via stakeholder participation and validation – can select the most suitable baseline indicators.

9.1 Biophysical landscape indicators

The main identified observations and development goals are related to climate change, land use, soil erosion and gully formation. Here is an overview of the most important observations and development goals identified:

- From the Coupled Model Intercomparing Project Phase 5 (CMIP5) analysis, it has been concluded that without comprehensive measures (RCP8.5 scenario) combating climate change there will be a precipitation increase of 123mm and a temperature increase of 1.14˚C in the UGA catchment by 2050;
- Landscape restoration of heavily degraded soils and areas as well as on slopes of more >10% through sustainable land management (SLM) programs, including soil water conservation (SWC) measures, agroforestry and farmer managed natural regeneration

(FMNR) is necessary among other things through promotion and practical training of rural upland farmers;
    - There should be special focus on Upper Dire and Bosena tributaries in northwest of UGA sub-catchment where slopes can reach up to 60% and were bare landcover allows runoff, erosion and landslides to occur extensively
- Combat deforestation, including setting up conservation areas, through stricter compliance and promoting the purchase of fuel-efficient cooking stoves so that illegally harvested fuel wood and charcoal is less necessary;
- give support reforestation and sustainable wood production, for example through economic woodlots;
- Strengthen and provide special protected status for at least 150 ha of (still) forested areas in the north and northwestern parts of the UGA sub-catchment in collaboration with the Ministry of Environment, Forest and Climate Change (MoEFCC) and the Ministry of Agriculture and Rural Development (MoARD), or its regional subsidiaries.

Key indicators

Suggested key or **Objectively verifiable indicators (OVIs)** in relation to the **Biophysical Landscape** of the Upper Great Akaki sub-catchment**:**

1. Effective catchment based IWRM (or a Catchment Management Plan; CMP) and land use planning developed through inter-institutional partnerships (AAWSA, OWERDB, Berek Woreda, etc.) within UGA sub-catchment, including capacity building and stakeholder platform facilitation (contributing to: R1, R2, **R4**);
2. No. of catchment treatment structures or SWC measures constructed/rehabilitated on 750 ha on 'Moderate-high' and 'High' erosion sensitive lands, contributing to i) improved agricultural livelihoods, ii) groundwater infiltration, iii) landscape resilience and iv) aiming at soil loss reduction of 20% (R2);
3. A bare minimum of 150 ha of still wooded and forested areas with a high natural value on steep slopes in the north and northwestern parts of the UGA sub-catchment should receive special protected status and its ecosystem value strengthened (R2).

9.2 Water Supply indicators

Regarding to identifying development goals and key project indicators it is important to realize that: AAWSA's water production in the UGA sub-catchment from Legedadi and Dire dam reservoirs amount currently to a daily estimated production of 214,000 m3/day thereby covering 39.5% of AAWSA's total daily production and supplying an estimated 2.6 million people in Addis Ababa with water (unconfirmed). In addition, the following main observations and development goals have been identified:

- With more than 50% of UGA sub-catchment's inhabitant's dependent on (shallow) groundwater, make protection and replenishment of this a political top priority, and at the same time offer them other water supply options, such as access to public piped schemes and standpipes;
- Based on expert judgment by the Consultant the potential abstraction volumes of planned (deep) groundwater boreholes to be constructed in the UGA sub-catchment, including the 4BHs project for SBWSSE, appear in general to be overestimated and advises to use more conservative numbers of 50% to 75% of the current indications;
- Stronger and more dedicated focus on NRW reduction of AAWSA's and Sendafa-Beke Water Supply Services Enterprise (SBWSSE) supply systems is a significantly more cost-efficient investment that can be implemented in the shorter term and can have a longer-lasting result as long as it is linked to good coordination, implementation, maintenance and management;

- Develop an awareness and dissemination campaign on resilient rainwater harvesting and buffering techniques (3R), and provide implementation support to showcase such techniques as alternative domestic water source.

Key indicators

Suggested key or **Objectively verifiable indicators (OVIs)** in relation to **Water Supply:**

4. Sediment load reaching the Dire and Legedadi Reservoir will have decreased by 5-10% by the end of the project (R2);
5. Increase potable water coverage in whole of UGA sub-catchment from current 63.8% to >75% (R4);
6. Household (HH) survey respondent satisfaction about provision and access to good quantity and quality water has increased with 20% (current baseline: 100% dissatisfaction) (R1, R4);
7. Increase access to public/communal piped schemes and standpipes, whether or not fed by rainwater harvesting or 3R measures, by construction of #50 water supply facilities, prioritizing the most underserved communities, to make inhabitants less dependent on unreliable, unsafe and drought sensitive (shallow) groundwater sources (R4);
    - Determination of suitable locations must be determined by means of thorough water resources assessment or feasibility studies by experienced and renowned hydro(geo)logists or water resources experts. This was not within the scope of works of this Baseline Survey assignment.
8. Reduce the time that particularly women spend on average on water fetching by more than 50% and up to maximum 1 hour per day by creating more nearby water sources, and offering innovative ways to transport the water, such as rollable water containers and decentralized, off-grid water point systems (R4);
9. The percentage of 73% that women and girls contribute to fetching water must be reduced to at least below 60% and with the aim of a 50-50% distribution with men, for example through awareness and gender equality trainings (R4).

9.3 Institutional Framework indicators

The main identified observations in relation to the institutional setup of land and water management and all further IWRM and socioeconomic related fields are listed below:

- 76% of respondents indicated that there is no local responsible body for the coordination for WASH in the study area.

WASH sector perceptions and findings from the focus group discussions (FGDs):

- Acute water shortage. Lack of sanitation facilities, and those there in very bad state
- Lack of coordination in WASH sector
- No technical capacity among communities to manage water schemes
- FGD respondents indicate to have little knowledge about land, water and environmental policies and strategies in place
- Complete lack of waste management, including local policy or action plan to address this
- One FGD respondent indicated development of tree nursery site in collaboration with woreda Agricultural office

WASH sector perceptions and findings from key informant interviews (KIIs):

- There is no responsible body in the area to coordinate WASH and the situation seems to be fragmented and tends to move in isolation;
- There is severe water shortage which in turn becomes difficult to keep improved sanitation and hygiene very well;

- Most of the respondents do not have adequate knowledge about the national policies, development programs and strategies at woreda level;
- There is no consistent program set to advocate for safe water, sanitation and hygienic practices;
- There are huge capacity limitations in the sector, specifically at lower level with respect of human power, physical facilities, financial resources (budget), technologies and operating system.

9.3.1 Development goals

- Promote appropriate linkage mechanisms for the coordination of water resources, sanitation and hygiene management activities, but also other related sectoral fields and departments such as forestry and agriculture, between the federal and regional Government agencies;
  - Think of: MoH, MoEFCC, MoARD, Environmental Protection Authority (EPA), Oromia Water and Energy Resource Development Bureau (OWMEB), or its regional subsidiaries.
- Strengthen water resources management, health, environmental protection and agricultural development institutions, for sustainable development and management of the WASH sector;
- It is highly desirable to form joint planning, implementation and monitoring mechanism for the WASH sector and smooth information sharing among the partners of the sector;
- The sector management needs to follow workable form of coordination approaches which has to include useful elements of periodic dialog, communication and feedback mechanisms which can obviously satisfy the interest of all in the sector;
- The regional government needs to allocate adequate budget for infrastructure development, program delivery, human resources development, advocacy and education targeting safe water, sanitation, hygiene, healthy and safe environment, the impact of climate change and on mitigating environmental degradation and on ensuring ground water source and food security;
- Improve hygiene facilities such as toilets in schools and communities considering safe space for girls that includes separate toilets and wash rooms.

9.3.2 Key indicators

Four indicators are employed to measure the performances of WASH facilities and used to assess the capacity of partners such as government agents, local administrations and communities and the intensity of the collaboration and networking existing among these groups for the management of WASH climate change and environmental protection by focusing on the conservation of water sources:

A. **Outcome Indicator 1:** The consistent progress in capacity of national, regional and local agencies in managing the water, sanitation and hygiene facilities (R1);
B. **Outcome Indicator 2:** Knowledge of institutions' contribution to the mitigation of climate change has a measurable impact on environmental protection including the protection of water sources (R1, R2);
C. **Outcome Indicator 3:** Hand washing knowledge and practice exists and institutions have a strong advocacy system in place to realize this impact (School WASH, ONE WASH) (R4, R7, R4);
D. **Outcome Indicator 4:** Adequacy of the integration and collaboration exists between the WASH sector actors and this coordination is based on systematic management approach (R1, R3).

9.4 Socio-economic indicators

The main findings of the socioeconomic assessment reveals that there is an encroachment of development interventions coupled with poor social & economic infrastructure that pave way for over-cultivation and shortage of land. Besides the existing sanitation facilities such as liquid and solid waste disposal sites are at rudimentary stage that calls urgent attention of stakeholders. All these factors also influence the availability and quality of water in the catchment. Looking at a number of key socio-economic areas, these are the most important findings from analysis of the Baseline Survey results:

Population characteristics

- The total population of Berek Woreda was established at 86,458 (2018 census), of which 43,690 are male and 42,768 are female
- Household (HH) survey encompassed 2,131 people, of which 719 were younger than 18 years old (34%) and 1,412 older than 18 years old (66%). Average household size is 6, whereby 88% of households are male headed.
- 55% (230) of HH survey respondents depend for income and livelihood on farming practices, followed by 15% (63) who work as a private worker such as (hand)craftwork or shop owner. This is followed by unskilled labor (7%, 32) which means usually manual labor, both on a fixed and on-call basis, livestock raising (6%, 25) and working as a government employee (6%, 27);
- Wealth ranking: 51% of the respondents rank themselves at middle income level, but 42% rank themselves on a poorer income scale, namely: 19% at lower middle income level (75), 20% as poor (81) and 3% as very poor (12).

Agriculture

- Despite the fact that agriculture is the main livelihood within the UGA sub-catchment, users are unable to link up with improved agricultural practices affecting crop and livestock production, while the unpredictable nature of rainfall exacerbates this;
- Paddocking of livestock, possibly supplemented with hay and other crop feed through a cut-and-carry system, offers opportunities to increase livestock productivity and prevent the spread of animal diseases (e.g. anthrax, blackleg and FMD);
- Other limiting factors and constraints to agricultural development are: high population growth and the associated land fragmentation, limited provision of new technologies, lack of product diversification, inadequate agricultural market system and limited access to credit facilities.

Social services (Education, sanitation & health)

- Based on education statistics from 2018, the Berek district has 45 primary schools, of which 10 are governmental and 35 are private schools. Conditions on the private schools are on average better, with six times less students and only 15 students per teacher compared to over 42 students per teacher on a governmental school;
- School dropout typically starts after grade 5 and 6, after which only less than 40% of the original number of students remains after grade 8 (around 900 from the 2,400 in grade 5);
- None of the primary schools, most notably the rural ones, have a piped water connection and rely on water harvesting or children bringing their own water to school;
- The total **number of students who have to use 1 latrine is high**:
    - The number of girl students per latrine on governmental (78 per latrine) schools in Berek Woreda is well over the Ethiopian standard of maximum 50 girl students per latrine/toilet seat (MoE, 2017);
    - The average number of 69 boy students at governmental schools that have to share 1 latrine or urinal is just under the Ethiopian standard of maximum 75 boy students per latrine/urinal (MoE, 2017);

- Particularly in the rural areas it was observed that **many school toilets are poorly designed, constructed and managed**. Schools with non-separate toilet blocks for boys and girls have found that female students in particular tend to be absent, due to fear of being bullied and humiliation, especially during the period of menstruation;
- According to KII with school supervisors, many primary **school students prefer open defecation as the school latrines are not clean and safe for usage**;
- Of the 21 urban primary and secondary schools, only 5 of them have a separate Menstruation Hygiene management facility;
- 31% of the Household survey respondents (102 out of 328) does not have access or limited access to sanitation facilities;
- Of the respondents who have access to a form of sanitation at household level or communal (69%), more than two thirds (69%) of them replied that adult women typically have the responsibility of cleaning the latrines;
- Waste disposal and management: 36% of the respondents dispose their liquid waste directly into streams, rivers and open land remain significant, while of the 11% irregular disposal it remains unclear where the waste water going. In addition, it is generally known that the waste residues in septic tanks (37%) and pit latrines (9%) continue to infiltrate and 'leak' to the underlying aquifer, where it can contaminate the groundwater;
- The four health centers and 22 health posts in Berek district employ 79 health professionals, but officially there is not one single doctor active in the area (figures from 2018) while not having a protected water supply on their premises either;
- The sanitation and hygiene facilities at these health centers and posts are usually bad and appalling. It is estimated that 15% of patients, many of whom are women who come for giving birth, develop one or more infections during their hospital stay.

Infrastructure and Services

- The kebeles have no adequate electric power supply connection to national grid system. By way of illustration, only 45% of the HH survey respondents indicate that they have a home electricity connection;
- Due to limitations of micro-finance, including an interest rate of 10% per month, small size loans and group collaterals can become already a hindrance to the member of the community to get maximum benefit out of the credit.

9.4.1 Development goals

General

- Provide a framework (project cycle) for impacted community action, and encourage and coordinate the participation of other stakeholders, and build linkages among them;
- IWRM4WASH project should must make every effort to better integrate water supply and sanitation and hygiene, including coordinated planning;
- Create enabling environment for private public partnership (PPP) particularly for sanitation marketing and business opportunities in this regard;
- Set quality standards and provide regulatory procedures, especially with regard to compliance with education, health, sanitation and waste management standards;
- Promote participatory monitoring and evaluation (M&E) to ensure quality, equity, sustainability and accountability;
- Of the nearly 800 farmers interviewed during Data Collection (HH survey and FGDs) who engage in backyard vegetable farming, 90% are women. For crop growing they depend on rainwater or water fetching from far. Give this large group of women access to hybrid micro-finance opportunities such as rent-to-own principles to get access to low-tech and low-cost irrigation tools.

School sanitation

- Improved, safe, sanitary WASH facilities in schools will facilitate and sense of security as well as educational efficiency and progression, especially those of female students;
- The aim should be to double the construction of safe and improved latrines, faucets and menstruation hygiene management facilities per school to meet the Ethiopian standards set by the Ministry of Education (MoE, 2017), especially those at governmental schools;
- there must be training for both school management and students to deal with the available sanitation facilities with care and hygiene, and to bring the risks of unsanitary conditions needs more attention;
- a school or community-led caretaker program could be set up to keep the latrines clean and orderly, perhaps even inviting to use;
- Support and strengthen girl and sanitation clubs at schools and their advocacy work regarding menstruation, sanitation and hygiene.

Sanitation

- Upgrading and cleaning up existing latrines, and constructing new latrines calls for sanitation marketing to facilitate the production and availability of slabs and other related industrial materials at affordable price at close distance. Innovative, business-like ways of cleaning and reusing latrine material should be considered to create local entrepreneurship and employment through the support of training courses and access to small start-up capital as part of the *market-based approach* of the IWRM4WASH project;
- Support renewed awareness campaigns about the importance of good sanitation facilities and their direct influence on essential issues such as improved education, health, work productivity and employment;
- Given the low latrine coverage, the IWRM4WASH project should support regional initiatives to increase the number of improved clean sanitation facilities in the catchment, with the aim of achieving a doubling of this number;
- Support local entrepreneurship and employment through education training and small start-up capital to facilitate the immediate material production and possibility of latrine construction at medium to large scale.
- Support the improvement of WASH facilities at health centers and posts to halt the spread of various infectious diseases, including COVID-19;
- The reduction of some of the most common diseases in the area are waterborne or caused by the lack of WASH knowledge, practices as well as improved facilities at household level or at school. Therefore very important to start addressing these WASH issues at the source;
- Identify the barriers to appointing experienced doctors and managers, and support their recruitment where possible.

9.4.2 Key indicators

Suggested key or **Objectively verifiable indicators (OVIs)** in relation to the **socioeconomic development** of the UGA sub-catchment**:**

10. 25% of the HH sample that ranked themselves on a poorer income scale (168 out of 400) have moved towards the middle-income level or higher by the end of the IWRM4WASH project (R3);
11. In the selected intervention areas, particularly in the Upper Dire, due to the proposed socioecological landscape conservation & restoration as well as improved agricultural practices, the HH survey and FGD perception of increased crop productivity will have increased from 44% currently (2020) to more than 60% upon completion of the IWRM4WASH project (R3);

12. Encourage the participation of women in the 26 irrigation user associations present in UGA sub-catchment, and aim that the proportion of women of the current 209 members increases from 30% currently (2020) to 50% by the end of 2024 (**R4**);
13. Overall sanitation facility access should be improved by the IWRM4WASH project by construction of 250 improved clean sanitation facilities, resulting in a proper sanitation coverage increase from 35% to at least 75% in large parts of the UGA sub-catchment (**R4**);
14. School sanitation facility access should, as aim by the IWRM4WASH project, be doubled through construction of safe and improved latrines, faucets and menstruation hygiene management facilities per school to meet the Ethiopian standards set by the Ministry of Education (MoE, 2017), especially those at governmental schools and in rural areas in particular (**R4**);
15. Setup, support and strengthen school sanitation caretaker programs as well as girl and sanitation clubs, including their advocacy work regarding menstruation, sanitation and hygiene (**R4**).

9.5 Environmental indicators

9.5.1 Main findings

- Berek woreda Forest Development and Utilization Enterprise under Oromia Region Forest and Wildlife Development Enterprise is managing 9,000 ha of tree plantations, whereby *Eucalyptus globulus is the* main tree species planted as raw material for industries, as construction material and as timber and firewood. Eucalyptus tree plantation is being considered more profitable than crop production;
- 5% of the tree plantation sales by the Berek woreda Forest and Wildlife Development Enterprise goes back into kebele committees to fund community development activities;
- Because of the short-term high yields that can be achieved, farm land is converted to stone quarry sites in an alarming rate that in some places transform the landscape into barren, unrecoverable land. There is no reinstatement works after the extraction of stones, nor monitoring its mining and to what extent by regulatory bodies;
- Dominant land use in the UGA sub-catchment is farm or crop land (currently >50% and still growing). Followed by urban settlement and grassland, whereby grassland has decreased in acreage by 43%, while urban settlement has increased by exactly 100% in the past 50 years. With livestock heads fairly stable around 290,000 heads, this will inevitably lead to conflicts about land and land use;
- Manufacturing industries: An oil processing industry was found disposing unregulated and untreated industrial waste (residue of hydrocarbon) on its premises, but also to surrounding land and water bodies, thereby heavily contaminating the environment. This was confirmed by the water quality analysis results stated in section 4.4.2;
- Horticulture and flower farms: three flower farms cover about 25 – 35 ha each, of which two are located downstream of the Dire dam reservoir in the Legedadi dam sub-catchment;
- Despite some industries having reasonably good waste management systems in place, the majority of manufacturing industries do not have an environmental management plan in place, while regular monitoring by regulatory bodies is absent also due to low capacity and lack of integration among sectorial district and regional offices;
- It has been observed that (e.g. due to overflow) untreated industrial waste is still discharged into the environment and important water sources such as wetlands and dam reservoirs, with indications of high BOD, high number of Total dissolved solids (TDS) and high concentrations of fecal coliforms;
- With 66% of household (HH) survey respondents feeling the impact of climate change, the local perception of this phenomena is high. Following the Consultant's finding regarding

increasing rainfall in the area up to 123mm until 2050, 80% of respondents confirm that this is already happening;

- With increasing rainfall, there will also be more erratic rainfall as well as longer periods of drought. This is already happening and has a major impact on depleting (shallow) groundwater levels on which a majority of the population in the UGA sub-catchment depends on (>50% is groundwater dependent);
- Integrated water resources management (IWRM), including soil and water conservation (SWC) and sustainable land management (SLM) practices in Legedadi and Dire sub catchments is relatively weak, with no SWC measures observed during field visits. Out of the 299 respondents asked whether they perform SWC works or not in their plots of land, 54% replied that they perform soil conservation works and 19% replied that they do not do soil and water conservation works;
- Population growth and land fragmentation: Land fragmentation induced by increasing population growth has put its contribution on land degradation and reduction of farm productivity. Dividing and re-dividing of the landholding of a family among their offspring reduces size of land per household. Increasing urbanization and emerging industries are also posing pressure on farming communities and their lands in the catchment;
- A lack of institutional capacity was observed for enforcing and monitoring compliance with national environmental objectives. This mainly applies to the district (woreda) level where the main executive and monitoring responsibilities lie. Discussion with Berek woreda environmental protection and climate change office head revealed that only 50% of the allocated manpower is deployed and the remaining 50% of the job titles still remain vacant.

9.5.2 Development goals

- **Training and appointing of stakeholder (and environmental) managers** at regional or district level who know the area well and are close to people, to prevent conflicts of interests and to arrive at widely supported solutions;
- **Knowledge and organizational strengthening of relevant district offices** for the enforcement of water, land and environmental objectives;
- **Training and appointing of stakeholder managers** at AAWSA, Berek woreda and/or Oromia Water and Energy Resource Development Bureau (OWMEB) who know the area well and are close to people, to prevent conflicts of interests and to arrive at widely supported solutions;
- **Develop an integrated, multi-year catchment management plan (CMP)** – or else at least a land zoning or land use management plan – including agroclimatic and soil suitability maps, in particular as development step towards sustainable land management practices in the Upper Dire highlands. Involve all relevant stakeholders in this development process and implement it with diligence;
- **Each industry has to prepare environmental and social impact assessment (ESIA)** and get approval from environmental protection office before starting the construction, production and/or exploitation on its premises. Site specific management plan should be in place and the responsible office at Woreda level should monitor its proper implementation and whenever there is unforeseen impacts, the environmental management plan must be updated to incorporate any unforeseen impacts. Industries with potential to pollute the environment need to have environmental experts among their manpower;
- **No industrial waste should be allowed to discharge in the environment** without adequate treatment. Industry owners should be promoted to reuse or recycle waste

products as much as possible, and otherwise be fined if the Ethiopian environmental and waste disposal requirements are not met;

- **Awareness creation on soil water conservation (SWC) and sustainable land management (SLM)**, introduction of where which type is most effective, and support community-based implementation;
- **Give priority for soil and water conservation (SWC) works** to improve the land productivity, to minimize reservoir siltation and to improve livelihood of the people residing in the catchment. More focus for the SWC measures should be given to steep slope areas and hill sides;
- **Crop farming should not be allowed on steep slopes above 50%,** preferably not on slopes steeper than 15%, and should only be eligible for wood lots for the plantation of indigenous trees or other multipurpose trees which could improve the economic return and minimize downstream siltation;
- **Build the capacity of the Woreda EFCC office** by manpower, laboratory equipment and transport facilities to enable them to properly discharge and enforce its own environmental management, monitoring and awareness creation responsibilities;
- **Stone quarrying activities should be closely monitored, properly managed and approved** by the Woreda Environment, Forest and Climate Change (EFCC) office. Site specific environmental management plan for each quarry site should be prepared and approved by the woreda EFCC. Each of the abandoned quarry sites should be progressively reinstated and responsible office at Woreda level should monitor its implementation;
- **Diversification of livelihoods through support for promoting and setting up agroforestry**, farmer managed natural regeneration (FMNR) farming, wood lots (*Eucalyptus* or other economic multipurpose trees) and other alternative forms of livelihood, such as: dairy farming, paddocking of livestock, cut-and-carry system and bee keeping;
- **Explore other ways of income sources and distribution**. Think of farmers using tree plantation as out grower and sharing the benefit in their own conservation organization/union or share with the Berek woreda Forest and Wildlife Development Enterprise for conservation and reinvestment in the area.
- **Awareness campaign about the effects of human actions on land and water availability versus climate change**, creation of water buffering and storage in the landscape for times of excess as well as lack of water;

9.5.3 Key indicators

Suggested key or **Objectively verifiable indicators (OVIs) for Environmental development:**

16. Knowledge and organizational strengthening of relevant district offices for the enforcement of water, land and environmental objectives (R3);
17. Promotion of inter-institutional and inter-departmental cooperation and improve integration among sectorial district and regional offices by organizing multi-disciplinary practical water and land use planning workshops (R1);
18. Establishment of a 100m 'no-activity' buffer zones around Legedadi dam reservoir, including awareness raising of nearby living communities and other stakeholders (R2);
19. Vocational training towards Creation of off-(farm)land jobs will be required to reduce land fragmentation so that unemployed youth shifts from farming to restorative business sector on land and water. This will require: 1) attracting low-skilled, but sustainable and low-environmental impact industry to Berek Woreda, 2) offering short-term vocational (re-)trainings in the fields of: wood works, metal works, sustainable agriculture, dairy farming, small-scale business, middle and retail management, and 3)

introduction of economic zoning for restorative business development, conservation as well as for mixed sector optimization (R3, R4).

9.6 Gender & Youth

General

20. Encourage establishment of women and youth SMEs to engage in small-scale horticulture and animal rearing (R4);
21. Establish water, irrigation and forest user and management associations and ensure women and youth participation (R2, R4);
22. Establishing training and research Centre or create linkage with existing training and research institutes to help identify suitable and productive economic activity for each kebele and to provide various trainings for women and youth based on demand (R3, R4);
23. Strengthen the practice of Local fund raising mechanism like EKUB, EDIR, and establish private Saving and Credit Associations, particularly for women and young professionals (R3, R4) .

Women empowerment

24. Close to 90% of households are male headed. Women empowerment and strengthening of female leadership should already be supported and encouraged at household level (R4);
25. Improve gender mainstreaming in every public and private sector organizations (R4);
26. Establishment of at least 5 women self-help groups, each group comprising of 10 to 20 members, to reduce land degradation and erosion (R2, R4).

Youth empowerment

27. Young professional programme developed and implemented with 10 high potential young professionals supported (R4);
28. 10 high potential young professionals participating in training, coaching and mentorship programmes in the WASH or land and water management sector (R3, R8).

References

Belay et al, 2019: Assessing the Effect of Land-Use and Land-Cover Change on Groundwater Recharge in Akaki Catchment, Central Ethiopia.

Chen, X., Liang, Z., Zhang, Z., and Zhang, L., 2020. Effects of Soil and Water Conservation Measures on Runoff and Sediment Yield in Red Soil Slope Farmland under Natural Rainfall, in Sustainability 2020, 12, 3417; doi:10.3390/su12083417

Dave Richards, 1995: A photographic Guide to Birds of East Africa.

Eliku, T. and Leta, S., 2018. Spatial and seasonal variation of physicochemical parameters and heavy metals in Awash River, Ethiopia. Applied Water Science 8 (6), Article number: 177, October 2018.

Ethiopian Tourist Trading Enterprise 1995: Endemic Mammals of Ethiopia.

FDRE Proclamation No. 1/1995. The Constitution of Federal Democratic Republic of Ethiopia.

FDRE, Environmental Protection Authority, Environmental Impact Assessment Guidelines Document, Addis Ababa, July 2000.

FDRE, Environmental Protection Authority, Environmental Impact Assessment Procedural Guideline Series 1. December 2003, Addis Ababa.

Maetens, W., Poesen, J. and Vanmaercke, M., 2012. How effective are soil and water conservation techniques in reducing annual plot runoff and soil loss? A pan-European and Mediterranean review and analysis. Geophysical Research Abstracts, Vol. 14, EGU2012-360, 2012

Mesfin Tadesse, 1995, Some Endemic Plants of Ethiopia 2. The Environmental Policy of Ethiopia, 1989

Ministry of Education (MoE), 2017. National School Water, Sanitation and Hygiene (SWASH) Implementation Guideline, Ministry of Education, Federal Democratic Republic of Ethiopia, October 2017, Addis Ababa, Ethiopia

National Report on Environment and Development. A Report prepared for the United Nations Conference on Environment and Development, Rio de Janeiro, 1992. Addis Ababa, Ethiopia, 1992.

Proclamation No. 299/2002. Environmental Impact Assessment Proclamation.

Proclamation No. 300/2002. Environmental Pollution Control Proclamation.

Proclamation No. 456/2005. Proclamation on Rural Land Administration and Land Use.

Standard Environmental Methodologies and Procedures Manual. Volume I. Ethiopian Roads Authority, Addis Ababa. 1999.

Tauro, F., Cornelini, P, Grimaldi, S., Petroselli, A., 2018. Field studies on the soil loss reduction effectiveness of three biodegradable geotextiles in Journal of Agricultural Engineering 2018; volume XLIX: 799, pp. 117-123

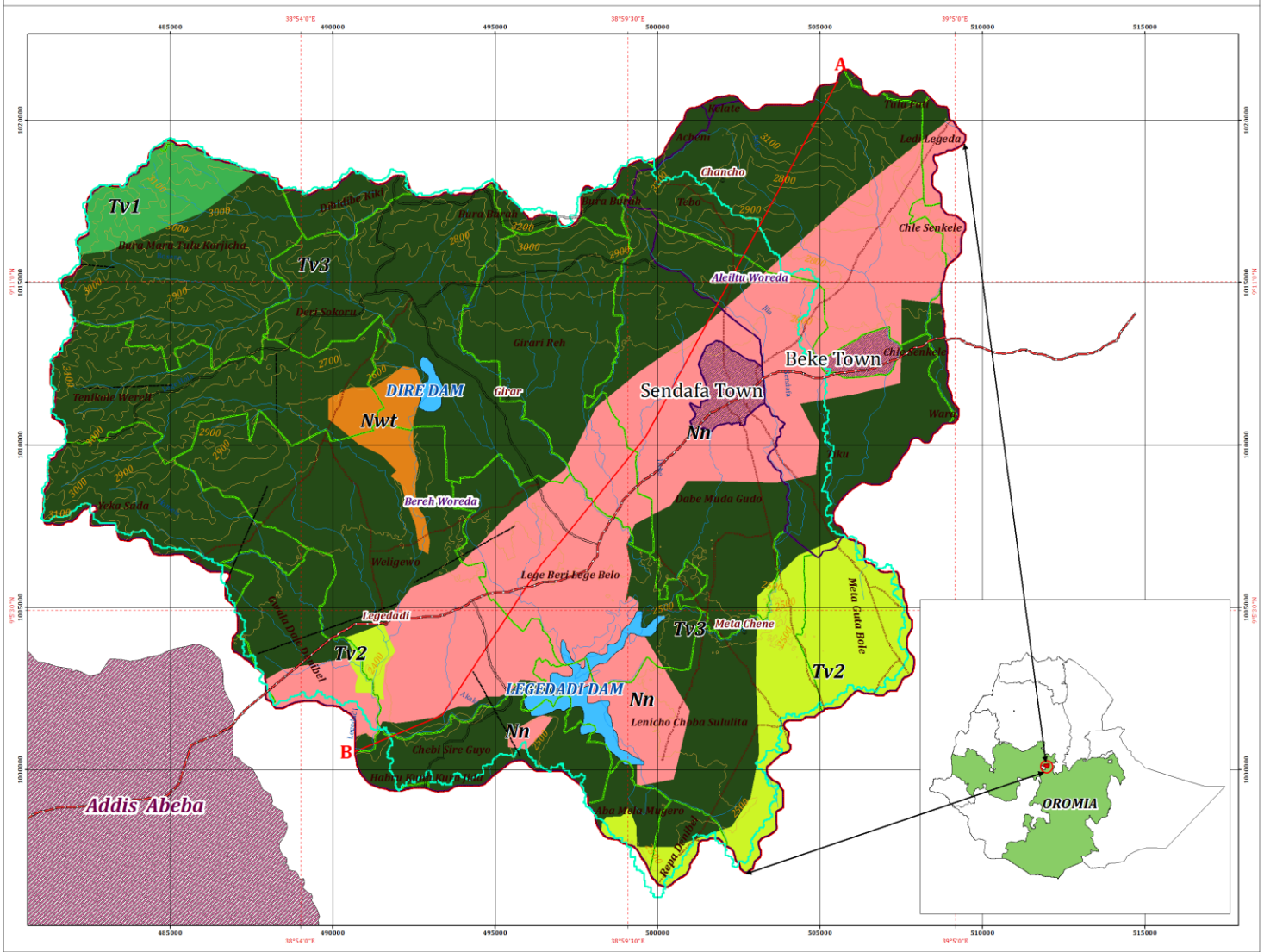
Useful Trees and Shrubs for Ethiopia. Identification, Propagation and Management for Agricultural and Pastoral Communities. Azene Bekele-Tesema with Ann Birnie and Bo Tengnäs.

Zhao, J., Yang, Z., and Govers, G., 2018. Soil and water conservation measures reduce soil and water losses in China but not down to background levels: Evidence from erosion plot data

Annexes

Annex A
Geological Map

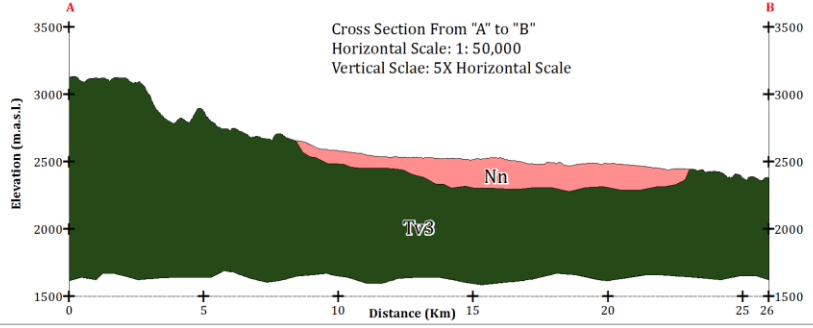
GEOLOGICAL MAP OF IWRM4WASH PROJECT- UPPER GREAT AKAKI CATCHMENT



Horizontal Datum: WGS 1984
Vertical Datum: Mean sea level
Projection: Universal Transverse Mercator, Zone 37N

Scale: 1: 50,000

4 2 0 4 8 12 Km



Legend

LITHOSTRATIGRAPHIC UNITS

Tertiary

Pliocene Volcanics

- **Nwt** — Wechecha Trachytes; trachyte lava flows and domes
- **Nn** — Nazareth Group (Lower): Welded pyroclastic flows, ash flow tuffs, pantelleritic ignimbrites

Miocene Volcanics

- **Tv3** — Termaber Basalts: Greyish, black, light to dark gray, transitional to alkaline, olivine-pyroxene phyric basalt with minor aphanitic basalts; mostly shield volcanoes
- **Tv2** — Middle Plateau Basalts: phyric (olivine-plagioclase, plagioclase-olivine,olivine,pyroxene-plagioclase phyric) basalts and minor aphanitic basalts; fractured and jointed

Oligocene Volcanics

- **Tv1** — Aiba Basalts: Flood basalts with rare basic tuffs, agglomarates, volcanic breccia

GEOLOGICAL STRUCTURE

---------- Lineament

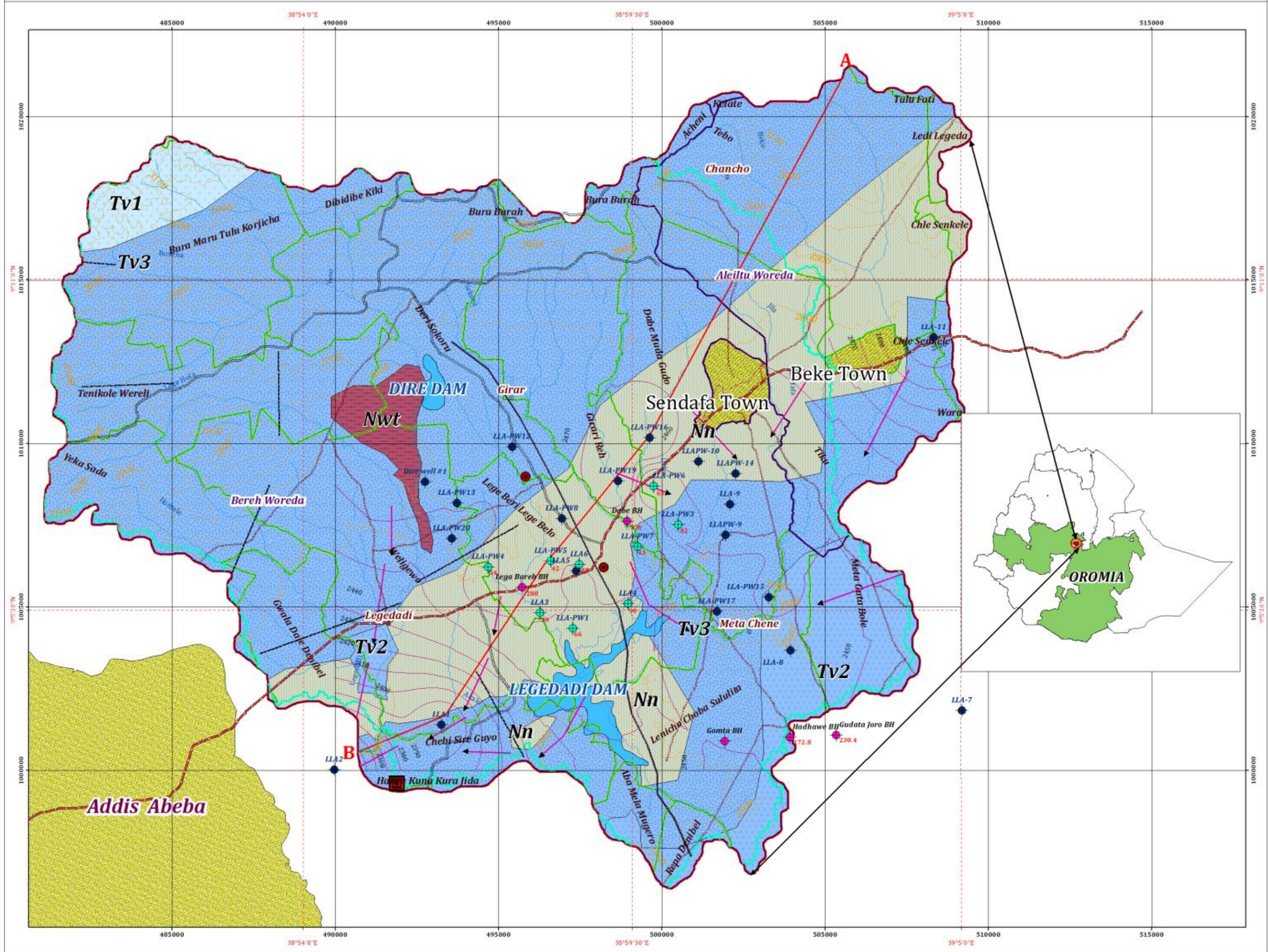
OTHER SYMBOLS

- Settlement/Village
- A B — Cross Section Line
- Contour Line (100m Interval)
- All Weather Road (Asphalt)
- All Weather Road (Gravel)
- Dry Weather Road
- Drainage
- Kebele Boundary
- Watershed Boundary
- Town
- Water Body
- Woreda Boundary
- Upper Great Akaki Catchment

October, 2020

Annex B
Hydrogeological Map

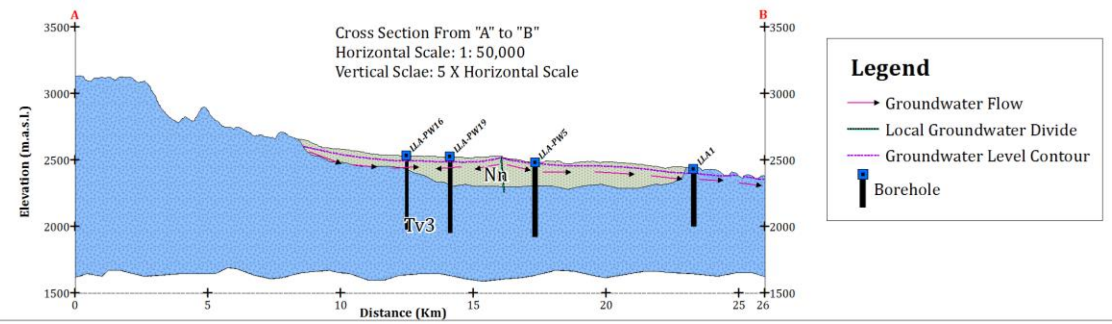
HYDROGEOLOGICAL MAP OF IWRM4WASH PROJECT- UPPER GREAT AKAKI CATCHMENT



Horizontal Datum: WGS 1984
Vertical Datum: Mean sea level
Projection: Universal Transverse Mercator, Zone 37N

Scale: 1: 50,000

4 2 0 4 8 12 Km



Legend

AQUIFER CLASSIFICATION

Aquifer Unit I: Extensive and moderate to high productive fissured basaltic aquifers which are mostly associated with and overlain by acidic volcanics. The depth to groundwater level is relatively deep with a static water level ranges between artesian (around north of Legedadi Dam) and 85.1 m.b.g.l. (around east of Beke Town). In general, groundwater is deeper at the eastern and central parts of the area. These aquifers exhibit moderate to high boreholes yield that ranges between 32 l/s at central part and west of Sendafa town and 117.41 l/s around east of Legedadi Dam and south of Sendafa town (average wells yield is about 79 l/s). The transmissivity value of this aquifer unit varies from 40.8 to 48600 m2/d with average value of about 5850 m2/d. Few deep wells with yield <10 l/s and low transmissivity recorded. The water quality of the groundwater in this unit is very good and categorized under fresh water that its average EC value is about 386.01 μs/cm.

Aquifer Unit II: Low to moderate yielding weathered, bracciated and fractured basaltic aquifer with small areal extent over the north western watershed boundary area. Groundwater occurrence constrained by closed porosity and limited recharge

Aquifer Unit III: Low to moderate productive fissured acidic volcanics aquifer with dual porosity (Primary porosity in acidic rocks and fractures in basaltic components). Groundwater within this aquifer unit is relatively shallower HDWs with SWL at 2.5 m recorded and they have moderate permeability (K=2.6 m/day) and average values of (SWL= 28 m.b.g.l., T= 12.7 m2/day) with average well discharge of about 10 l/s.

Aquifer Unit IV: Minor aquifer and localized aquicludes of rhyolitic and trachytic lava domes. They exhibit very low permeability (K=< 0.1 m/day), T= 9.9 m2/d, and wells' yield vary between 0.31 l/s and 1.8 l/s.

LITHOSTRATIGRAPHIC UNITS

Tertiary

Pliocene Volcanics

Nwt — Wechecha Trachytes; trachyte lava flows and domes

Nn — Nazareth Group (Lower): Welded pyroclastic flows, ash flow tuffs, pantelleritic ignimbrites

Miocene Volcanics

Tv3 — Termaber Basalts: Greyish, black, light to dark gray, transitional to alkaline, olivine-pyroxene phyric basalt with minor aphanitic basalts; mostly shield volcanoes

Tv2 — Middle Plateau Basalts: phyric (olivine-plagioclase, plagioclase-olivine,olivine,pyroxene-plagioclase phyric) basalts and minor aphanitic basalts; fractured and jointed

Oligocene Volcanics

Tv1 — Aiba Basalts: Flood basalts with rare basic tuffs, agglomarates, volcanic breccia

GEOLOGICAL STRUCTURE

Lineament

OTHER SYMBOLS

- Settlement/Village
- Borehole of Sendafa-Beke Water Supply (Daily Production (m^3))
- Borehole of AA Water Supply (Abstraction Rate (l/s))
- Borehole
- Hand Dug Well
- Abandoned Solid Waste Site
- Cross Section Line (A — B)
- Contour Line (100m Interval)
- All Weather Road (Asphalt)
- All Weather Road (Gravel)
- Dry Weather Road
- Drainage
- Local Groundwater Divide
- Groundwater Flow Direction
- Groundwater Contour Line
- Kebele Boundary
- Watershed Boundary
- Town
- Water Body
- Woreda Boundary
- UGA Catchment

© Geological Map Source: ATA, 2014

October, 2020

Annex C
Common Diseases in Berek Woreda

Top Ten of Most Common Diseases in Berek Woreda

S.NO	Ten top diseases	<1year		1-4year		5-14 year		15-29		30-64		>=65year		Total
		M	F	M	F	M	F	M	F	M	F	M	F	
1	Acute upper Respiratory infection unspecified)	247	200	572	518	370	797	548	829	299	367	71	64	4882
2	Tonsillitis (Acute *pharyngitis* unspecified)	186	105	694	588	492	454	452	1446	214	192	22	14	4859
3	Typhoid Fever	0	1	16	15	142	146	615	895	580	576	58	81	3125
4	*Diarrhea*	314	219	730	498	156	219	236	255	198	147	30	33	3035
5	*Dyspepsia* (in ability to swallow)	0	0	15	5	69	100	409	909	309	499	43	64	2422
6	Fever (fever of other and unknown origin	34	35	94	96	328	134	337	599	255	275	16	47	2250
7	Typhoid Fever (with other Complication)	1	1	16	8	96	69	403	651	364	430	85	43	2167
8	Common cold (Acute *nasopharyngitis*)	279	240	421	350	150	108	151	133	107	87	32	29	2087
9	Urinary tract infection	1	7	11	21	31	49	297	605	288	438	57	89	1894
10	Typhus Fever	0	0	17	9	110	98	334	417	286	326	74	23	1694

Source: district Health Office, 2020

Annex D
Socioeconomic results from FGDs

Socioeconomic results obtained from the FGDs

The discussants reflected trends they observed on their socio-economic wellbeing in the last five years. The FGD discussant highlight among other dispossession of farm land by different development activities for which they perceived as a treat to construct sustainable means of livelihood for dispossessed community members. FGD Discussant voice their concern on the following issues for which member of the study community perceive as challenges to earn means of livelihood and or to improve their living standard.

1. Unemployment
2. Difficulty and continuous struggle to cover living cost
3. Lack of access road within the village & poor maintenance of existing road
4. Lack of animal feed
5. Lack of veterinary professionals
6. Frequent baseline survey with no or little response to the community inquiries
7. Flood problem during the rainy season soil erosion because of high runoff during the rainy season
8. Formation of Gully because of high runoff
9. Poor quality of education for children
10. School dropout
11. High production cost for agriculture & less return
12. Change in type of crop produced because of crop diseases
13. Problem with supply chain of agricultural impute
14. Shortage of potable water
15. Bad smell produced by odor produced from communal latrine
16. Absence of designated places for solid & waste water disposal
17. Over cultivation existing farmland
18. Lack of budget to support community development
19. Absence of electric power and frequent interception even fro villages get connected to the main grid
20. Decrease of production because of loss of soil fertility
21. Untimely supply of agricultural impute
22. Lack of rural credit & high interest rate of tradition lender up to 15% per month
23. Food insecurity
24. Shortage of land for agriculture
25. Animal diseases
26. Encroachment of development activities such water reservoir, floriculture & Government forest and different investment/ dispossession of land that was serve for crop cultivation & grazing
27. Access to safe water & sanitation facilities
28. High production cost among other because of inflated price of selected seed variety, fertilizer, herbicide & pesticide
29. Crop disease
30. Poor management of community latrine & lack of water for Slum area in Sendafa town
31. Dislodging of community toilet is handled by community contribution
32. Absence of storm water & drainage channel in the town of Sendafa-Beke
33. Absence of independent toilet for male & female among slum area dweller user of communal toilet
34. High price of livestock & human medicine
35. Earn living from the sale of firewood for which female member of the community involved

List of KII Participants

Ser. No	Full Name	Organization	Position	Telephone Number
1	Seyum Demsie	SWSSE	Head, Human Resource	0911381299
2	Mengesha Guta	"	Head, Planning	0923994134
3	Seyum Hirko	Health Office	Acting Head	0911984465
4	Lelisie Kna'a	Health Office	Expert	0911566254
5	Mengistu Kena'a	"	Office Head	0913613039
6	Fekedu Telila	"	D/ Office Head	
7	Lema Negash	WMEO	Office Head	0922570542
8	Hussen Temam	"	Expert	0933205121
9	Yasin Zika	Livestock & Fisher	Office Head	0921131309
10	Fikedu Girma	"	Expert	0921594719
11	Dereje Megarssa	Agriculture Office	D/ office Head	0912350798
12	Abas Hase	Education Office	Expert	0923073761
13	Negash Alemu	"	Expert	0973134134
14	Gutama Fikedu	"	Expert	0935090403
15	Abonesh Zerfu	Finance Office	Expert	09158819

List of FGD Participants

Dire Sokoru Kebele Date 10/09/2020

Ser. No	Full Name	Sex	Age
1	Fata Kebede	M	46
2	Berenu Kebede	M	45
3	Abebe Ragassa	M	70
4	Fekedu Sanyi	M	69
5	Tesfaye Demisie	M	49
6	Bekelu Mamo	F	48
7	Deferu Lema	M	55
8	Sime Hirko	M	72
9	Bekelu Teso	F	28
10	Shura Kadiro	M	45
11	Debele Teka	M	32
12	Degafa Negesh	M	32
13	Sisey Beyene	M	27
14	Nasir Hussen	M	30
15	Zewiditu Assefa	F	23
16	Tedese Hunde	M	48
17	Dita Hundie	M	34
18	Batutu Mengistu	M	30
19	Tigst Hailu	F	26

Lega Bolo Lega Bari Date 14/09/2020

Ser. No	Full Name	Sex	Age
1	Dinke Worku	F	42
2	Alemu Bulbula	M	64
3	Bute Kumbi	M	50
4	Zewde Tulu	M	49
5	Yirgelem Worku	M	28
6	Mekonen Demsie	M	53
7	Rorisa Demsie	M	58
8	Merga Gerbi	M	52
9	Abera Debele	m	76
10	Gasu Hailu	M	45
11	Kebede Bejiga	M	45
12	Girma Negash	M	40
13	Gemechu Bedhene	M	58
14	Abera Ayene	M	60
15	Dirbe Raragassa	M	50
16	Asret Feyisa	M	31
17	Getecho Kebede	M	23
18	Dereje fikedu	M	21
19	Buruse Tefer	M	36

Sendafa Bake Town Date 17/09/2020

Ser. No	Full Name	Sex	Age
1	Legessa Kebede	M	35
2	Meserat Abera	F	49
3	Abdurezek Ahmed	M	44
4	Yerosan Dubere	F	21
5	Ketema Dinku	M	52
6	Abdu Faris	M	50
7	Ayelech Worku	F	55
8	Beleynesh Benti	F	27
9	Yeshmebet Bado	F	28
10	Askele Gebre	F	62
11	Tureta Shumi	F	70
12	Gezu Beshade	M	37
13	Aster Tsegaye	F	26
14	Lema Negassa	M	25

van Hogendorpplein 4
2805 BM Gouda

Telefoon: +31(0)182 – 686 424
Internet: www.acaciawater.com
Email: info@acaciawater.com