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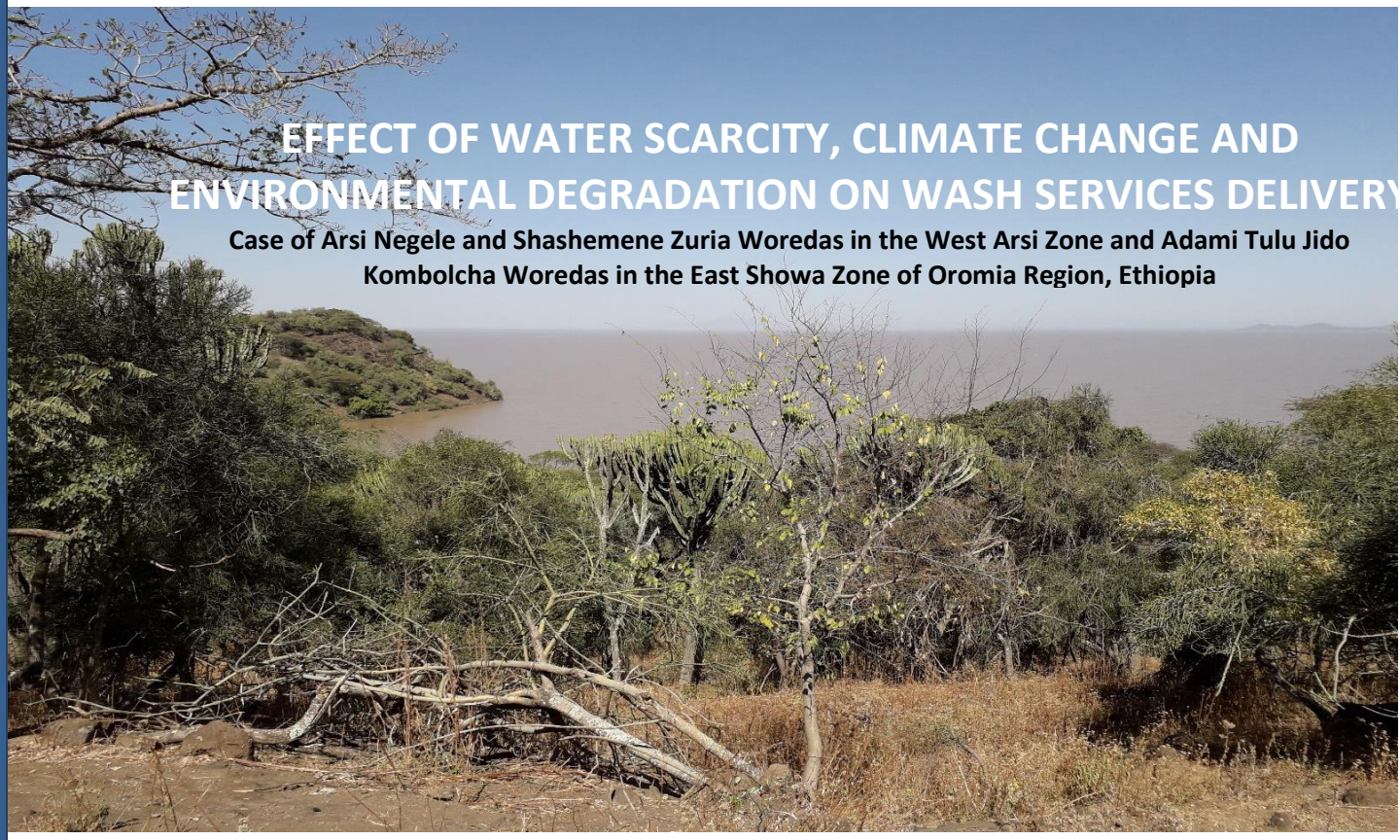

EFFECT OF WATER SCARCITY, CLIMATE CHANGE AND ENVIRONMENTAL DEGRADATION ON WASH SERVICES DELIVERY

Case of Arsi Negele and Shashemene Zuria Woredas in the West Arsi Zone and Adami Tulu Jido Kombolcha Woredas in the East Showa Zone of Oromia Region, Ethiopia

April 2020
Addis Ababa Ethiopia

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WETLAND INTERNATIONAL
ETHIOPIA OFFICE

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Issues and Revision Records

Date	Originator (s)	Checked by	Approved by	Document Description
April 2020	*Abebe L* *Ayalew K* *Chala Abebe* *Mikyas Wolde* *Berhanu R*	*Ayalew K*	*Abebe L*	*Final*

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ACRONYMS

ACF	Action Contre La Faim (Action Against Hunger)
ANCEDA	Arsi Nature Conservation and Environmental Development Association
ATJK	Adami Tulu Jido Kombolcha
CRVB	Central Rift Valley Basin
CRVBDO	Central Rift Valley Basin Development Organisation
ESIA	Environmental Social Impact Assessment
ESMP	Environmental Social Management Plan
FGD	Focus Group Discussion
HH	Household
HHS	Household Survey
IWM	Integrated Watershed Management
KII	Key Informant Interview
MCM	Million Cubic Meter
MOA	Ministry of Agriculture
MoWIE	Ministry of Water Irrigation and Energy
MOWR	Ministry of Water Resources
NGOs	Non-Governmental Organizations
NMA	National Metrological Agency
NRM	Natural Resources Management
OWWDSE	Oromia Water Works Design and Supervision Enterprise
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goal
TOR	Terms of Reference
WASH	Water Sanitation and Hygiene
WRDA	Water Resources Development Act
WUA	Water User's Association

EXECUTIVE SUMMARY

The Central Rift Valley (CRV) of Ethiopia is a vital region in terms of its enormous ecosystem services (ES) and augmented biodiversity. Nevertheless, its ecosystem service and biodiversity are under extreme stress from rapid population growth, unjustifiable developmental activities, unscheduled urbanization, uncompromising agricultural spreading out, climate change, and the associated changes in land use and land cover (LULC). The negative influences of the continuing natural resources outrageous conditions challenged the livelihood of communities as well as the ecosystem in the CRV.

The Emerging challenges of climate change coupled with the non-climatic factors like the ever-increasing population are exacerbating the problem of overexploitation of the limited natural resources which is resulted in Environmental Degradation. Environmental degradation can only be remedied by restoring some of the functions of the ecosystem, helping the partially restored system improve itself naturally, removing stressors, restoring habitats that have been lost and improving the robustness of the ecosystem to absorb human stresses.

Some of the aquatic ecosystem functions can be restored by a combination of engineering, hydrology, ecology, and phytotechnology (i.e. using and harvesting plants to remove nutrients and contaminants from water) solutions to improve the healthiness of the river mouth ecosystem. Previous studies indicate that the capacity and efficiency of wetlands to remove pollutants (nutrients, suspended solids, and metals) from water has led to the widespread use of wetlands to improve the quality of floodwater runoff from urban catchments and agricultural lands.

Improving WASH is a key way to reduce inequalities – data from the World Health Organization and UNICEF, among others, indicate that it is the poorest, the young and the elderly, excluded groups and women and girls who suffer most from poor WASH services. Better WASH means higher levels of school achievement and greater productivity.

The WASH SDG Program in Ethiopia is working on achieving sustainable and equitable use of WASH (water, sanitation, and hygiene) by all following the three strategic objectives below:

- Improving behavior change interventions leading to increased demand for improved WASH facilities and practices;
- Improving WASH service provision leading to increased availability and affordability of WASH products and services, which contributes to sustainable and equitable access to WASH;
- Strengthening the WASH governance and institutional framework leading to governments enabling efficient and effective delivery of inclusive and sustainable WASH services, which contribute to sustainable and equitable WASH.

Currently, the natural resources base in Ethiopia is under increasing population pressure and inappropriate farming and management practices. Small-scale farmers increasingly facing risks from land degradation, overgrazing, and deforestation especially for the expansion of agriculture fields. There is also a widespread problem of recurrent drought, erratic rainfall and water scarcity, shortage of pasture and food insecurity.

Increased competition for the limited water resource has resulted in the rapid depletion of sources which in turn creates an unmanageable water scarcity problem. Such scarcity of resources also results in conflicts between upstream and downstream users of land, forest, and water. On the other hand, the increase in temperature and reduction of rainfall cause reduced stream flows in major catchments, reduced recharge of groundwater, reduced inflows to water storages, or intensified droughts.

Data generation for the present study was made through the application of several metrological components. The first component consisted of the administration of household surveys, the second component was made up of focus group discussions, and the final component involved key informant interviews. As additional triangulation, the relevant secondary data were collected and reviewed, and personal observations were made.

The household surveys, focus group discussions and interviews complemented each other and verified the collected data. While walking through the area, the study team made observations of the resources and of people's behaviors and activities, which also helped in the triangulation of the collected information and the generation of new questions for the interviews or discussions.

The study was conducted in the Ziway-Shala Basin particularly in the three Woredas, namely, Arsi Negele, Shashemene Zuria, and Adami Tulu Jido Kombolcha Woredas. The study was conducted based on the following specific objectives:

- Assessing how water scarcity effect on WASH services delivery in the project areas;
- Assessing the impacts of climate change on WASH services delivery in the project area.
- Assessing how environmental degradation affects WASH services delivery.
- Assessing the link to food security, livelihoods and disaster risks.
- Assessing the capacity of WASH sector stakeholders to assess the effects of climate change on water resources and other WASH-related issues and plan for interventions in the WASH sector.
- Draw applicable operational and policy recommendations based on the research findings

As the study findings show, water scarcity is associated with the increased experience of overexploitation, pollution, siltation, and uncontrolled population growth which in turn are mentioned as key factors to exacerbate water scarcity, affected the WASH Service Delivery to a noticeable level. Similarly, lack of ESIA and ESMP for big investment projects created an opportunity for water bodies to be polluted by waste disposal and agrochemicals. Besides, high water abstraction from Lake Ziway and rivers like Bulbula contributed to severe water scarcity.

Also, it was noted during the FGD and KII discussions, floods and drought have a triggering effect on poor WASH Service Delivery. For example, floods frequently trigger major destruction to basic facilities such as water supplies, sanitation, waste disposal systems, and other essential services.

On the other hand, drought instigates water scarcity, so people are more prospective to use insecure water sources such as polluted rivers, streams and lakes. Moreover, the finding indicates that deforestation and land degradation are the most depressive problems in the study area. Hence, environmental protection needs to be enhanced and promoted. Social capital and welfare of farmers are highly interlocked to agriculture, and land for this purpose must be managed appropriately in a sustainable manner.

As per the projection made for the coming 45 years, the available water is by far less than the projected demand in the scenario period. Hence, it will not satisfy the demand in the coming 30 years even under advanced irrigation systems. The projection is grounded on the main water demanding sectors. The main water demanding sectors in the basin are irrigation, industrial, domestic, livestock, and environmental flow requirement. The main challenge faced in the CRV is, more than 95% of the water consumption is from irrigation. The current annual water demand of the area is 566.73MCM (Oromia Water Works Design and Supervision Enterprise, OWWDSE, in Gadissa et al., 2019).

1. INTRODUCTION

1.1 General

According to Eyasu et al (2019), Central Rift Valley (CRV) of Ethiopia is a vital region in terms of its enormous ecosystem services (ES) and augmented biodiversity. Nevertheless, its ecosystem service and biodiversity are under extreme stress from rapid population growth, unjustifiable developmental activities, unscheduled urbanization, uncompromising agricultural spreading out, climate change, and the associated changes in land use and land cover (LULC). The negative influences of the continuing natural resources outrageous conditions challenged the livelihood of communities as well as the ecosystem in the CRV.

On the other hand, exposure to climate change is related to adverse effects in temperature rise, heavy rain, floods and recurrent drought throughout the globe. Studies over the past two decades have provided important information on climate change. Surveys such as that conducted by IPCC (2014) have shown that climate change is evolving as a principal risk on crop growing and animal husbandry, food security and livelihood of lots of people whose number is in millions in various locations of the globe. Also, many studies have begun to examine climate change effects on crop growing and animal husbandry (Kumar et al., 2014; Lobell et al., 2012). In this regard, agriculture will possibly considerably be obstructed as a result of the failure of rainfall and temperature increase.

Over the past decade, most research in climate change and much of the current literature on climate change pays particular attention to the impact of climate change on global and sectoral aspects, overlooking the unforeseen effects on WASH service delivery at a local level. Limited studies tried to capture the unforeseen impact of change in climate on WASH Service Delivery. This study has given due attention to examining the Effect of Water Scarcity, Climate Change and Environmental Degradation on WASH Services Delivery in Arsi Negele and Shashemene Zuria Woredas in the West Arsi Zone including Adami Tulu Jido Kombolcha Woredas in the East Showa Zone of Oromia Region, Ethiopia.

Extensive research (Howard et al. 2010 in Prabhakar et al.,2016; Brakes & de Roda Husman 2013; Hutton & Chase 2016;) has shown that climate change has substantial ability to aggravate water stress and insecurity, increase incidences of water-transmitted infectious diseases, slow or reverse the progress of improved WASH coverage, exacerbate inequalities, and undermine the achievement of related Sustainable Development Goal (SDG) targets and human rights concerning water, sanitation, and hygiene (WASH) services.

According to the World Bank (2008), inadequate WASH, directly and indirectly, affects public health. Directly, poor WASH causes diarrheal infections and other health effects, which in turn lead to mortality, especially in young children. Indirectly, poor WASH contributes to poor nutritional status in young children who experience diarrheal infections. Problems related to water supply and health are intensified where industrial pollutants contaminate water systems because treatments that control infectious agents do not effectively remove many toxic chemicals from drinking water.

1.2 Objective

The overall objective of this study is to conduct a comprehensive assessment of how water scarcity, climate change, and environmental degradation affect WASH (Water, Sanitation and Hygiene) services delivery in the WASH SDG program intervention areas.

The specific objectives of this assessment are:

- Assess how water scarcity effect on WASH services delivery in the project areas;
- Assess the impacts of climate change on WASH services delivery in the project area;
- Assess how environmental degradation affects WASH services delivery;
- Assess the link to food security, livelihoods, and disaster risks;
- Assess the capacity of WASH sector stakeholders to assess the effects of climate change on water resources and other WASH-related issues and plan for interventions in the WASH sector;
- Draw applicable operational and policy recommendations based on the research findings;

This study addressed the following overarching questions:

- What are the vulnerabilities of climate change in the target/WASH Project areas?
- What can the WASH projects do to tackle the insecurities of access to water and sanitation?
- How the sanitation system is affected by climate change either directly or indirectly?
- Why should IWRM be of importance to WASH projects?
- Why should emergencies and Disaster Risk Reduction be the attention of WASH projects?
- Why should climate change funding be of relevance to WASH projects?
- Why should climate change mainstream be of importance to existing development programs?
- Do drought and dry-spell durations have implications for the sustainability of WASH services

1.3 Limitation and Scope of the Study

The study was limited geographically to Arsi Negele and Shashemene Zuria Woredas in the West Arsi Zone and Adami Tulu Jido Kombolcha Woredas in the East Showa Zone of Oromia Region, Ethiopia. In total, there are 10 Woredas (altitude ranges from 1400 to 4000 m a s l) in the Central Rift Valley of Ethiopia. The study focuses on the Water Scarcity, Climate Change and Environmental Degradation effect on WASH Services Delivery. These Woredas specifically oriented in the Ziway-Shala Sub-basin.

2. BACKGROUND

2.1 Natural Resource Management

Natural resource base covers a wide range of physical resources (e.g. water, air, climate, soils, and minerals), and biological resources (e.g. flora, fauna, agricultural produce, ecosystems services and management units, such as watersheds and common property areas). Proper integration, normal interaction, and management of these resources are essential for the healthy functioning of the ecosystem and the survival of biota within and around including the wetlands.

Natural resource management refers as a scientific and technical principle that forms a basis for sustainable management (conservation and use) and governance of natural resources such as land, water, soil, plants, and animals, with a particular focus on how management affects the quality of life for both present and future generations. It is widely recognized that natural resources contribute significantly to development in different ways: as an economic activity and source of growth; as a livelihood, by providing jobs for people; and as a provider of environmental services that can have both good and bad outcomes (Ochola et al., 2010).

One of the challenges in Africa's development is related to the rapid rate of degradation of natural resources due to a complex combination of factors. Such degradation reduces the natural resources both quantitatively and qualitatively thereby compromising development activities based on these resources to fight poverty promote security and preserve the ecosystem that poor people rely on for their livelihoods, the government must place pro-poor economic growth and environmental sustainability (Ochola et al., 2010).

However, in the past, most conservation policies and strategies of governments were founded on the simplistic idea of separating people from their environments. Vast areas of the tropics were declared protected areas for conserving biodiversity and ecosystem services.

Currently, the natural resources base in Ethiopia is under increasing population pressure and inappropriate farming and management practices. Small-scale farmers increasingly facing risks from land degradation, overgrazing, and deforestation especially for the expansion of agriculture fields. There is also a widespread problem of recurrent drought, erratic rainfall and water scarcity, shortage of pasture and food insecurity.

Natural resources, agriculture, and human activities are highly interrelated in Ethiopia (Emama et al., 2015). The country's natural resources base, soil, water, and forests are the foundation of any economic development. Currently, forest lands are widely used for cultivation, grazing, and wood extraction (MEFCC, 2018). The annual loss of the highland forest area has been estimated to be between 150,000 ha to 200,000 ha (Bongers and Tennigkeit, 2010). From the total wood product demand in 2015, wood consumed in the country (production + import-export) was about 130.3 million m^3 round wood equivalents (RWE). About 92.3% of this amount consumed in a form of wood fuel. The demand for wood fuel could be increased in the future as the population is getting increased. In 2015 the annual

volume of wood harvested for wood fuel was approximately 120.4 million m^3 RWE (115.024 million m^3 as firewood and 5.408 million m^3 for conversion into charcoal (MEFCC, 2018 in FSR, 2015). Furthermore, deforestation is an increasingly rising surface run-off and causes biodiversity loss which is an important source of genetic diversity in the country (Assefa and Bork, 2014). Thus, arresting deforestation and enhancing the source of rural energy (particularly for cooking and lighting) is vital to addressing food security, rural poverty and NRM (EPA, 1994).

2.2 Soil and Water Conservation

Soil plays a significant role in the maintenance of a climate favorable to life as it contributes to the regulation of the carbon cycle and its consequent effects on climate change (Daba et al., 2018; FAO, 2014b). Soil processes help regulate climate, including the thermal and moisture balance, greenhouse gases, and particulates in the atmosphere. Soil can also adversely impact the maintenance of air quality (FAO and ITPS, 2015).

Soil supports all life on earth and is the most valuable natural resource to mankind. Due to the increased demand for food and fiber, in many parts of the globe forests and grasslands are converted to farmlands. The conversion of vegetation to agriculture often increases soil erosion and crop production and food security (Pimentel and Burgess, 2013).In addition to erosion, soil chemical and physical properties may be affected by agricultural practices. These include loss of soil structure, nutrient depletion, compaction, intensification of soil salinity and other. The effect of soil erosion not only leads to the loss of fertile land but also affect Rivers and lakes through sedimentation. It also shortness the life of hydraulic structures and challenges the intended purpose it is built for. Degraded land may reduce water holding capacity and is susceptible to flooding. Therefore, soil health should be a concern of many farmers in the developing countries whose livelihoods are depending on mainly agriculture and sustainable land management practices may prevent soil degradation and erosion.

Soil erosion is one of the causes of land degradation in most parts of the country causing a great amount of topsoil and nutrient loss, affecting agricultural productivity and threatening food security (Mekonnen and G/Michale, 2014; Taddese, 2001). The most common human-induced causes include deforestation, inappropriate agricultural practices such as over-cultivation (inadequate replacement of important nutrients into the soil) and overgrazing, and inappropriate institutional and policy applications (Suthcliffe, 1993; Mengistu et al., 2011; Wolka et al., 2015).

2.3 Land Use/Cover Change

The land use/cover change is a growing concern worldwide particularly in Ethiopia. Thus, studies over the past two decades have provided important information on land use/cover change. For instance, a study conducted by Bewketu and Ayenew (2015) analyzed land

use/cover change for Rift Valley Basin based on available data between the period of 1997 and 2008. As shown below in table 1, the result shows that there was an extensive expansion in cultivated land (91%) and a reduction in vegetation cover (80%) and Grassland (67.76%), respectively.

Table 1: Land Use/Cover Change in the CRVB

No	Land Use type	% Area Coverage (1997)	% Area Coverage (2008)	Change (%)
1	Cultivated land	43.25	82.58	90.94
2	Vegetation	39.18	7.81	-80.07
3	Grassland	11.86	3	-67.76
4	Water body	5.7	4.94	-0.13
5	Bare land	0.02	1.52	75
6	Urban area	0.002	0.14	69
	Total	100	100	

Source: Bewketu and Ayenew (2015)

2.4 Environmental Degradation

Ethiopia is endowed with diverse natural resources such as forest, soil, mineral, wildlife, climate, ecological diversity, and others. However, the country is not able to sustainably exploit the existing potential of natural resources because of various reasons. The Emerging challenges of climate change coupled with the non-climatic factors like the ever-increasing population are exacerbating the problem of overexploitation of the limited natural resources. Interventions like diversifying alternative livelihood options, promotion of environmentally friendly and climate-smart agriculture, strengthening of institutional arrangement for planning and actions for preserving the remaining natural resources could at least help to arrest further destruction and degradation of natural resources.

Environmental degradation can only be remedied by restoring some of the functioning of the ecosystem, helping the partially restored system improve itself naturally, removing stressors, restoring habitats that have been lost and improving the robustness of the ecosystem to absorb human stresses. Some of the aquatic ecosystem functions can be restored by a combination of engineering, hydrology, ecology, and phytotechnology (i.e. using and harvesting plants to remove nutrients and contaminants from water) solutions. The solutions can also help to improve the healthiness of the river mouth ecosystem. The healthiness of the inlet is controlled both by a few parameters, including the residence time, the river mouth sediment and water column food webs, and the buffer effect and the habitats bestowed by the periphery wetlands.

2.5 Climate Change

Climate change over the 21st century is projected to reduce renewable surface water and groundwater resources in driest subtropical regions (robust evidence, high agreement),

intensifying competition for water among sectors (Intergovernmental Panel on Climate Change (IPCC), 2014).

The increase in temperature and reduction of rainfall cause reduced stream flows in major catchments, reduced recharge of groundwater, reduced inflows to water storages, or intensified droughts. Water resources are believed to be particularly vulnerable to increased temperature and alternations in precipitation patterns (Daba et al., 2018). Climate change will also result in increased floods and drought, which will have significant impacts on the soil and water resource availability. According to the information obtained from participants, the watershed is becoming vulnerable to climate change as a result, it had experienced drought in 2009 and flood in 2005.

The participants also indicated that the magnitude of temperature in the area is increasing from time to time while the seasonal frequency of the rain is declining. Studies conducted in the rift valley also indicates that the current climate is getting much drier, hotter and worse for farming than it used to be (Ariti et al., 2015).

Climate is one of the major factors affecting the formation of soil with important implications for their use, development and management perspective regarding soil structure, stability, and topsoil water holding capacity, nutrient availability and erosion (Daba et al., 2018; FAO, 2014a; Pareek, 2017). Some of the soil properties that could be modified by climate change include organic carbon content, characteristics of soil biota, moisture and temperature regimes and processes such as erosion, salinization or physical, chemical or biological fertility (Daba et al., 2018; Hansen et al., 2007). The most common climatic parameters driving these changes would be temperature, rainfall (quantity, intensity, and temporal distribution), together with atmospheric chemistry, especially carbon dioxide and nitrogen and Sulphur compounds due to the increase in temperature and drought (Daba et al., 2018). The previous study conducted on Lake Ziway indicated that climate change impacted the flow of Ketar River. Flow reduction was observed during the rainy season 'Kiremt' on average. Showing a reduction of 10.78%, 17.58% and 19.23% for the periods of 2020s, 2050s and 2080s respectively (Abreham et al., 2018).

2.6 Wetlands

The term 'wetland' is used to describe places within the landscape that are inundated with water for all, or at least part of the year. Natural wetlands encompass a diverse range of aquatic ecosystems, ranging from permanently inundated environments such as freshwater lakes to variably inundated environments such as freshwater marshes/swamps.

The capacity and efficiency of wetlands to remove pollutants (nutrients, suspended solids, and metals) from water has led to the widespread use of wetlands to improve the quality of floodwater runoff from urban catchments and agricultural lands that rely heavily upon microbial processes to intercept, transform and remove pollutants from the floodwater. The presence of emergent aquatic plants within wetlands is crucial to the long-term performance of the wetland system, as the plants play a major role in the uptake of nutrients, and the health of the wetland sediments and microbial communities. The key treatment mechanisms associated with constructed water treatment wetlands are summarized as follows.

1. **Physical Removal**
   - Sediment capture; vegetation in the wetland facilitates enhanced sedimentation of particles down to the fine colloidal fractions.
   - Adsorbed pollutant removal; a high proportion of adsorbed pollutants are removed through the capture of fine particles.
   - The presence of vegetation minimizes the likelihood of widespread re-entrainment of trapped sediments.

2. **Biological and Chemical Uptake**
   - Dissolved pollutants uptake epiphytic biofilms present on the surface of the aquatic vegetation uptake dissolved pollutants.
   - Chemical adsorption of pollutants to fine suspended particles are removed through enhanced sedimentation and adhesion facilitated by macrophytes and biofilms.

3. **Pollutant Transformation**
   - The regular wetting and drying cycle within wetlands lead to more stable sediment fixation of contaminants (such as phosphorus and metals) in the substratum.
   - Microbial processes such as nitrification and denitrification result in nitrogenous pollutants such as ammonium and nitrate being converted to nitrogen gas and being dispersed into the atmosphere.

Wetlands, therefore, need to be carefully designed or protected to provide the best conditions for plant growth to ensure the long-term performance of the wetland.

2.7 WASH Services

Water, sanitation, and hygiene – WASH [1] – are among the most basic human needs. WASH is essential to good health – the leading medical journal, The Lancet, cites access to sanitation as one of the key social determinants of health, and one that should be part of any post-2015 agenda. Improvements to WASH represent a good economic investment. Some countries lose as much as 7% of GDP because of inadequate sanitation. Improving WASH is a key way to reduce inequalities – data from the World Health Organization and UNICEF, among others, indicate that it is the poorest in most parts of the world and the young and the elderly, excluded groups and women and girls are who suffer most from poor WASH services. Better WASH means higher levels of school achievement and greater productivity. Children learn more when they are not missing school because of diarrheal disease and workers are more productive when they are not sick, or kept home caring for others who are. WASH is also closely linked with dignity, and in 2010 the UN General Assembly recognized WASH as a basic human right, a decision echoed by the Human Rights Council later that year.

2.8 WASH SDG Program

According to the ToR prepared for this study, the WASH SDG Program in Ethiopia working on achieving sustainable and equitable use of WASH (water, sanitation, and hygiene) by all following the three strategic objectives:

- Improving behavior change interventions leading to increased demand for improved WASH facilities and practices;
- Improving WASH service provision leading to increased availability and affordability of WASH products and services, which contributes to sustainable and equitable access to WASH;
- Strengthening the WASH governance and institutional framework leading to governments enabling efficient and effective delivery of inclusive and sustainable WASH services, which contribute to sustainable and equitable WASH.

2.9 Policy and Institution

There are supportive policy and legal frameworks that facilitate improved WASH development and the use of natural resources. Several strategies and policies refer to and support the need for WASH development, natural resources management and conservation, community participation.

The WASH service delivery is managed by the Woredas water offices. In some regions, the exclusive government body is institutionalized with regional offices to take care of water resources development including for irrigation development.

There are supportive policy and legal frameworks that facilitate the participatory plan, development, and use of natural resources. Several strategies and policies refer to and support the need for the development of natural resources, community participation and diversified agriculture for improving land productivity and community livelihood.

Rural development policy promotes the protection and preservation of natural resources, which in turn contributes to increased agricultural productivity at the same time achieving sustainable development. It also provides provisions for proper use and management of agricultural land, which implies improving land productivity by encouraging different conservation and rehabilitation mechanisms, and rational utilization of the country's land resource. Food Security Strategy focuses on environmental rehabilitation to reverse the current trend in land degradation and contributes to food security. Natural Resources and Environment Policy opt to improve and enhance the health and quality of life of all Ethiopians by promoting sustainable social and economic development through sound management and use of natural, human-made and cultural resources and the environment as a whole.

Plan for Accelerated and Sustained Development to End Poverty (PASDEP) which has been updated as Growth and Transformation Plan (GTP) represent the continuation of emphasis given to Environment and Development and highlights that environmental resources are the foundation of social and economic development as they are the sources of goods and services needed for poverty reduction and economic growth; and that their mismanagement coupled with their underutilization has so far reduced their contribution to Ethiopia's overall development. The PASDEP prioritized sustainable land management and sector-specific strategies to address the problem of land degradation and desertification comprehensively.

Environmental Policy of Ethiopia set Strategic Goals towards the Realization of the Environmentally Sound Development Vision of Ethiopia. Conservation Strategy of Ethiopia

emphasizes the importance of incorporating environmental issues into development activities right at the initial stage of development. Proclamation on Conservation, Development, and Utilization of Forests, provide for the Conservation, Development, and Utilization of Forests. It aims at promoting the integration of trees into the farm landscape, protecting the land against degradation by soil erosion, floods, landslides, desertification and other effects of ecological imbalances, and to conserve ecosystems and genetic resources.

The Regional Rural Land Use and Administration Proclamation address that 'if a land user does not properly use and protect his land, he shall lose his use right'. Community-based Participatory Watershed Development guidelines and the Land-use certification are also believed to strongly support participatory watershed development initiatives. The community Watershed Development Strategy reconciles watershed logic with community participation, the Ethiopian Strategic Investment Framework for Sustainable Land Management rebuild Ethiopia's natural capital assets by overcoming the causes and mitigating the negative impacts of land degradation on the structure and functional integrity of the country's ecosystem resources. "In the constitution of Ethiopia, the need and importance of natural resources management has been indicated to show the emphasis given by the people and the government.

Fisheries Development and Utilization proclamation, (Proc. No. 315/2003) were issued in January 2003 to ensure fish biodiversity and its environment as well as to prevent and control overexploitation of fishery resources, increase supply of safe and quality fish and ensure the sustainable contribution of fisheries towards food security and expand aquaculture development. The proclamation has established with a requirement that a person who undertakes commercial fishing or aquaculture should first obtain a permit. Also, it establishes a requirement for a permit for subsistence fishing in national parks or fishery reserved areas, fishery research and for transferring fish between different water bodies.

Conservation, Development, and Utilization of Forests Proclamation (Proc. No. 94/1994) were issued to provide the basis for sustainable utilization of the country's forest resources and ensure the conservation of existing forests and establishment of State Forests. The law prohibits the felling of Hagenia abyssinica, Cordia africana, Podocarpus gracilior, Juniperus procera, and Olea africana. It provides the power for designation, demarcation, and registration of forests to the then Ministry of Agriculture and Regional Governments. The proclamation then goes on to give some specific direction for the utilization of State and Regional Forests, and lists prohibited activities within protected forests.

Community-based Participatory Watershed Development guidelines and the Land-use certification are also believed to strongly support participatory watershed development initiatives. The community Watershed Development Strategy reconciles watershed logic with community participation, the Ethiopian Strategic Investment Framework for Sustainable Land Management rebuild Ethiopia's natural capital assets by overcoming the causes and mitigating the negative impacts of land degradation on the structure and functional integrity of the country's ecosystem resources. "In the constitution of Ethiopia, the need and importance of

natural resources management has been indicated to show the emphasis given by the people and the government.

However, coordination and cooperation among GO and NGOs appear limited. For instance, there are several interests in water utilization by different organs and individuals. But they rarely attempt to contribute to watershed management and the GO and NGOs commonly operate separately and their effort poorly coordinated to create pooled strength for complementing achievement. Therefore, considering the promising policy framework, institution arrangement and government effort to enhance watershed resource management, all institutions need to operate in a coordinated approach.

The common lands lack enforcing institutions and considered as land under weak ownership. It has been exposed to overexploitation and degradation. The interventions on such land are less sustainable as everyone wants to take resources from it and rarely individuals attempt to invest or manage it and thus expressed precisely as 'the tragedy of commons. Such challenges recognized in watersheds where this survey carried out. Therefore, property rights should be defined properly.

2.9.1 Policy and Legislation of WASH in Ethiopia

There is no distinct policy and legislation about WASH despite there is one WASH National program that was initiated by the Federal Democratic Republic of Ethiopia to facilitate the WASH Service Delivery Program. Besides, there is the WASH SDG program which is in line with the Sustainable Development Goals (strategy 6). Previous research (e.g. Roger et al, 2015) has established that Ethiopia has made immense progress in extending access to safe water over the last two decades, but sustaining systems and services remains a huge challenge.

In addition to the above facts, the Federal Government has established water resources development policy through its Ministry of Water Resources (MoWR), in which a clear framework of water resource development as a way of creating a conducive environment for the sectors was developed.

In a study by the Ministry of Water Resources (2002) on water sector development program, different variables are related to water resources with its current per-capita freshwater resources estimated at 1,924 m^3, Ethiopia is endowed with one of the largest surface freshwater resources in sub-Saharan Africa. However, only 2 percent of the potential is annually utilized, 86 percent of that going to irrigated agriculture. On the other hand, Ethiopia's land resource potential for irrigation development, disregarding available water, is very large.

Ethiopia's various resource potentials have been identified and described in different master plans for integrated development of major river basins.

Both the urban and rural water supply and sewerage coverage in Ethiopia are low. Various sources of information cite figures for water supply coverage but often differ because data is not accurately recorded.

Although Ethiopia has not yet formally articulated a national, long-term development vision, elements of a vision are available in the various national and sectoral policy or legislative frameworks.

Prosperity and harmony emerge from the emphasis given to development, peace, and democracy in the draft Second 5-Year Programme. The Poverty Reduction Strategy Paper elaborates those vision elements through a road map for reducing poverty and promoting development via pro-poor growth strategies, good governance, decentralization, and empowerment, without necessarily setting a target such as that in the Millennium Declaration Goal of reducing poverty by 1 half by the year 2015.

One of the policies of water in relation to Policy on Cross-Cutting Issues is Recognition of the basic minimum requirement, as the reserve (basic human and livestock needs, as well as environment reserve) has the highest priority in any water allocation plan (MWR, 2001).

The existing Ethiopian water sector policy is extensive and focuses particularly on Environment, Watershed Management, Water Resources Protection, and Conservation

The Environment Part combines environment conservation and protection requirements as integral parts of water resources management. Besides, it encourages that Environment Impact Assessment and protection requirements serve as part of the major criteria in all water resources projects. On the other hand, the Watershed Management Promote practices of efficient and appropriate watershed management to maximize water yields and quality. Also, it Ensures that watershed management practices constitute an integral part of the overall water resources management.

In the case of the Ethiopian Water Resources Management Policy, the policy supports Water Resources Protection that paves the way to create appropriate mechanisms to protect the water resources of the country from pollution and depletion to maintain sustainable development and utilization of water resources. Also, it set up standards and classification for various uses of water in terms of quality and quantity for different scenarios incorporating thresholds and arrays for appropriate and acceptable levels. Above and beyond, ascertain procedures and mechanisms for all whereabouts that are damaging to water resources including waste discharges, source development, catchments management, etc. the other important issue contained within in the policy is water resources conservation that gives due emphasis on how to conserve water resources through the integration of appropriate measures in the main water use categories.

Although the reality is different on the ground, one of the policy issues is technology and engineering that considers as core issue standards and design criteria which in turn, has given due attention to formulation and adoption of national standards and criteria for the design,

installation, construction, operation, maintenance, inspection, and other activities in all water resources management undertakings.

2.9.2 Institutional Arrangement

Although the intuitional arrangement at higher-level changes, the Water User's Association (WUA) is a stable institution at the community level. Traditional irrigation systems were used to be developed and managed through the Water User's Association. The WUA plays functions of construction, water allocation, operation, and maintenance and were headed by individuals (Belay and Bewket, 2013). This association comprises up to 200 users grouped into 20 to 30 groups of farmers who share a common main canal or its branches (MoA, 2011a).

According to the National Hygiene and Sanitation Strategy for Ethiopia (2005), a was committee is organized from the National to Kebele level. At the kebele level, the committee consists of the Kebele executive committee, health post, Water and Sanitation (WatSan) Committee, school director, Traditional Birth Attendant (TBA), and or Community Health Worker/Agent (CHW/A), development agents, Women's Groups, Community Based Organizations (CBOs) such as the Idirs. The committee members will be responsible for promoting individual and community behaviour change and lead by example. However, the study team couldn't see such an organized team in the study areas except for some efforts by committed individuals. Thus, in order to meet the objectives of WaSH Service Delivery effectively and efficiently, it is advisable to strengthen this unit both at the Woreda or/and kebele level.

On the other hand, in terms of the use of water economically, the water user's association is key to the success of irrigated crop production since they are formal institutions established by the beneficiary water users for their interest in the ineffective management of their schemes. Since the water consumption by the irrigation, users is excessive in the CRV, it is also good to strengthen the WUA committee on how to use economically the water resource for irrigation in the CRV catchment. It is believed that WUA plays an integral role in the overall management of the irrigation system.

3. APPROACH AND METHODOLOGY

3.1 Description of the Study Area

The Central Rift Valley of Ethiopia is an important wetland ecosystem having a chain of hydrological interconnected lakes critically challenged by environmental and social problems resulting from competing use of water & other natural resources.

Ziway- Shala basin is characterized by a semiarid to the sub-humid type of climate with mean annual precipitation and mean annual temperature varying from 600mm and 25^0c on the drier part around the lakes to 1200 mm and 15^0c on the humid plateau and escarpments. Highlands flanking the rift valley intercepts most of the monsoon rainfall in the region, resulting in a strong moisture deficit at the rift floor in general and near the lakes in particular (Christine et al, 2001). Lake Ziway, located in the rift floor, is the highest of a chain of four lakes it is situated at an elevation of 1636masl, Langano is situated at an elevation of 1585masl, Abiyata is situated at an elevation of 1578 masl and shala is situated at an elevation of 1558 m a s l. The open and shallow lake Ziway has a catchment of about 7000 km^2, an average surface of 490km^2, an average volume of 1.8 km^3, and a maximum depth of 9 m. Its two main tributaries, the Meki and Ketar rivers drain the western and eastern plateau, respectively. The lake, in turn, drains toward Lake Abiyata through the Bulbula River (ibid).

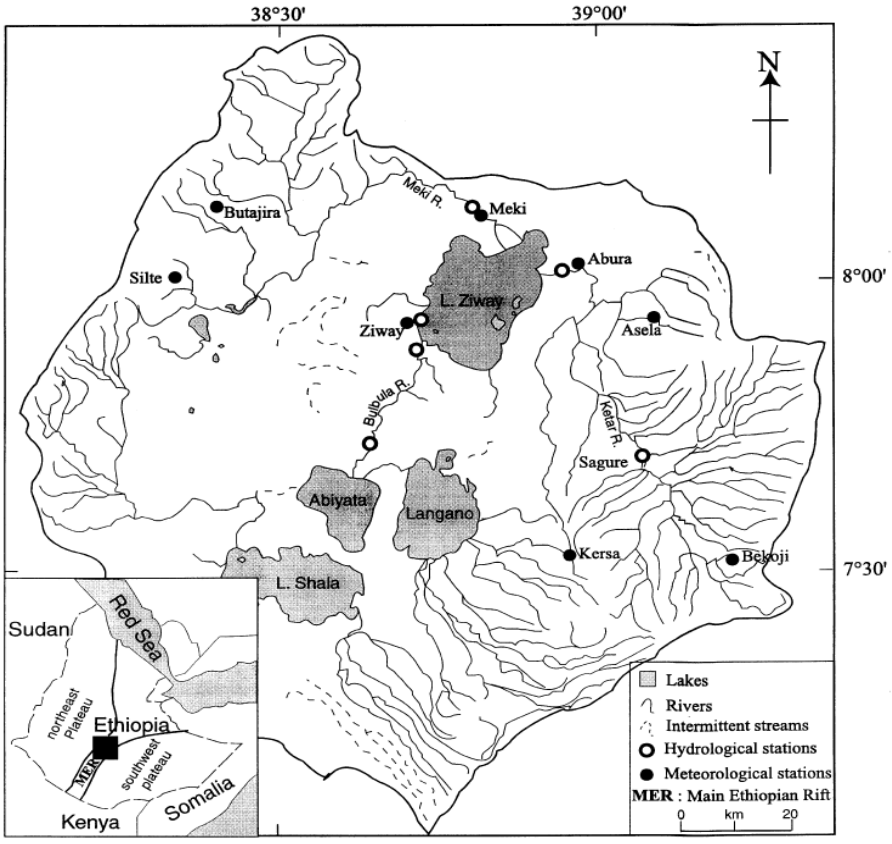

Figure 1: Location Map of Ziway Shala Basin

Source: Christine et al (2001)

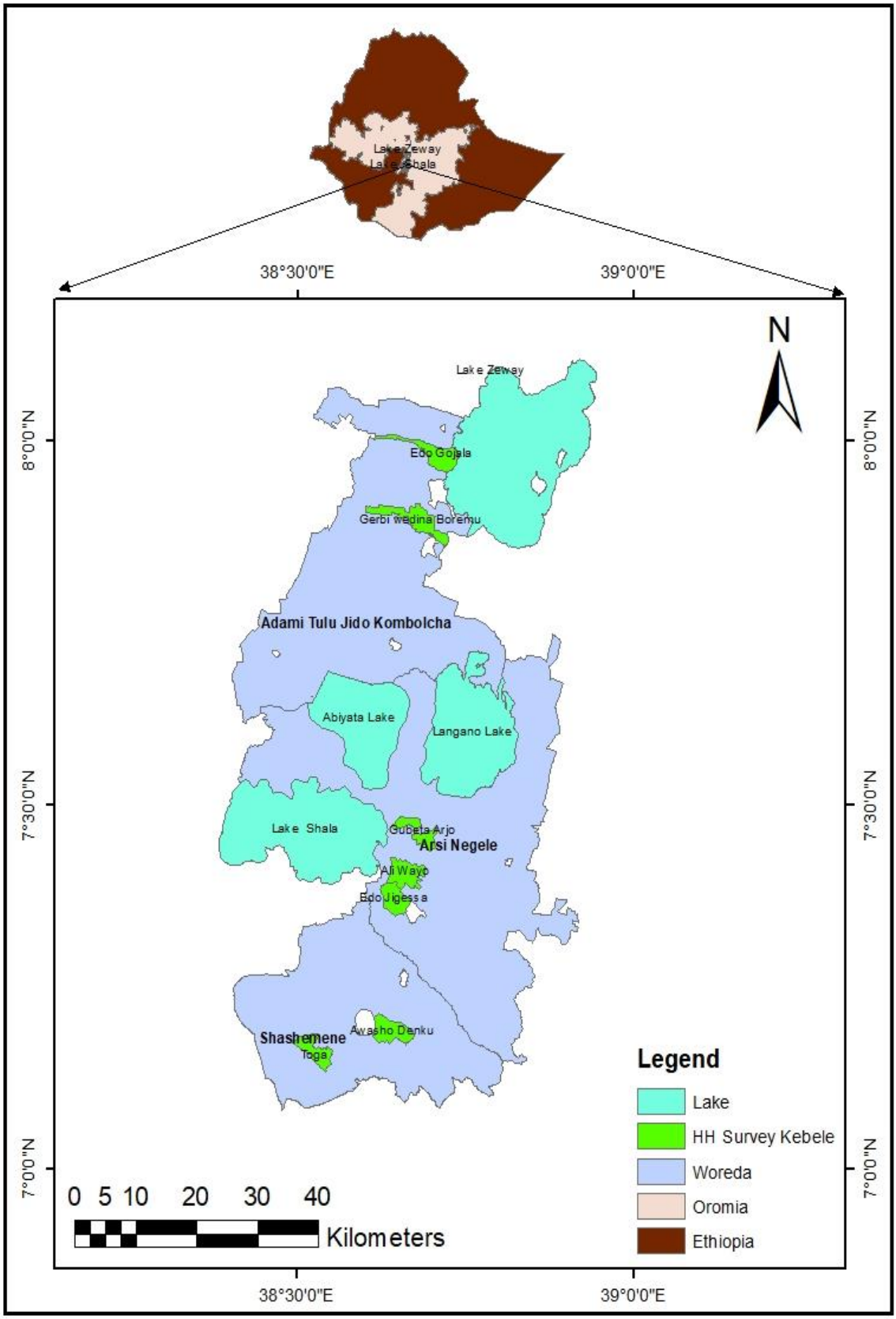

Figure 2: Location Map and Watershed Boundary of the Study Area

Figure 3: Parts of the Study Area

3.2 Method

The study was conducted in three Woredas of two zonal administrations, Namely, West Arsi and East Shoa Zones. Accordingly, a multi-stage sampling technique was employed to select study kebeles from each woreda and households from the selected kebeles. The probabilistic sampling technique was combined with the non-probabilistic to ensure the inclusion of all interest groups. Random sampling technique was used to select HH and collect quantitative data using questionnaires where a purposive sampling technique was applied to select key informants to conduct interviews and FGDs.

Various data collection methods were employed for the study. These are desk reviews of the available and relevant previously published and unpublished reports from various sources, interviews, and discussions with all appropriate stakeholders to get their perspectives.

The study was accomplished in three phases, the inception, Field level data collection, and Synthesis and report preparation as shown in the diagram below.

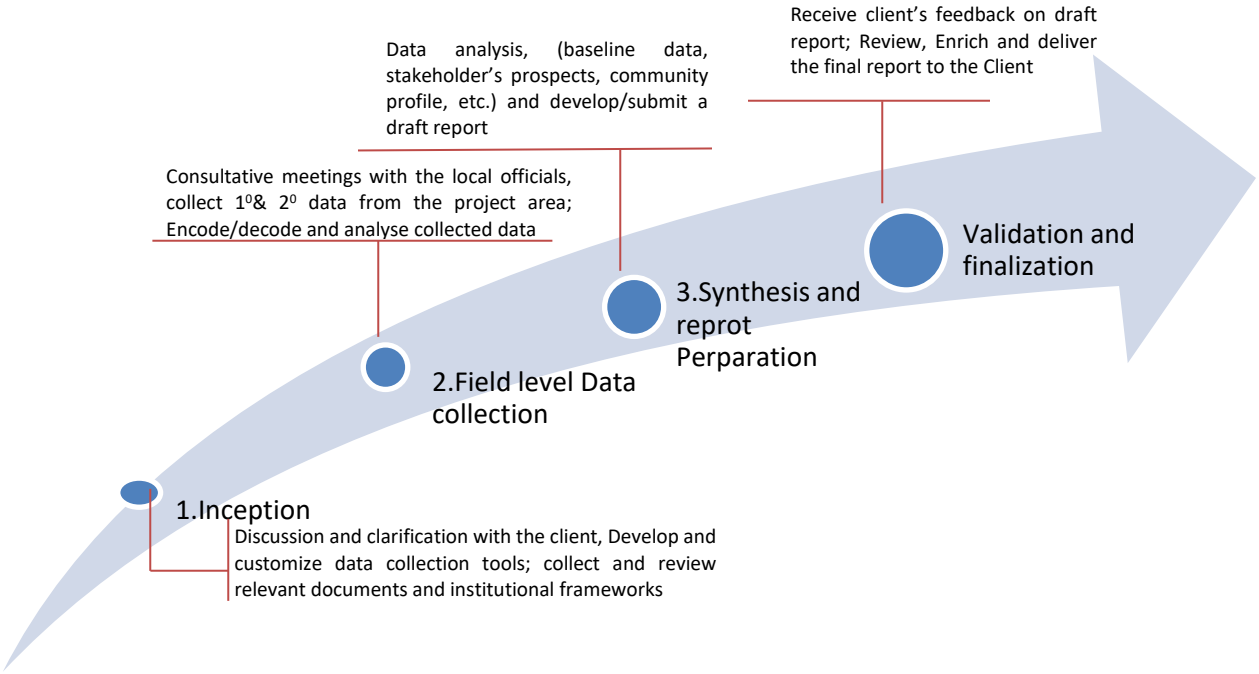

Figure 4: The Survey Process

Both qualitative and quantitative data were collected through a combination of methods from both primary and secondary sources. These include, for example, Type and status of water resources, climate change, water land characteristics, the status of soil conservation, weather-related information; demographic characteristics such as gender, family size, age, education, number of household members, economic characteristics such as landholding, livestock holding, income and institutional factors such as access to market, social services such as clinics, schools, and access to market, infrastructures. The study in this regard used a mixed research method, which assumes that qualitative data is embedded in quantitative and vice versa.

The primary data was the main input of the study & was obtained from the environment, key informants, focus groups and sample households using a structured and semi-structured questionnaire and checklists, through physical observation, interview, discussion, and PRA methods. Secondary data was collected from the relevant line offices (BDA, Ministry of Water, Irrigation and Energy (MoWIE), the Rift Valley Lakes Basin Development Office (RVLBDO), Woreda sector offices, and NGOs). Before approaching the sectors, supportive letters from the client office was acquired. Published and unpublished documents explored from the internet and other sources were also reviewed.

Key informants were identified from the local community and local officials purposively considering their exposures and relation with the objective of the study. The participants to the FGD were randomly identified from the local community but with the consideration to include all profiles of the community.

A household that participates in the Household survey was identified from the community through Simple random sampling. A robust and user-friendly **SURVEY SOLUTIONS,** a digital survey application, was employed for household survey data collection and management. SURVEY SOLUTIONS data management system helps to track proper data collection online and immediately communicate with enumerators to rectify gaps whenever they are spotted.

Villages in the study area are very scattered and demanding extra effort to administer the interviews. To reach the randomly selected sample households' the team of enumerators and team members of the consultant have made an intensive walk to residential areas. Maximum effort was made to make a fair representation of women and men respondent households though female-headed households were limited in number. Afaan Oromo was the language used for data collection during requesting the respondents though the Questionnaire was prepared in English.

The consultants supervised the work of enumerators at a different level. They were on spot supervision while enumerators were conducting a household interview. Moreover, the filled data were checked for completeness, consistency, and validity on a daily basis. There was a debriefing session in the morning on the quality of data collection and feedback was provided.

3.2.1 Desk review

Relevant documents were collected from different sources including the client office, government line offices (Agriculture, Environment, Water and energy, etc.) at Woreda level and Web sites and thoroughly reviewed. Survey instruments were developed based on the result of the desk review and incorporated into the inception report along with the refined methodology.

3.2.2 Structured Survey

The structured survey was administered on randomly selected households. The steps and methods followed by the household survey were as follows.

3.2.2.1 Study Population

The total number of households residing in the target kebeles was considered as the study population.

3.2.2.2 Sample Frame

The list of households residing in selected kebeles of the target Woredas was used as the sample frame for the study. 3kebeles from Arsi Negele, 2 Kebeles from Shashemene Zuria

Woreda and 2 Kebeles from Adani Tulu Jido Kombolcha Woreda were selected as the study area. The kebeles were purposefully selected considering the interest of the client and served as a sample frame from the sampling purpose. The list of households was obtained from the kebele administrators and organized by the village for a fair representation of the study population.

3.2.2.3 Sample Size and Sampling

The adequacy of sample size is one of the key factors for objective judgment. It is known that the sample size should be statistically significant to make objective judgments. In this regard, an adequate number of households and the sampling method was employed as discussed below.

The sample size for the House Hold Survey was determined using the web-based on the interpolation formula and sample size calculator (http://www.raosoft.com/samplesize.html). The parameters used for the determination of the sample size are as follows.

- ✓ Population size, 8,987HH residing in all the study kebeles,
- ✓ Confidence level, 95% which is a 5% margin of error; the amount of error that can be tolerated in the generalization of the results of the survey.

Hence, the sample size of households at the Kebele level was calculated using kebele population as a sampling unit, where N= total households in the selected kebele; 5% margin of error; population proportion, 50%; 95% confidence interval. The sample size (n) equals to some households taken as a sample out of N in the kebele.

The selection of sample households for the survey depended on various circumstances and availability of resources such as personnel, time, budget and the size of the population. The overall goal for the selection of samples was to represent a good spread of situations in the communities to get reasonable baseline information. Therefore, the total sample size for the study, as determined using the formula was 208 households.

Based on the above approach and Method, the sample size for the study using all the data collection methods (Qualitative and Quantitative) is calculated/determined and presented in the following table.

Table 2: Sample Size for HHs/Quantitative Method

S/N	Woreda	Kebele	Population (N)	Sample HH(n)
1	Arsi Negele	Ali Wayyo	1,533	35
		Gubeta Arjo	560	13
		Edo Jigessa	930	22
	Sub Total		**3,023**	**70**
2	Shashemene Zuria	AWASHo Denku	2,201	51

S/N	Woreda	Kebele	Population (N)	Sample HH(n)
		Toga	733	17
	Sub Total		**2,934**	**68**
3	Adami Tulu Jido Kombolcha	Garbi Widdena Boramu	1560	36
		Edo Gojala	1470	34
	Sub Total		**3,030**	**70**
	Total		**8,987**	**208**

After the sample size determined, sample households were identified using a simple systematic random sampling method. The sample interval was determined based on the sample size and picking the first respondent was made randomly and then proceeded with the selection of the next respondents based on the sample interval. In the case where the sampled household was absent for a long time or throughout the study period, the next household was considered. During selection, an identification number was given to sample households to safeguard privacy.

3.2.2.4 Questionnaire Development

The structured survey questionnaire was developed based on the result of the document review. The project's overall goal, objectives and outcomes (components) along with the objectively verifiable indicators were reviewed and framed to questions. The survey questionnaire was shared with the client as part of the inception report and comments were incorporated. The final version of the questionnaire was pretested and the reflection from the client incorporated and applied for the survey.

3.2.2.5 Enumerators Selection and Training

Enumerators were selected from the government sector offices of the three study Woredas in collaboration with the client's field office facilitator. The criteria for the selection of the enumerators were their ability to speak and read the local language, similar experience in the past, physical fitness to travel on foot and made home to home level data collection, respect to the local norm and culture and willingness to participate in the survey.

Enumerators were trained on the survey questions and methods by the study team. The snapshot of the project, survey objective, the details of the questions contained in the questionnaire, the do and don't do and the application of electronic device and software (**SURVEY SOLUTIONS**) were a major part of the training. At the end of the training, a mock exercise was made to make sure that enumerators understood the survey questions properly. After the training, the questionnaire was pretested on a few households/not the sampled one/s to verify the questions and understood its suitability to the respondents. This process helped to identify some gaps in the questionnaire and the comment from the enumerators and pretesting were incorporated and the final version was applied for data collection.

Figure 5: Enumerators Training

3.2.2.6 Survey Administration

The questionnaires were administered and face-to-face interviews with sample households. Also, before administering the survey questionnaires, clarification was made to all respondent households regarding the uniqueness of the study and its goals. Consent to participate was requested. Any respondent who doesn't seem willing to participate in the interview was abandoned.

3.2.3 Key Informant Discussion (KII) and Focus Group Discussion (FGD)

A semi-structured questionnaire was developed by the research team based on indicatives and interests provided by the client. It consisted of a closed-ended and some open-ended questions and was harmonized with the study objectives.

Discussions with key informants and focus groups were made for capturing information and realities on the ground. Key informants were identified from stakeholders including; community members, experts at Woreda and Kebele level and officials at the Woredas level.

Figure 6: Discussion and Interviews

Interviews with key informants and focus groups were guided by the semi-structured questioner and checklists. The discussions were more focused on additional issues and information which were not captured in HHS.

A total of 7 FGDs and 40 KIIs were conducted. The FGDs were conducted at target kebeles, with a mixed group (male and female representatives). Similarly, the KII was conducted at Woreda, kebele, CRVBDO, and NGO as summarized below.

3.2.4 Direct Observations

The consultant team visited the communities living in the local area and conducted transect walks with selected knowledgeable individuals to generate essential data and information through direct observations. Biophysical features including the level of soil degradation, the status of soil conservation, soil types, gully areas, forests, and other natural resources were observed. During the transect walks around the study area, an intensive informal discussion was also made with the inhabitants. This helped the team to complement and triangulate the findings obtained through formal discussions with stakeholders and household surveys. Issues that need special attention during the observation were captured using cameras (e.g., figure 7 below). The study team had a chance to have a direct observation and informal discussions

with the local community members while they fetch water from the community water taps. There was a long queue to fetch water. Many of them put in line their Jericans (containers made of plastics with a size ranging from 10-25 litres even more) and leave the area until their turn approaches.

Figure 7: Observations & Informal Discussions at Garbi Widdena and Ali Wayyo Kebeles

3.2.5 Triangulation

The study methods applied in this assessment were intended to evaluate the data via qualitative and quantitative methods according to the model of triangulation so that the results mutually supported each other and the intersecting individual findings represented the overall results. To check for consistency of data collected through household surveys, focus group discussions, key informant interviews and on filed observations triangulation was made.

The household surveys, focus group discussions and interviews complemented each other and verified the collected data. While walking through the area, the study team made observations

of the resources and of people's behaviors and activities, which also helped in the triangulation of the collected information and the generation of new questions for the interviews or discussions. Informal discussion was employed to check the data and no checklist was used as a basis for questions. Informal discussions were conducted at places where local people gathered.

3.3 Data Analysis

Data analysis was started parallel to the data collection exercises. The completed household survey questionnaire was checked/cleaned for consistency, completeness, and validity.

The quantitative data were analyzed using both descriptive and inferential statistics. Descriptive statistics include frequency distribution, percentages, and measures of central tendency were conducted using SPSS software, Version 23. Similarly, qualitative information was analyzed using content analysis. The information collected through the interviews and discussions was organized and constructed coherently as per their thematic area and summarized in matrixes and tables to look at possible relations. Finally, the findings from the qualitative and quantitative data were cross-checked for the consistency of the findings.

4. FINDINGS AND DISCUSSION

4.1 The overall demographic situation of the Ziway Shala sub-basin

Population growth depends on fertility, mortality, and migration. The total population in the CRV (Ziway Shala sub-basin) is about 1.9 million (Pascual-Ferrer and Candela, 2015). The population in the basin has increased rapidly in the last decades due to natural population growth and migration to the CRV from other regions (Scholten, 2007). The corresponding average growth rate is 3.15%. There is also high population migration from rural to urban in the Ziway Shala sub-basin. As the population increases, pressure on land increases.

4.2 Demographic Characteristic of the study Woredas

Demographic characteristics of the household (HH) comprise, gender, age, education, marital status, and health status, type of the household (HH) head, and others. The details of the demographic situation of the study areas are discussed below.

4.2.1 Population by Gender and Family Size

The overall result of the household survey indicates that 44.7% of the sampled households are male and the remaining 55.3% are female. However, the proportion differs across the study kebeles. For instance, in Awasho and Toga kebeles of Shashemene Zuria Woreda, and GarbiWiddena and Edo Gojala kebeles of ATJK Woreda, the proportion of female is a bit higher than male proportions. On the other hand, the female proportion in Gubeta Arjo, Ali Wayyo and Edo Jigessa kebeles of Arsi Negele Woreda is lower compared to others as indicated above as shown below in table 2.

The discussion made with the key informants and secondary data shows that the proportion of females is relatively high in the study area as compared to Oromia, the zone and Woreda. According to the projected population from CSA, 2017, the proportion of females in Arsi Negele and Shashemene was 50.7 and 50.3 respectively. On the other hand, the projection in the same year in Adami Tulu Jido Kombolcha Woreda shows the proportion of females is 49.8 which is a bit lower compared to the other two Woredas mentioned above. Compared to the CSA projection of 2017, the result of the survey household is not in line, i.e. there is a discrepancy between the SCA projection and the survey result concerning the male-female ratio.

Table 3: HHs Population Disaggregated by Gender

Gender	Name of Kebele							Overall
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa	
Male	18	8	7	16	18	14	12	94
	35.3%	47.1%	53.8%	44.4%	51.4%	41.2%	54.5%	44.7%
Female	33	9	6	20	17	20	10	115
	64.7%	52.9%	46.2%	55.6%	48.6%	58.8%	45.5%	55.3%
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**

The average family size is 5.5 with the maximum and minimum size of 1and 11, respectively. The average family size is relatively higher than the regional and national rural family size, which is 5.4 and 5.2 persons, respectively. Thus, unless family planning exercised in the study areas, population growth will create pressure on scarce natural resources such as land, water, and other natural resources.

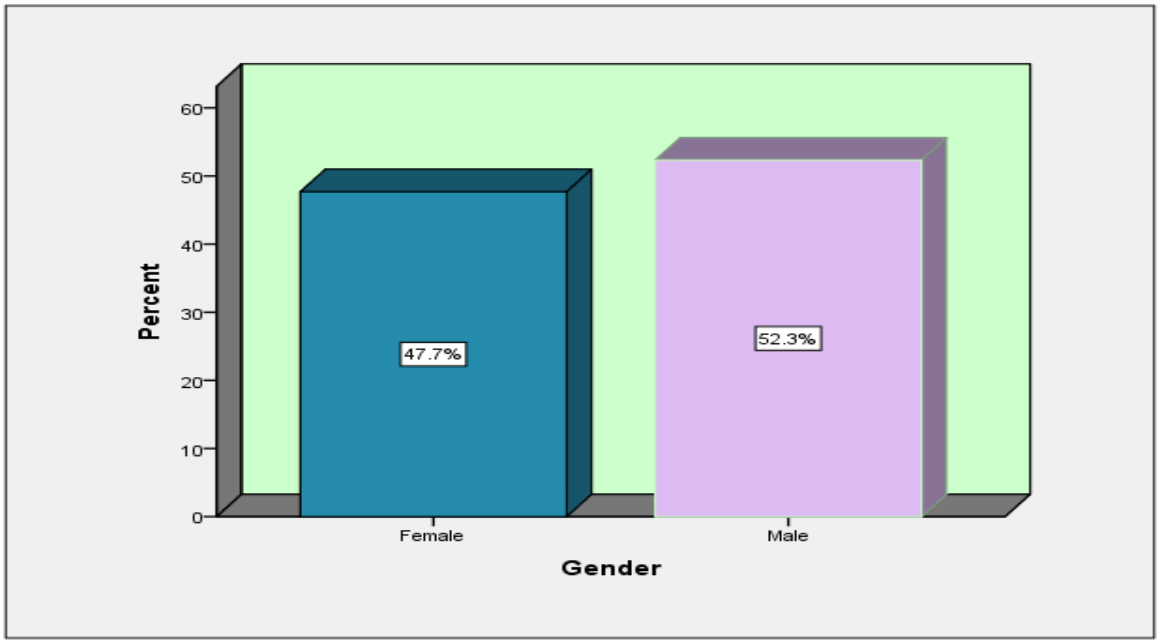

Figure 8: HHs Population Disaggregated by Gender

4.2.2 Age structure

The age distribution of the sampled households indicates that 56.3% are below 16 years old in all the study kebeles. Similarly, 29.2% are within 16-31 age groups, 13.6% within 32-65 age groups and 0.9% are above 65 age groups. The finding shows that the age pyramid of the study kebeles is heavy from the bottom. Also, the survey shows that 42.8% are within 16-65 age groups which are considered as productive age groups whereas 57.2% are within below 15and above 65 years old which is considered as Non-productive age. One can infer that there is enough labor for any intervention in study areas despite the non-productive age group is a bit higher compared to the productive one. The details of the age structure are summarized below.

Table 4: Population Distribution by Age Group in the Study Kebeles

Frequency (N) and %	Age group				Total	Productive age	Non-productive age
	0-15	16-31	32-65	>65		Age 16-65	Age<16 & Age>65
Frequency(N)	644	334	155	10	1143	489	654
%	56.3	29.2	13.6	0.9	100.0	42.8	57.2

4.2.3 Marital status

The result of the survey shows that 80.3 % of the sampled respondents are married, 15.9% are single, 2.4% are widowed and the remaining 1.4% of respondents are divorced. About the marriage type, 78.9% is monogamy and the rest 21.1% is polygamy (Table 5 and Figure 9).

Table 5: Marital Status of Respondent HHS

Marital Status	Name of Kebele							Overall	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Single	5	5	1	4	5	11	2	33	15.9
Married	45	11	12	31	26	23	19	167	80.3
Divorced	0	0	0	1	1	0	1	3	1.4
Widowed	1	1	0	0	3	0	0	5	2.4
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**	**100**

As indicated below in table 5, the result shows that marriage is exercised at the minimum legal age for marriage (18) which is the standard age of marriage. Ethiopian family law under Article31 (1) has defined the marriageable age of a boy and girl is 18. At this juncture, it is important to clarify the context under which the data on marriage was collected. Even though the legal age for marriage is 18 by law, marital status under this particular case was assessed at the age of 15 and below. This was a proxy approach to investigate the existence of early marriage in the area through which the survey result doesn't reveal that early marriage exists within the target areas.

A study conducted by Nawal (2006), in some parts of Ethiopia, 50% of girls are married before the age of 15. This implies the existence of cultural influence and the need for strengthening awareness promotion in the area or else, the ever-increasing population growth will be exacerbated. Consequently, completion for resource utilization increases which in turn, leads to the depletion of natural resources such as water and others. During FGDs and KIIs, the study team noted this in the target areas.

Table 6: Age VS Marital Status

Age Group	Marital Status				Overall
	Single	Married	Divorced	Widowed	
0-17	718	0	0	0	718
	80.0%	0.0%	0.0%	0.0%	62.8%
18-40	177	161	6	1	345
	19.7%	69.1%	100.0%	16.7%	30.2%
>41	3	72	0	5	80
	0.3%	30.9%	0.0%	83.3%	7.0%
Total	**898**	**233**	**6**	**6**	**1143**

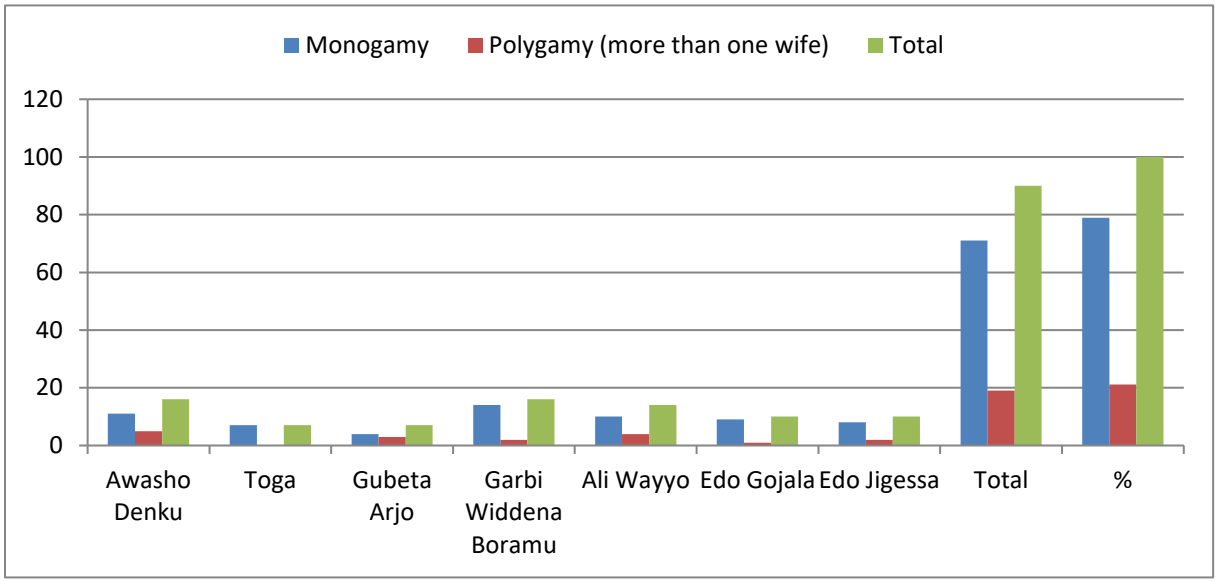

Figure 9: Marriage Type in the Study Area

4.2.4 Education Status of Respondents

Education is one of the key factors that influence a person's socioeconomic status. In general, it is assumed that the higher the level of education of a person, the more knowledgeable she/he is about the use of health facilities, family planning methods, and the health of children and other social and economic conditions such as income and skills.

Information on the educational status of household members indicates that the majority of household members are at the primary education level. As shown below in figure 10, 52.6% and 24.4% of the respondents are at the primary and illiterate level, respectively. On the other hand, 7% of respondents can read and write. The proportion of the secondary and preparatory level is 9.9% and 3.4%, respectively. The proportion of respondents and their families at a higher level is 2.6% as shown below in figure 10.

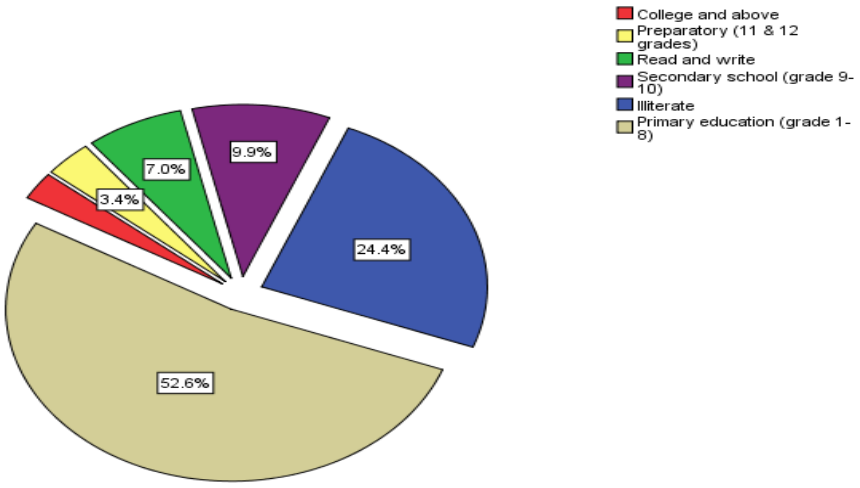

Figure 10: Education level

4.2.5 Health Status

The result of the survey showed that 94.7% of the respondents and their families are healthy at the time of the survey. Few were experiencing sickness and unable to engage in daily livelihoods for a limited period. For example, within the study kebeles, 3.8% and 1.4% of the households responded that their family members are bedridden and disabled, respectively (Table 7). Major diseases in the area were reported to be Malaria, Diarrhoea, and TB in order of their priority. The household situation within the family shows that many members of the households were still living together with the family under the same roof. The following table presents a summary of the health status of the study Woredas. Since the area where the study conducted, most of it is located at a lower altitude and malaria-prone area, malaria is the number one top-rated disease in the study Woredas/kebeles. Diarrhoea is rated as the second most common disease. This shows that the WASH Service delivery is a critical problem particularly potable water is not available to the required level. During the FGDs, a shortage of potable water was raised as a critical issue across the study kebeles. The problem is associated with Institutional capacity problems to manage and supply water equitably for the beneficiary community despite there are water schemes constructed by the government and NGOs. The other problem is the unavailability of water schemes in some spots of the study kebeles. Thus, this situation made the local community desperate to access potable water. Also, they claimed that the situation compelled them to spend unforeseen expenses for diarrheal treatment.

Table 7: Health Status of Respondents and Their Family

Health Status	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Healthy	49	16	12	34	35	31	20	197	94.7
Bedridden	2	1	0	1	0	3	1	8	3.8
Disabled	0	0	1	1	0	0	1	3	1.4
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**	100

4.3 Livelihoods

A livelihood comprises the capabilities, assets (including both material and social resources) and activities for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets, while not undermining the natural resource base (Ellis, 2000).

Livelihood strategies are the activities realized by household members (farm production, off-farm activities, migration, etc.), resulting in outcomes such as food or income security (Ellis et al. 2003). These activities are characterized by different allocations of natural (land area, irrigation, soil productivity), physical (working tools, livestock), financial (access to credit), public (roads, schools, health centres, other public services), social (civil organizations, migration networks) and human (education, household size, training) assets, income-earning

activities (on-farm, off-farm), and outcomes (food, income, security) (Winters et al. 2002). Together these determine the well-being attained by an individual or household.

Livelihood diversification is 'attempts by which individuals and households find new ways to raise incomes and reduce risk (economic, environmental and social), which sharply differs by the degree of freedom of choice (to diversify or not) and the reversibility of the outcome' (Hussein and Nelson, 1998). Diversification includes activities both on and off-farm that are carried out to generate additional income to that of the main livelihood activities. However, the level of its intensity and participation of rural households in the diversification is uneven (Assan, 2014 in Lemi 2005). Its intensity is also affected by the size of landholdings, the value of livestock owned and the level of income from crop production. According to Ellis and Allison (2004), livelihood diversification is a means of enhancing the performance of the food security of households and thus leading to an increase in rural incomes. Further, Holden et al. (2004), arguing that diversification is a means to build up rural assets and equitably. The livelihood situation of the study kebeles was assessed to understand the situation in the study areas.

4.3.1 Main Occupation

As shown below, the main occupations of HHs in the study kebeles are farming that includes both crop and livestock keeping, which accounts for about 87.0%. The proportion of households engaged in daily labor is 4.8%. Those households engaged in crop production only and trade is the same proportion which is 3.8%. Other occupations like salaried employee are insignificant as summarized in table 8 below.

Table 8: Household Main Occupation

Name of Kebele	Main Occupation					Over all
	Farming (both livestock & farming)	Crop Production only	Trade	Salaried employee	Daily labor	
Awasho Denku	42	2	0	1	6	51
	20.2%	1.0%	0.0%	0.5%	2.9%	24.5%
Toga	15	0	0	1	1	17
	7.2%	0.0%	0.0%	0.5%	0.5%	8.2%
Gubeta Arjo	11	1	1	0	0	13
	5.3%	0.5%	0.5%	0.0%	0.0%	6.3%
Garbi Widdena Boramu	36	0	0	0	0	36
	17.3%	0.0%	0.0%	0.0%	0.0	17.3
Ali Wayyo	27	3	5	0	0	35
	13.0%	1.4%	2.4%	0.0%	0.0%	16.8%
Edo Gojala	34	0	0	0	0	34
	16.3%	0.0%	0.0%	0.0%	0.0%	16.3%
Edo Jigessa	16	1	2	0	3	22
	7.7%	0.0%	1.0%	0.0%	1.4%	10.6%
Total	**181**	**7**	**8**	**2**	**10**	208
	87.0%	**3.8%**	**3.8%**	**1.0%**	**4.8%**	100.0%

4.3.2 Crop Production

Crop production and food insecurity in Ethiopia are linked to seasonality of rainfall and its patterns. Droughts and other related disasters (such as crop failure, water shortage, and livestock disease, land degradation, limited household assets, low income) also are significant factors for low crop production and food insecurity. Other important factors of food security are rapid population growth, rain-fed agriculture, underdevelopment of water resources, low economic development, weak institution, conflicts, fluctuations of production, and high levels of illiteracy, poor health, and sanitation (Olana et al. 2018).

According to the survey result, most farmers across the study kebeles are dependent on rain-fed agriculture. For instance, as indicated below in figure11, 81.6% of respondent households are harvesting only once in a year. The remaining 18.4% of respondent households produce twice a year by using small scale irrigation practices. Also, participants in the household survey, FGDs, and KIIs explained that they use lakes (Ziway), Rivers (Bulbula,) and Groundwater for small scale irrigation. They also clarified that they use motorized pumps to abstract water either from lakes or groundwater.

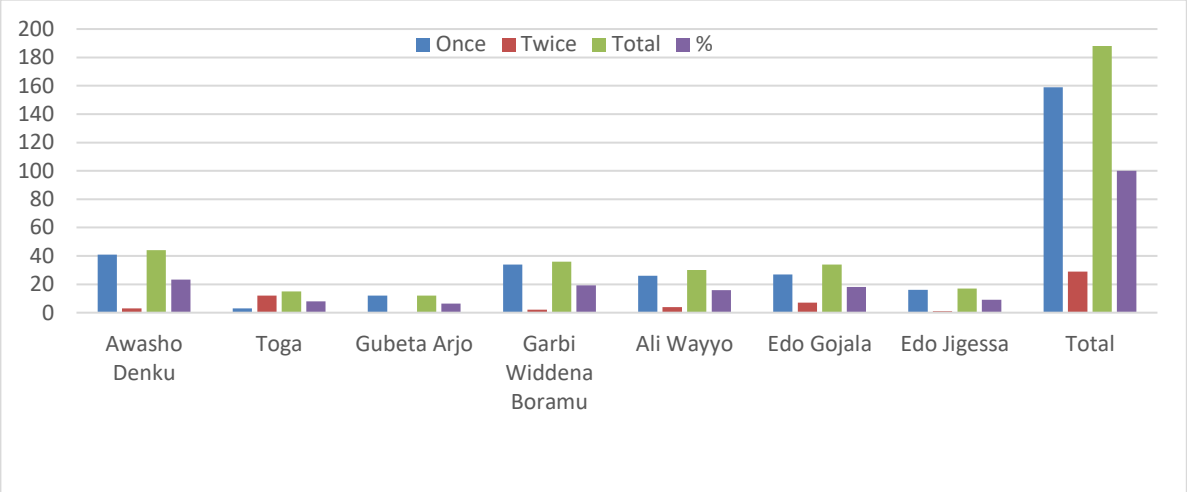

Figure 11: Frequency of Harvesting in the Study Area

4.3.3 Farming Practice

The farming system in the study kebeles is not different from the country's pattern. The main issue which needs to be considered is the need to modernize agricultural practices (e.g. intensification). There should be standard regulations on what to farm, how to farm and where to farm.

It was noted that the inhabitants of the study areas predominantly practicing traditional farming systems. Evaluating the level of practice from the standpoint of food insecurity and land degradation, there is much more to be done in terms of introducing knowledge and acquainting with the skill of improved farming to the farmers to improve production and

productivity in the area. According to the KII and FGDs, they apply their indigenous knowledge and there is also support from the Development Agents which need be strengthened.

All except biological forms of pest management practiced by the farmers of the area, pesticide application is the most commonly practiced one. The respondents used a combination of Pesticide, and cultural (including hand weeding) means to control the effect of pest on their production.

The following issues were raised to be the major problems related to the farming practice in the area:

- Traditional farming system; people are using traditional methods;
- Land scarcity due to population pressure which leads to agricultural land expansion.
- Lack of grazing land, and animal fodder in the area.

4.3.4 Livestock Keeping and Products

Livestock production is one of the important economic resources in Ethiopian and plays a crucial role in the rural economy. However, its contribution is very minor which is about 15% of the GDP and 38% of the total gross value of annual agricultural outputs (Birhan, 2013). At the household level, livestock plays a critical economic and social role in the lives of pastoralists, agro-pastoralists, and smallholder farmers' households. Livestock full fills an important function in coping with shocks, accumulating wealth, and serving as a store of value in the absence of formal financial institutions and other missing markets. In the case of pastoralists, livestock represents a sole means to support and sustain their livelihoods.

Regarding smallholder mixed farming systems, livestock provides nutritious food, additional cash income, transportation, farm outputs and inputs, and fuels for cooking food and heating (Negassa et al, 2011).

According to Halcrow (2009), the livestock types and numbers in the sub-basin of the CRVB is as listed in table 9 below. Of the listed livestock type, the cattle population is the highest and the small ruminants, sheep and goats ranked second and third respectively. However, as shown above in table 1, vegetation and grassland which are essential for these animals as a source of feed is shrunk by -80.07% and -67.76% due to land use/cover change between 1997 and 2008.

Table 9: Livestock Types and Numbers in the Sub-Basin

Zone	Cattle	Sheep	Goats	Horses	Donkeys	Mules	Poultry
Arsi	618,102	295,530	107,510	75,617	75,416	3,446	447,434
East Shewa	250,456	28,189	103,256	2,637	30,544	1,858	209,259
West Arsi	612,790	130,870	137,081	38,013	74,293	882	481,719
Total	**1,481,348**	**454,589**	**347,847**	**116,267**	**180,253**	**6,186**	**1,138,412**

Source: (Halcrow, 2009)

Livestock populations within the target areas are dominantly local breeds. Traditionally, the local community keeps many livestock types; because the one who has many is considered as prestigious by others. In other words, among the local community, it is perceived as the measure of prosperity. In the study kebeles, respondent households own four categories of livestock type as summarized in Figure12 below. From resource (Water, grazing land, etc.) competition point of view, having a large number of livestock particularly cattle, Shoats, and Equines contribute to high water consumption and overgrazing that exposes the environment to soil erosion which in turn contributes to water bodies (lakes, rivers) siltation and decrease in groundwater recharge due to low percolation. As shown in the figure below, on average, one household owns 4.3 Cattle, 4.7 Shoats and 1.9 Equines.

According to the survey results, the livestock types in the study area are Cattle, Shoat (sheep and goat), Equines (Donkey, Horse, Mule) and chickens and beekeeping. Cattle are kept for draft power, meat, milk and milk products and as a store of wealth. Donkey plays an important role in individual households as they are used to transport farm products, farm inputs, and other services and water. Moreover, sheep, goats, and chickens are kept for meat, egg, and beekeeping for honey production as a source of additional cash income. In the study areas, during FGDs and KIIs, it was noted that livestock production is constrained by drought & shortage of water, deforestation, and shortage of grazing land. According to the participants, the shortage of water and a shortage of grazing land is highly aggravated by Environmental degradation and Climate change effects. Overall, as shown below in figure 12, the proportion of Shoats is 39.1%, cattle 29.7%, Chicken 22.1%, Equines 8.1%, and beekeeping 0.9%, respectively.

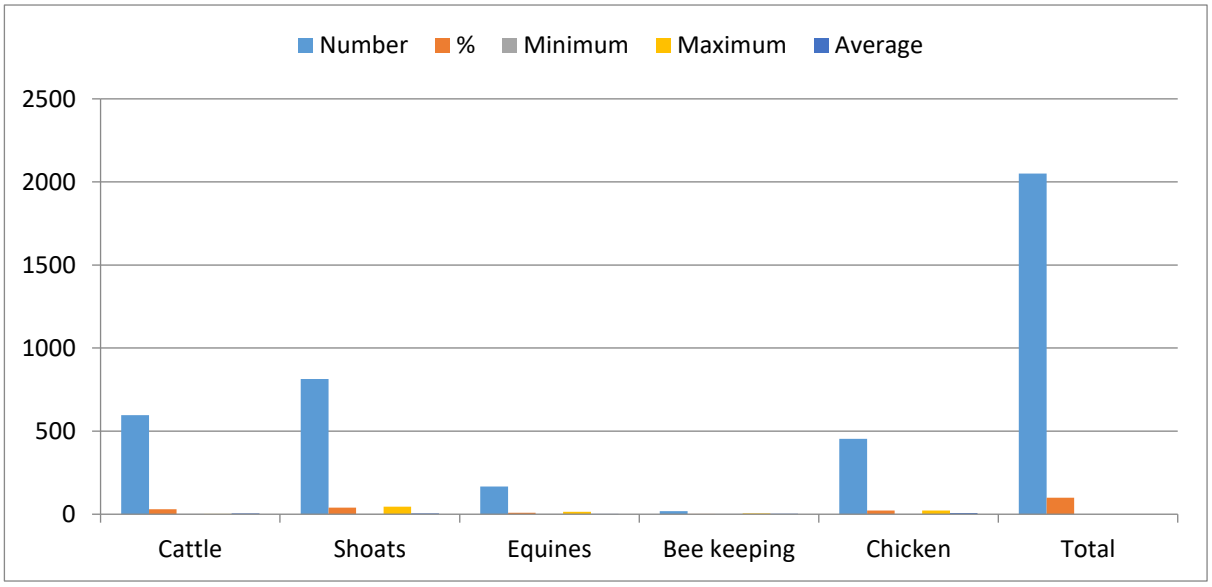

Figure 12: Livestock Population in the Study Kebeles

It has been reported that there are a limited number of feed sources in the study area as shown below in table 8. The major sources of feeds were grazing lands managed under the common and private property. Of the respondents, 66.9% replied that they use Grazing and Crop residue to feed their animals, grazing only reported by 22.1.1% of respondents, the rest 8.1% and 2.9% of respondents feed their animal's crop residue and concentrate, respectively. Thus, because of the unproportioned presence of livestock and feed resource, overgrazing is becoming a problem in the study area.

Table 10: Livestock Feed in the Study Area

Feed Source	Name of Kebele							Over all	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Grazing and Crop residue	30	7	9	20	23	16	10	115	66.9
Grazing	9	4	0	12	3	10	0	38	22.1
Crop residue	0	3	4	1	0	3	3	14	8.1
Concentrate	0	0	0	0	3	1	1	5	2.9
Total	**39**	**14**	**13**	**33**	**29**	**30**	**14**	**172**	**100**

According to the CSA survey report for 2017, grazing and crop residue are the major sources of livestock. Similar to the national figure, the data from the study area is also skewed toward Grazing and Crop residue. The shortage of availability of feed for livestock is reported as the key challenge. And the major reasons for this shortage mentioned by the FGD participants were grassland degradation and the transfer of grassland into croplands.

As can be seen above in table 10, grazing and crop residue is the major source of feed for livestock's 66.9% of the respondents followed by free grazing which is used by 22.1% of the respondents. It is also known that about 8.1% of the households use crop residue to feed their animals, and the rest 2.9% of respondents feed their animals concentrates. This fact is a clear indication of the availability of pastureland in the area and its implication on the size and quality of herds kept by the community.

Overall, according to the FGD and KII participants, shortage of feed, shortage of capital, shortage of water and disease prevalence are the major livestock keeping problems for most of the Households. The result shows that pastureland is the major problem followed by livestock diseases and shortage of water are front line problems affecting the production and productivity of livestock. The table below indicates the level of each problem thus implying the priority of intervention to improve livestock production.

4.4 Water Resources in the Ziway-Shala Sub Basin

It is a well-known fact and previous studies show that water is a shared resource and is critical for sustainable livelihoods. To begin with, all households need water for domestic use, i.e. for drinking, food preparation, washing, cleaning, etc. Access to adequate, clean water will greatly contribute to improved health and better productivity. Secondly, there are distinct population

groups whose livelihoods are water-based, entirely or to a considerable extent; such groups include fishermen and artisans such as tanners and potters. Thirdly, water resources can play a significant role in improving food security and household income. In Ethiopia, the development of water resources for agricultural purposes on the one hand and rural water supply schemes is on the other.

The Ziway- Shala Basin consist of 4 Lakes namely, Ziway, Shala, Abijita, and Langano. Of which, the only freshwater lake in Ziway and perennial rivers including Meki, Ketar, Bulbula, and Harakalo. Among other things, the Ziway-Shala basin comprises the catchments of lakes Ziway, Langano, Abiyata, and Shala. Lake Abiyata is connected to both Lake Ziway and Lake Langano through Bulbula River and Horakela River, respectively.

Large scale floriculture (e.g., Sher Ethiopia), and Castel winery and small-scale irrigation farms by smallholders established in the area are all targeting the potential of the lake for irrigation. Previous studies show that some of the lakes and tributary rivers are used for irrigation, soda abstraction, commercial fish farming, and recreation; and they support a wide variety of endemic birds and wild animals. lakes shrunk due to excessive abstraction of water; others expanded due to an increase in surface runoff and groundwater fluidity from percolated irrigation water. Also, inappropriate exploitation of water and land resources in the lake's catchment and direct lake water abstraction intensified now and then by climatic changes. The terminal lakes show a dramatic reduction in the level and increase in salinity. These changes appear to have grave environmental consequences on the fragile rift ecosystem, which demands extremely urgent integrated basin-wide water management practice.

According to Caroline et al (1998), the surface hydrographic network of the Ziway–Shala lake basin system is principally well developed to the north of the area, with the Meki and Katar rivers inflowing Lake Ziway from the western and eastern escarpments. Lake Langano is mainly maintained by five major rivers, Huluka, Lepis, Gedemso, Kersa, and Jirma, flowing northwest then north from the southeastern escarpment and characterized by weak, low water flow. Lake Abijata receives flow at its northern end from the Bulbula and Haro Kallo rivers flowing from Lake Ziway and Lake Langano, respectively. The surface inflows to Lake Shala come from two main sources, the perennial Adabar River which enters from the southeastern rift escarpment, and the main branch of the Gidu River flowing from the western escarpment.

4.4.1 Water Balance and Demand in the Ziway-Shala Basin

Bearing in mind the current and the likely future water use effectiveness, a projection of water demands for different purposes in Ziway sub-basin in the coming 45 years was carried out by (Gadissa et al, 2019 in OWWDSE, 2016). The projection is grounded on the growth in irrigation, industrial developments, and rises in domestic water requirements due to an increase in population and per capita water demands. As a result, evidence suggests that the total annual water demand in the 2040s, 2050s, and 2060s will be 3600.18MCM, 4868.98MCM, and

6140.44MCM, respectively if the existing condition continues. On the other hand, the demands will be 1877.57MCM, 2552.16MCM, and 3229.42MCM, respectively, if pressurized drip irrigation is used for irrigation water demand. The main water demand sectors in the basin are irrigation, industrial, domestic, livestock, and environmental flow requirement. The main challenge faced in the CRV is, more than 95% of the water consumption is from irrigation. The current annual water demand is 566.73MCM.

The water balance of the lakes in the study area was simulated using models. Ideally, all regional model simulations should span the period 1951-2100 to include a recent historical period, plus the entire 21st century. However, this is computationally difficult. Thus, the period is divided into 30-year time slices (Giorgi et al., 2009). According to the same sources, the time slices have the following order of priority: 1951-1980, 1981-2010, 2011-2040, 2041-2070, 2071-2100. The first of these (1981-2010) represents the reference period for model evaluation and the calculation of climate changes. The second priority time slice, covering a future period, was selected as a compromise between the needs of the impact community in terms of future time horizon and the requirement to obtain a robust change signal (). Thus, the 2041-2070 period was selected from the future period and the 2030s were not considered.

Groundwater exchange in most situations is negligible compared to other flows (Bengtsson & Malm, 1997). This is valid when a longer period is considered because of the impact study, hence the groundwater component of the water balance model was neglected for this particular study. Among the many reasons, Vallet-Coulomb *et al*. (2001) described some reasons why groundwater is neglected during water balance analysis. Piezometeric data are too scarce for estimating the groundwater contributions to the water budget of the Lake from a hydrodynamic approach. In the case of Ziway, the topography in the lake surroundings is quite flat and the lake itself is very shallow (average depth of 4m). Hence, a significant groundwater inflow to the lake is not expected and The Overlake rainfall was assumed to be equal to evaporation from the lake surface. Hence, the 791.7 MCM is surface water inflow to Lake Ziway.

It has to be noted that it was only the water demand projection that was taken from OWWDSE (2016). The water availability was projected using RCMs and SWAT models. The data from OWWDSE is a recent study. Hence, water demand projection was cited by Gaddisa et al, 2019 from OWWDSE (2016).

Conversely, the future available water in the Meki-Ketar (Ziway) sub-basin of CRVB is projected and its deviation from currently available water is shown below in Table 9. One of the greatest challenges is the available water is by far less than the projected demand in the scenario period. Hence, it will not satisfy the demand in the coming 30 years even under advanced irrigation systems. This will make possible the drying up of the already shrinking lakes in the basin.

According to (Gadissa et al, 2019 in OWWDSE, 2016), the water demand assessment in the basin indicates that the annual irrigation water demand is 549.05 MCM, Livestock water demand is 11.62 MCM, Domestic water demand is 5.10MCM, and Industrial water demand is 1.02 MCM. This corresponds to 96.88%, 2.05%, 0.9% and 0.18%, respectively. Hence, irrigation water demand is more than 95% of the total demand. Irrigation water demand in the Ziway sub-basin is extremely increasing over time due to the expansion of irrigated area through pumping from Lake Ziway. The scenario development in water demand projection considers irrigation water demand by looking at different irrigation technologies that improve irrigation efficiency. Also, it has to be noted that industrial water demand in this part is to consider hotels and commercial centers. However, Soda Ash is from Lake Abiyata and doesn't include floriculture and Castel Winery. Since Lake Abiyata is not freshwater, it is not considered in water demand analysis in relation to WaSH or other services such as irrigation and other services.

Table 11: Annual Available Water (MCM) of the Basin for Different Scenarios

Source	2010s	2040s		2050s		2060s	
	(Current)	RCP[1]4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
Meki	276.5	254.9	280.6	214.5	265.4	271.4	297.1
Ketar	464.4	376.7	336.1	297.4	501.5	431.8	469.1
Ungagged[2]	50.8	45.1	44	30	48.3	51.6	52.1
Total	791.7	676.7	660.7	541.9	815.2	755	818.3
Deviation%		-14.5	-16.6	-31.6	3	-4.7	3.3

Source: (Gadissa et al, 2019 in OWWDSE, 2016)

According to (Gadissa et al, 2019 in OWWDSE, 2016), generally, average outcomes indicate that there will be a change in streamflow of Meki River by -10.4% and 0.5% under RCP4.5 and RCP8.5, respectively. On the other hand, the streamflow of Ketar River will change by -18.8% and -3.4% on average under RCP4.5 and RCP8.5, respectively.

[1] The scenarios are called Representative Concentration Pathways (RCPs). There are four pathways: RCP8.5, RCP6, RCP4.5, and RCP2.6 - the last is also referred to as RCP3-PD. (The numbers refer to forcing for each RCP; PD stands for Peak and Decline. RCPs are referred to as pathways in order to emphasize that their primary purpose is to provide time-dependent projections of atmospheric greenhouse gas (GHG) concentrations. ***Source:*** IPCC Expert Meeting Report, Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, And Response Strategies, IPCC 2007.

[2] The ungauged catchment is the area surrounding Lake Ziway, which doesn't have a gauging station but has runoff contributing to the lake when it rains. According to Gaddisa et al, 2019, the runoff from the ungauged catchment was estimated using the SWAT model.

Also, according to the Rift Valley Basin Master plan studied by Halcrow (2009), the annual available groundwater resource in Ziway Shala Sub-basin is 19 MCM. In the study of water balance at Lake Ziway, it can be seen that the net groundwater inflow (inflow – outflow) to Lake Ziway is insignificant. Different studies (Vallet-Coulomb *et al*., 2001) also show that the net groundwater influx to Lake Ziway is negligible in water balance analysis of Lake Ziway. Hence, the net groundwater inflow to Lake Ziway is insignificant and neglected while analysing water balance at Lake Ziway. To further substantiate the study, the streamflow data for Meki and Ketar rivers were obtained from the Ministry of water, irrigation, and electricity. The data analysis for the two rivers from 1988 to 2010, which were considered as the 2010s data(current) in table 11 presented in the table 12 below.

Table 12: The average daily streamflow of Meki and Ketar Rivers

Year	Meki	Ketar
1988	7.26	15.89
1989	6.96	7.66
1990	10.48	11.81
1991	8.6	8.45
1992	9.89	10.73
1993	14.27	13.59
1994	12.98	11.69
1995	9.91	11.01
1996	9.78	16.29
1997	6.01	9.38
1998	15.84	22.64
1999	7.45	16.08
2000	3.78	26.69
2001	9.07	17.76
2002	6.36	13.93
2003	7.08	16.03
2004	7.21	10.42
2005	7.85	16.43
2006	7.93	15.02
2007	11.73	17.26
2008	5.65	16.59
2009	6.83	16.63
2010	8.79	16.63
Average	**8.77**	**14.72**

Source: Ministry of Water, Irrigation, and Electricity (MoWIE), 2010

Hence, the average streamflow of River Meki to Lake Ziway is 8.77 m^3/s. This can be converted to an average annual volume as 8.77*365*24*3600/1,000,000, which is equal to 276.5 million cubic meters (MCM). The average streamflow of River Ketar is 14.72 m^3/s and the annual volume becomes 464.4 MCM when converted in the same procedure.

4.4.2 Irrigation Practices in the Study Areas

CRV basin contains a chain of three lakes with exceptional hydrological and ecological characteristics incorporating a biodiversity abundant national wetland park. The irrigation development has been linked with the overexploitation of the inadequate water resources and the increased competition for land and water resources. Policymakers and other stakeholders seem to have an inadequate capacity to act in response to the negative effects of the continuing resource deprivation on the local livelihoods and the ecosystem. Recent evidence by Hengsdijk et al (2010) suggests that encouraging policies for agricultural investments, both small scale and large-scale irrigated agriculture has stretched out quickly in the Central Rift Valley of Ethiopia.

Most of the irrigation schemes in the area are of the traditional type. Traditional irrigation is a complement to rain-fed agriculture, and the crops grown in the area are often horticultural and fruit trees. Farmers have a profound consciousness of the benefits of irrigation and are enthusiastic to endow their labor in the construction and repairs of the schemes.

According to WRDA's Estimate of Irrigation Potential (1986), there is 50,000ha irrigable land in the CRVB. One of the most serious environmental hazards initiated by large-scale irrigation schemes is salinization and the loss of precious land. Poor water management and scanty drainage invariably increase water salinity and waterlogging, and as the water evaporates a whitish salt residue is left on the soil. In its milder form, salinization will decrease the productivity of arable land and pasture, but in more serious cases it can ruin the land for good. Of the total respondents (n=208), only (n-=29) 13.9% of households are participating in irrigation farming. This shows that most of the smallholders are engaged in rain-fed agriculture. It is understandable that as a matter of chance the purposefully selected kebeles are not involving in irrigation practices to a significant level. However, while the discussion was undergoing with FGD and KII participants, it was noted that many farming communities near Lake Ziway, Bulbula, and Meki rivers are practicing small scale irrigation by pumping the groundwater since the water table is near to abstract it from the ground.

During the transect walks the study team has proved this fact as shown below in figure13. According to a watershed management officer of Rift Valley Lakes Basin Development Office (RVLBDO), currently, the peak number of irrigation users are 5000 and above. All are using motor pumps.

According to the officer, water utilization is not efficient. Of the 43 kebeles of ATJK Woreda, 12 kebeles use Bulbula River for irrigation purposes. Besides, the two Woredas (ATJK and Dugda) farming community uses lake Ziway for irrigation purposes. Lake Ziway is surrounded by 27 kebeles; 9 kebeles from ATJK Woreda, 8 kebeles from Dugda Woreda and 10 kebeles from Ziway Dugda woreda. All these rely on the existence of the lake.

Figure 13: Onion Production Using Groundwater Near Lake Ziway

The survey result also shows all the households who are practicing in small scale irrigation, they pump water from water sources (Lake, Spring, and groundwater) using motor pumps to abstract water and the type of irrigation they are practicing is furrow which is not advisable as far as efficient utilization of water is concerned. Rather it advisable to use pressurized irrigation economically in such a semi-arid area. As shown below in table 13, 75.9% of irrigation users abstract water from groundwater, 20.7% from the lake and 3.4% from springs, respectively. On the other hand, motor pump used as means of abstraction of water and the type of irrigation applicable in the study areas is furrow basin.

Table 13: Irrigation Practice in the Study Area

Sources of water for irrigation	N	%	Means of Abstraction of water	N	%	Type of Irrigation	N	%
Lake	6	20.7	Motor Pump	29	0.0	Furrow, basin	29	100.0
			Tridle Pump	0	0.0	Drip, sprinkler	0	0.0
Spring	1	3.4	Motor Pump	29	100.0	Furrow, basin	29	100.0
			Tridle Pump	0	0.0	Drip, sprinkler	0	0.0
Ground water	22	75.9	Motor Pump	29	100.0	Furrow, basin	29	100.0
			Tridle Pump	0	0.0	Drip, sprinkler		

4.5 WASH Service Delivery in the Study Areas

Escalation of the circumstances for water, sanitation, and hygiene (WASH) services is essential if those services are to be operational and long-lasting. Water is one of our most distinct natural assets and is noticeably vital to the WASH sector. The direct use of water is domestic uses, including drinking, washing and cooking, agricultural uses, predominantly irrigation, industrial uses, in manufacturing processes and energy generation. On top of the direct use of water for human activities, water is also essential for the environment and to maintain

biodiversity. Rivers, lakes, and wetlands are important habitats for wildlife and need a minimum amount of water at all times. This becomes a problem when the demand for water for human activities exceeds the supply. Then the need to address these services sustainably becomes urgent.

It is now well established from a variety of studies, that the need for sustainable WASH services to incorporate water guarantee concerns is developing and more and more recognized. WASH involves water abstraction from the hydrological cycle while climate change and growing competition are changing the availability of water in many areas in the world. Where WASH systems are not well managed, untreated human waste is often disposed of directly into water bodies, thereby degrading ambient water quality, and increasing the costs of providing clean drinking water later and elsewhere. Such adverse environmental impacts may also negatively affect the functioning of (especially) aquatic ecosystems such as wetlands and the potential to provide services and goods.

Sustainable Development Goal 6 recognizes these associations and endorses integrated approaches to deal with sustainable WASH services delivery in a progressively water insecure world. Integrated approaches that may take in water quality control, ecosystem management/restoration, and IWRM are very important for warranting the sustainability of WASH as stated in the SDG6 targets.

The survey result indicates that the main source of water for any purpose in the study areas is groundwater (49.6%) is followed by rivers (24.9%). The remaining proportion is lakes (18.2%) and springs (7.0%) as shown below in table 14.

Table 14: Water Sources in the Study Kebeles

Water sources[a]	Name of Kebele							Responses		Percent of Cases
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa	N	Percent	
Ground water	47	10	2	32	29	31	19	170	49.6	81.3
Rivers	28	3	6	19	10	8	11	85	24.9	41.1
Lakes	3	7	3	27	4	15	3	62	18.2	30.1
Springs	3	4	7	0	9	0		24	7.0	11.5
Total								341	100.0	164.1

a. Dichotomy group tabulated at value 1.

However, as depicted below in table 15, water suffers from overexploitation, erratic rainfalls, pollution, siltation, and uncontrolled population growth. The finding of the study in the 7 kebeles of Arsi Negele (3), Shashemene Zuria (2) and ATJK (2) Woredas indicates that water resources are under pressure by different factors that challenge the water balance and demand.

Of the total respondents, 30.8% replied that the water bodies' size/level is changing from time to time, erratic rainfalls are mentioned by 25.6% of respondents as one of the reasons for changing the size/level of the water bodies. Similarly, 18.5% of respondents informed that pollution is one of the factors affecting water bodies in the CRVB. The remaining respondents expounded that siltation (16.4%) and population growth (8.7%) contributes to changing of the water bodies significantly. Human requirements for resources are enormous and it is mounting as the population number rises and consumption per person increases with socio-economic progress. The depletion of natural resources by extraction and exploitation is especially of concern for non-renewable resources. Thus, as soon as the factors are known, it is advisable to increase or formulate mitigation measures to get this scarce resource with no interruption.

Table 15: Reasons for Changing of the Water Bodies in Size/Level in the CRVB

Reasons[a]	Responses		Percent of Cases
	N	Percent	
Over utilization	160	30.8	77.3
Erratic rainy seasons	133	25.6	64.3
Pollution	96	18.5	46.4
Siltation	85	16.4	41.1
Population growth	45	8.7	21.7
Total	519	100.0	250.7

a. Dichotomy group tabulated at value 1.

As shown below in table16, the type of water sources that are changing significantly i.e. either in a decreasing or increasing manner, are lakes, rivers, groundwater, and springs, respectively. Accordingly, the survey results from the lake are ranked first by 39.4% of respondents about decreasing or increasing the state. The river is ranked second by 38.6% of respondents relevant to decreasing or increasing the situation. Other types of water sources (groundwater and spring) ranked third and fourth by 13.9% and 8.0%, respectively in their decreasing or increasing state.

Table 16: The type of Water Source Changing Significantly in the CRVB

Water bodies[a]	Responses		Percent of Cases
	N	Percent	
Lake	196	39.4%	96.6%
River	192	38.6%	94.6%
Ground	69	13.9%	34.0%
Spring	40	8.0%	19.7%
Total	497	100.0%	244.8%

a. Dichotomy group tabulated at value 1.

During the FGDs and the KIIs, it was reported that because of environmental degradation, the groundwater is depleting. Sometimes, during the longest dry season, many boreholes and

shallow wells dry up and communities are forced to travel far distances in search of water for both human and animal consumption. On top of this, pollution of water sources especially lakes and rivers are becoming a critical challenge. Thus, to curb the situation, an integrated effort is needed by all development actors which are actively involving in the study areas. According to the participants, pollution is caused by different sources such as industries, domestic wastes, agrochemicals, etc. For example, chemical residues from industries are highly polluting Lake Ziway. On the other hand, agrochemicals from irrigation users are polluting the Bulbula River. Domestic waste is dumped simply in near water bodies such as Lakes and rivers. The team has also noted the case during transect walks (figure 14). According to the RVLBDO watershed management officer, waste management is weak in the Ziway and other towns in the area.

Majorly, the sources of pollution are two in the study areas; i.e. point source pollution from industries, households, teaching institutions like colleges and the non-point sources are irrigation farms that use agrochemicals and other inputs.

The main sources of pollution in the Ziway-Shalla sub-basin are domestic wastewater, agricultural waste, industrial wastewater, and solid waste disposal. Urban domestic wastewater is discharged directly to rivers and Lakes, where it pollutes the water and presents an environmental health risk to the user communities. All towns in the basin do not have a wastewater treatment plant. Sher Ethiopia's floriculture industry is the major pollution source to Lake Ziway. The industry had wastewater treatment plants but discharge its effluent without proper treatment since there exists no frequent monitoring and inspection by the regulatory body. One can witness this just by visiting the site. The area around Lake Ziway is going through a major agricultural transformation with both small-scale farmers and large horticultural companies using pesticides and fertilizers at an increasing rate.

Farmers and companies in the area use pesticides and chemical fertilizers, which may affect the water quality of the lake and the surrounding surface waters through the release of some trace elements and residues from the agricultural fields into the surface waters.

According to the Rift Valley Basin Authority (RVBA) assessment report (2016), Sher Ethiopia flower farm release 6,825 litters wastewater per day to Lake Ziway. Castle winery and irrigation PLC release 10,000m^3/y wastewater to Bulbula river; Frogrofico Boran Foods PLC releases 2,400M^3/day, which may affect groundwater; the Abiyata soda Ash factory uses 150m^3/ton/year of water through evaporation for soda ash production and in turn release polluted water to Lake Abiyata. The annual soda ash production is estimated to be 15,000 tons. Other industries like Ziway Rose PLC, Elfora agro-industry, and Lasal Agro-processing also release wastewater to Lake Ziway though the amount is not measured.

Because of this and other factors, Lake Ziway is no more in use for drinking. As a result, there is intermittent conflict on water resources in the Ziway -Shala Basin. The carrying capacity is at risk. In the three Woredas namely, ATJK, Dugda, Ziway Dugda and Arsi Negele occurrence of drought is 46-76% every year. Major problems mentioned by the local officials for the pollution of water bodies is the lack of ESIA from industries and lack of concern before implementation. In general, the three pillars of sustainability (Social, Environmental and Economic) need to get due attention and need integrated effort. According to the officials, the WASH Service Delivery is challenged by an increase in population growth, an increase in industries, an increase in irrigated farming and an increase in environmental degradation and Climate Change.

4.6 Effect of Water Scarcity in the WaSH Service Delivery

Increased competition for the limited water resource has resulted in the rapid depletion of sources which in turn creates an unmanageable water scarcity problem. Such scarcity of resources also results in conflicts between upstream and downstream users of water, land, and forest (Pandit et al., 2007; Taiwari and Pandurang et al, 2015). Soil and Water are natural resources which are essential for the survival of human being who depend on them for basic needs. However, continued pressure and over-exploitation of these essential resources to meet the demands of an ever-increasing population deplete these resources (Pandurang et al., 2013).

The main sources of water on the Earth's surface are surface water, groundwater and collected rainwater, all of which are dependent on rain and snow falling for drinking, washing, agriculture, and industry. The Sources of water in the study area shares a similar fact. Across the study areas, Rivers, springs, Lakes, and Ponds are widely used as water sources among the HHs.

Table 17: Water Consumption per Household in the Study Areas

Water Consumption (Litre)	Name of Kebele							Overall	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
15	0	0	0	2	0	0	0	2	1.0
20	5	1	0	10	0	14	1	31	14.9
25	1	0	1	11	0	12	1	26	12.5
30	0	0	0	2	2	0	2	6	2.9
40	9	5	1	5	8	4	3	35	16.8
50	6	3	2	5	4	2	3	25	12.0
60	10	4	0	0	5	0	3	22	10.6
75	1	0	0	0	1	0	2	4	1.9
80	8	1	1	1	3	0	1	15	7.2
100	5	0	4	0	9	0	3	21	10.1
120	4	2	3	0	1	0	1	11	5.3
125	0	0	1	0	0	0	1	2	1.0
140	2	0	0	0	0	0	0	2	1.0
150	0	0	0	0	0	0	1	1	0.5

Water Consumption (Litre)	Name of Kebele							Overall	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
160	0	0	0	0	1	0	0	1	0.5
200	0	1	0	0	0	1	0	2	1.0
220	0	0	0	0	0	1	0	1	0.5
400	0	0	0	0	1	0	0	1	0.5
Total	51	17	13	36	35	34	22	208	**100**

As shown above, in table 17, the minimum consumption of water for drinking is 15 litters per day per household (only 2 households) while the maximum is 400 litters though it is only responded by 1 household or 0.5% of the total respondent households. The KII in Edo Gojala Kebele showed that 1jerican which has a capacity of 20 litters is sold 0.5 ETB and the source is borehole constructed during the Derg time by Dembosko Catholic Relief Service. There is no new water point developed in the area since then which leads to increased pressure on the existing one. The communities living in Edo Gojala, fetch water from this water point. When there is a shortage of water during the dry season, adjacent kebeles also, fetch water from this water point for household consumption. Even though there is no limit, the common practice is collecting two (2) Jerica's (40-50 litres) per day per household. But when there is a special occasion like a wedding, they collect about 4 Roots (1 Root=200 Litres). In the case of livestock and Irrigation farming, Lake Zipway is in use and the amount of consumption varies across the type of animal. According to the KII and FGD, Camel, Cattle, Sheep, Equine consumes 80, 20, 10, 20liter respectively in every cycle.

Close to some water scheme in the area, some farmers use small scale irrigation by using groundwater. There is an increasing concern about agrochemicals since the irrigation users apply agrochemicals for their vegetables. Thus, there is an urgent need to address the safety problems caused by agrochemicals.

According to KII, in most cases, every six months, there is a water audit by the Worde water office. All water point gives service year-round. Some works with a solar pump, some are connected to the grid and some others depend on a diesel generator for power.

Many cross-sectorial studies suggest an association between WASH and its Sustainability (e.g., ACF, 2007). According to these studies, many factors that play a part in the sustainability of WASH services are listed below.

- The delivery of the proper level of benefits (quality, quantity, convenience, comfort, continuity, affordability, efficiency, equity, reliability, health).
- Continuity over a prolonged time and ability to be maintained and repaired to continue its life.

- its management is institutionalized (community management, gender perspective, partnership with local authorities, the involvement of formal/informal private sector)
- Its operation and maintenance, administrative and replacement costs are covered at the local level (through user fees, or alternative financial mechanisms).
- It can be operated and maintained at the local level with limited but feasible, external support (technical assistance, training, monitoring).
- It does not affect the environment negatively.

Among the most important of these factors is the need for the service users to be fully involved in its planning, development and continuing maintenance. Most of the water schemes which were observed during the transect walk lack the above-listed facts in relation to their sustainability and utilization due to lack of proper institutional arrangement.

4.7 Effect of Environmental Degradation on the Wash Service Delivery

In line with the Worde Water and Agriculture and Natural Resource respective offices, environmental degradation particularly deforestation is challenging the livelihood of the local community. Moreover, a recent phenomenon of water hycine on Lake Zipway, and trampling/compaction effect by animals are some of the major concerns raised and discussed. According to the experts, the trampling effect contributes to runoff and soil erosion during the rainy season and soil erosion by wind during the dry period.

The experts from the Worde offices enlightened that forests are one of the most widely used groups of natural resources and have been extensively used for different purposes. In the study areas/ Kebeles, overexploitation of forests occurs when forest areas are cleared and the trees are not replanted or allowed to regrow. In Ethiopia, clearing land for agriculture to meet the food needs of the growing population and the need for fuel and construction materials has given rise to continual damage to the forest area, which is even now ongoing. Thus, deforestation is a considerable causative agent of soil erosion which in turn affects the existence of water bodies such as lakes, rivers, etc.

As per the participants of FGDs, the pollution of Lake Zipway by chemicals from industries and smallholders is becoming a threat to the existence of the lake. Not only the lake but also the Bulbul River is highly polluted by solid and liquid wastes, as well as by the agrochemicals drains to it. Due to this fact, the local communities reported that they are forced to stop fishing from Lake Zipway because of the high concentration of chemicals. The following figure portrays the level of pollution of water bodies in the study area, thus the degradation of quality besides the quantity.

As a long term effect, it increases the overland flow, which means low infiltration, this, in turn, will be reduced the base flow of rivers (seasonality) that leads to insufficient groundwater recharge, sedimentation which reduces storage capacities water bodies such as rivers and

lakes. The cumulative effect is then aggravating water scarcity and instigating conflict among users. There are contemporary and to be an intensively emerging challenge to Wash service delivery. The degradation can also be linked to the breakage of the food chain and loss of habitat of wild animals, which a prevailing case in the area. This has made the community vulnerable to attacks from wild animals specifically hyena, to the level where some family member, especially in the Arsis Nigel area, is becoming a common problem. The community is exposed to such incidences that have been attached while they have been searching for water.

Figure 14: Status of Water Bodies Pollution in the Study Area

Through the physical observation and literature reviews, it is known that the study kebeles are dominated by the soil type of sandy loam followed by Sandy clay. They have weak to very weak soil structure. Thus, they are highly susceptible to both wind and flood erosion. Moreover, it is also susceptible to nutrient leaching. As shown below in figure-15, the practice of soil improvement differs across the study kebeles. Though the survey result indicates soil

conservation is labelled as fourth in terms of practices of soil improvement in the study kebeles, the reality on the ground doesn't reflect this. Therefore, intensive soil and water conservation measures should be implemented by mobilizing the community.

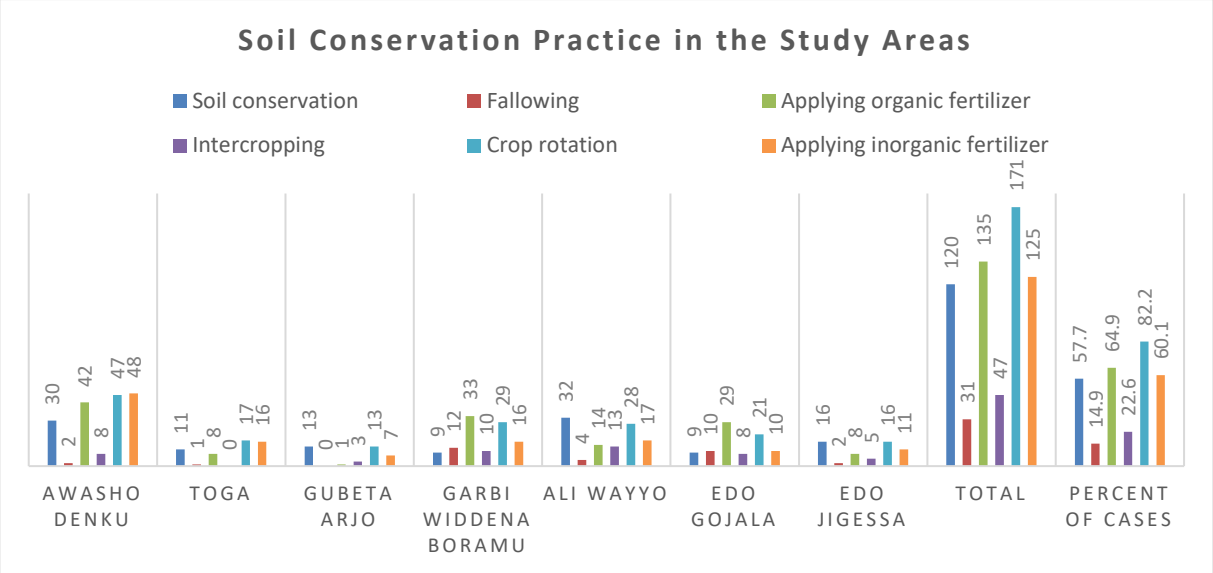

Figure 15: Soil Improvement Practices across the Study Keeble's

4.8 Effect of Climate Change in the Wash Service Delivery

According to the information obtained from participants, the study areas have experienced drought, flood, and reduction in the volume of river water, lakes following the dry-up of springs at the upper stream. They have also associated the reduction of the volume of water, the flood and the drought with climate change. They perceived that temperature has increased, precipitation decreased, and rain comes either too early or so late affecting their productivity as a result of climate change. As the area witnessed floods, drought, and a decrease in the volume of water, the level of significance of climate change on soil, water, and natural vegetation is significant.

Current climate variability is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters.

Effective mitigation and adaptation to climate change and the construction of a Climate Resilient Green Economy (CRGC) will depend on improved management and use of our natural resource assets mainly water. In this context, climate change impacts will be assessed and projected to proactively deal with the upcoming adverse impacts on the hydrological and ecological process in the Ziway-Shalla sub-basin.

4.9 Trend Analysis of Climate Change

The rainfall situation in the CRVB is a bimodal rainfall type despite there are variations in the rainfall pattern due to climatic variability as discussed in detail in the following sections. As shown below in table 18, a study conducted by Gadissa et al. (2019), reveals that the relative annual changes in terms of precipitation, maximum and minimum temperature were assessed for all grid points in the study area. The collective mean of five models was used to assess the climate change in future scenarios (2041–2070) with respect to the base/historical period (1985–2016) under RCP4.5 and RCP8.5. As a result, precipitation will extremely (11.71%) be reduced at Grid point 1 (near Fato and Hombole) under RCP4.5 but increase by 1.70% at Grid point 6 (near Langano) under RCP8.5. Overall, the results indicated that precipitation value will decrease on average by 7.97% under RCP4.5 and 2.55% under RCP8.5 in the study area. The results also indicate that all the values of maximum temperature will increase from 1.61°C at Grid 8 (near Kofele) under RCP4.5 to 2.57°C at Grid 2 (near Worabe) under RCP8.5. The results show that minimum temperature increased from 1.91°C at Grid 7 (near Bokoji) under RCP4.5 to 3.94°C at Grid 2 (near Worabe) under RCP8.5. According to the same source, the decrease in precipitation and increases in maximum and minimum temperature amounts are statistically significant at a 5% significance level ($P<0.05$).

Table 18: Change in Climate Data in Scenario Period as Compared to Historical Period

Grid	Precipitation (%)		Maximum temperature		Minimum temperature	
	RCP4.5	RCP8.5	RCP4.5	RCP8.5	RCP4.5	RCP8.5
1	-11.71	-7.04	+1.81	+2.44	+2.21	+3.15
2	-13.64	-8.33	+1.91	+2.57	+2.77	+3.94
3	-4.24	-0.73	+1.79	+2.44	+2.33	+3.25
4	-5.54	-0.21	+1.71	+2.34	+1.92	+2.73
5	-9.33	-1.69	+1.62	+2.19	+2.02	+2.84
6	-4.27	-1.7	+1.67	+2.27	+2.14	+2.99
7	-6.35	-3.13	+1.74	+2.41	+1.91	+2.77
8	-7.14	-1.11	+1.61	+2.21	+2.00	+2.86
Average	**-7.97**	**-2.55**	**1.73**	**2.36**	**2.16**	**3.07**

Source: Gadissa et al, 2019

Moreover, to evaluate the trend of climate variability, the meteorological data (temperature, rainfall, humidity, moisture, wind) variation in the past 30 years' in the CRV was analysed based on the data accessed from the NMA. According to the data, the mean annual rainfall taken from the 13 meteorological stations varies from an average 788.0mm in 1985 to 878.8mm in 2016 (Table 19). Similarly, as shown below in tables 20 and 21, the mean annual maximum temperature revealed a 0.5^0c increase in the past 30 years while the mean annual minimum temperature shows a 1.9^0c increase in the past 30 years. On the other hand, other metrological data such as Relative Humidity, Sunshine Hours and Wind Speed were considered in table 22.

Table 19: Mean Annual Rainfall (mm) in Central Rift Valley Basin

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsis Nigel	Bui	Butajira	Degaga	Langano	Meki	Wulbareg
1985	660.4	1094.0	1091.3	596.3	598.2	659.1	715.6	729.9	890.5	754.5	717.1	705.6	1032.0
1986	981.1	1382.9	870.3	938.0	816.7	576.9	891.9	852.3	1051.8	912.8	898.6	937.8	1412.4
1987	574.5	968.9	943.4	775.5	432.0	552.9	649.2	644.8	1247.9	678.1	646.1	804.0	1418.2
1988	717.0	908.0	979.7	874.4	1487.3	700.6	684.2	925.5	885.1	1026.5	825.0	728.8	1464.9
1989	670.9	1162.6	781.2	916.3	970.1	974.2	795.0	960.7	1393.4	1064.0	949.4	870.2	1137.6
1990	747.0	967.7	869.2	984.0	939.4	689.4	851.4	1080.4	1465.5	1045.0	909.1	921.3	1277.3
1991	790.8	784.0	671.6	796.3	704.7	801.6	703.4	1070.6	897.3	831.4	745.5	458.0	1366.3
1992	727.2	1184.2	1230.7	809.5	739.8	794.2	877.7	1002.1	851.2	880.2	1004.4	941.8	1534.3
1993	841.7	1056.8	1049.9	930.6	928.7	958.9	944.6	1087.5	981.1	1024.3	937.8	749.8	1377.4
1994	638.0	1103.5	926.5	727.0	589.2	517.3	687.9	759.9	1031.2	1169.2	947.0	638.8	1027.2
1995	1019.3	1080.3	867.7	866.9	713.8	564.0	813.0	1310.6	1100.8	975.2	818.1	384.3	926.7
1996	922.4	1241.4	952.1	877.0	816.0	912.1	949.9	1349.2	1463.8	1356.0	1002.0	918.9	1406.3
1997	882.6	1154.9	963.9	911.6	747.2	848.6	901.0	764.8	1240.3	1133.2	1072.7	869.0	1152.4
1998	928.3	1142.1	757.8	874.5	824.5	756.2	932.2	1046.2	1459.9	1036.9	1016.6	753.5	1343.0
1999	697.0	857.2	931.1	746.6	661.2	545.5	807.4	983.6	1057.4	1123.4	665.8	713.0	1140.0
2000	805.2	1061.8	924.6	797.5	719.7	704.3	807.0	998.4	848.9	1038.0	742.0	751.5	1663.0
2001	837.0	1438.8	1064.9	938.9	703.7	734.4	1292.6	1220.6	1313.5	1103.7	910.4	758.9	1228.9
2002	575.2	779.5	781.3	708.4	583.3	458.8	1178.7	901.3	1160.6	1088.4	775.8	511.6	1183.6
2003	771.2	978.7	701.6	758.6	775.5	850.8	1470.2	1053.7	1173.3	1155.7	781.6	808.1	1176.5
2004	602.2	1077.2	719.8	728.0	571.0	773.6	1486.5	921.2	854.3	821.4	802.1	601.1	949.6
2005	785.4	1082.8	1052.5	743.3	499.5	842.1	1258.3	1264.8	1816.5	1034.0	930.0	721.7	1060.2
2006	723.9	1268.2	1003.7	805.7	520.7	776.5	943.2	1233.6	1580.3	1133.2	1068.2	783.6	1530.8
2007	791.8	1194.1	4597.0	835.9	820.1	803.6	746.8	1198.3	1163.4	1088.5	878.7	797.8	1143.6
2008	848.9	1060.0	1097.9	820.5	1256.2	1042.1	774.3	1081.5	943.8	998.8	1005.7	788.0	1112.9
2009	647.4	1012.4	828.5	787.9	773.9	728.7	451.3	838.6	768.5	852.8	786.9	768.8	721.3
2010	961.4	1139.1	945.7	917.8	841.9	873.4	920.1	1521.6	918.5	1330.3	1213.0	906.6	885.4
2011	739.2	1032.7	792.1	849.7	644.2	696.4	464.4	1150.3	752.9	919.2	703.7	586.7	693.8

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsis Nigel	Bui	Butajira	Degaga	Langano	Meki	Wulbareg
2012	1568.0	852.1	708.1	961.2	875.2	692.4	374.8	727.3	884.0	964.5	1031.8	1132.0	926.3
2013	788.9	1071.7	831.1	749.8	706.9	738.6	206.0	942.0	783.8	1397.2	788.4	743.2	742.3
2014	838.8	1196.6	870.9	865.7	522.9	750.3	282.8	1009.9	795.3	852.8	713.1	858.4	717.4
2015	510.3	870.7	893.5	585.5	367.6	470.7	112.2	589.6	544.9	980.3	464.5	494.6	455.7
2016	811.3	1231.7	885.7	998.7	877.9	930.2	344.5	873.2	942.5	1269.0	662.2	705.6	892.1
Ave	**793.9**	**1076.1**	**1018.3**	**827.4**	**750.9**	**741.2**	**791.2**	**1002.9**	**1070.7**	**1032.5**	**856.7**	**753.5**	**1128.1**

Data source: National Meteorological Service Agency

Table 20: Maximum Temperature (°C)

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsi Neg	Bui	Butajra	Degaga	Langano	Wulbareg
1985	27.5	20.3	25.6	23.7	27.7	26.8	25.5	25.8	25.4	25.4	29.0	26.9
1986	28.3	20.5	24.8	23.2	28.1	27.2	25.8	26.0	24.9	25.5	29.3	27.0
1987	28.8	21.7	25.1	23.4	28.5	27.8	26.4	26.6	25.7	26.1	30.7	26.9
1988	27.3	22.1	24.8	22.8	27.5	27.6	26.0	26.0	25.7	25.6	29.1	25.9
1989	27.0	21.5	24.4	22.0	26.8	26.8	24.9	25.3	25.8	25.0	28.6	25.8
1990	27.4	22.0	24.8	23.1	27.6	27.3	25.4	24.6	26.4	23.8	28.4	25.9
1991	27.7	22.9	24.4	22.8	28.1	27.5	25.9	25.0	25.9	24.8	28.9	26.4
1992	27.8	21.9	24.2	22.4	26.9	27.2	25.7	24.8	25.9	25.3	28.5	25.8
1993	27.3	22.8	23.9	22.2	27.1	26.8	25.5	25.1	25.8	23.8	27.4	25.9
1994	27.1	22.5	24.1	23.0	27.7	27.9	26.0	26.0	26.4	24.5	28.6	27.7
1995	26.7	23.1	25.3	23.0	28.2	27.2	25.9	25.7	25.7	24.5	28.2	27.0
1996	27.4	22.8	25.6	22.4	27.7	27.7	26.0	24.8	25.3	23.7	27.1	25.8
1997	27.6	23.1	25.9	22.6	28.3	28.0	26.3	25.5	25.8	25.3	29.1	25.2
1998	27.6	24.2	26.6	22.8	28.5	27.8	25.5	25.3	26.5	24.0	28.1	26.0
1999	27.8	24.5	25.4	22.8	28.2	27.4	26.1	25.3	26.3	23.8	27.7	26.1
2000	27.7	23.4	25.2	22.7	28.2	27.4	26.2	25.5	26.0	24.3	27.9	26.0
2001	28.4	21.8	25.2	22.7	28.5	28.5	26.7	25.3	25.9	24.4	27.3	25.6
2002	28.0	21.9	26.0	23.8	29.6	27.8	26.5	26.6	26.3	25.0	29.0	25.9
2003	28.2	21.3	25.7	23.2	28.9	27.8	26.4	26.2	26.0	25.0	28.8	25.6

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsi Neg	Bui	Butajra	Degaga	Langano	Wulbareg
2004	28.2	20.9	25.3	23.2	30.1	27.7	26.8	26.4	26.3	24.4	29.0	26.5
2005	27.9	21.1	25.5	23.4	29.8	27.5	27.1	27.3	26.4	24.6	28.9	25.8
2006	27.8	21.4	25.1	23.0	30.0	27.5	26.6	27.1	26.0	24.3	28.8	25.6
2007	27.7	21.3	25.6	23.1	28.2	27.1	27.0	27.8	25.8	24.1	28.2	25.3
2008	28.4	21.1	25.2	23.2	22.7	28.0	26.6	27.8	26.2	24.1	28.1	25.8
2009	27.5	21.7	25.4	23.9	28.6	27.4	27.7	28.3	26.5	24.7	29.2	27.7
2010	27.9	21.2	25.3	23.1	28.0	27.8	26.7	27.4	26.4	23.7	28.6	27.8
2011	27.6	21.8	25.3	23.4	28.4	27.7	27.4	25.6	26.6	24.5	28.6	27.9
2012	27.4	22.1	25.5	23.6	28.6	27.2	27.5	25.6	26.4	24.6	25.7	27.6
2013	27.5	21.6	25.0	23.5	28.2	27.8	24.6	25.4	26.5	24.2	25.6	27.8
2014	28.7	21.6	24.9	23.9	29.6	29.0	25.5	26.1	27.4	24.2	26.4	29.1
2015	27.7	22.7	25.9	24.7	29.7	28.0	25.3	26.6	27.2	25.7	26.5	28.3
2016	28.3	22.4	26.5	23.7	28.2	27.7	25.6	26.1	26.8	25.2	27.7	28.0
Average	**27.8**	**22.0**	**25.2**	**23.1**	**28.2**	**27.6**	**26.2**	**26.0**	**26.1**	**24.6**	**28.2**	**26.6**

Data source: National Meteorological Service Agency

Table 21: Mean Annual Minimum Temperature (°C)

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsi Neg	Bui	Butajra	Degaga	Langano	Wulbareg
1985	11.5	9.2	7.6	11.8	13.2	12.0	10.9	11.3	15.0	10.9	10.7	11.6
1986	12.0	9.5	8.4	11.9	13.1	11.7	11.1	11.4	14.0	11.1	11.0	11.3
1987	12.4	9.9	9.1	10.3	12.5	13.9	11.9	12.0	13.8	11.6	11.3	11.5
1988	12.5	10.4	10.5	12.3	14.3	14.0	11.6	12.8	12.6	12.5	14.1	11.5
1989	12.1	10.5	10.1	11.3	13.4	13.8	11.2	12.4	13.3	12.1	13.6	11.2
1990	12.2	9.7	9.0	12.6	14.3	13.7	12.4	11.6	13.0	7.2	12.1	10.9
1991	12.6	11.4	10.3	12.2	14.6	14.0	12.7	11.4	12.8	9.4	12.2	11.5
1992	12.2	11.5	10.4	12.0	14.4	14.4	12.7	10.9	13.2	12.3	11.9	10.7
1993	10.3	11.0	9.8	11.6	14.3	13.8	12.1	10.6	12.5	9.6	13.6	11.1
1994	12.3	10.5	10.3	12.0	13.7	13.9	12.4	11.3	13.2	9.7	14.3	13.5
1995	12.4	10.0	10.2	12.1	13.6	14.3	12.4	9.2	13.2	10.2	14.0	12.1

Year	Arata	Asela	Huruta	Kulumsa	Ogolcho	Ziway	Arsi Neg	Bui	Butajra	Degaga	Langano	Wulbareg
1996	12.0	11.0	9.6	11.6	15.6	13.9	12.6	8.4	13.2	10.0	13.0	10.7
1997	12.5	10.8	10.0	12.1	16.3	14.5	13.1	8.8	13.3	10.1	14.8	7.3
1998	13.1	10.3	10.0	11.4	15.5	14.9	11.3	8.7	13.4	11.1	14.3	7.2
1999	12.0	11.0	9.9	11.9	13.3	12.5	10.1	6.7	11.9	9.4	13.1	11.1
2000	11.6	11.3	9.4	12.0	12.9	14.2	8.4	6.8	11.7	9.3	13.9	11.4
2001	12.2	9.1	9.5	12.1	13.0	14.6	11.3	7.1	11.7	10.3	14.1	11.4
2002	13.2	8.8	9.6	12.5	14.0	15.1	11.9	6.7	11.4	10.4	13.7	11.4
2003	12.7	8.6	10.5	12.5	12.9	14.9	11.4	7.8	11.1	10.1	14.6	11.1
2004	12.5	8.6	10.3	12.3	13.3	14.7	11.0	11.2	10.4	10.0	14.5	12.0
2005	12.2	8.6	9.6	11.9	13.6	14.4	10.6	11.4	10.1	10.4	14.4	11.1
2006	12.9	8.7	10.0	12.8	10.7	14.5	10.8	12.1	10.6	10.9	15.3	11.3
2007	12.7	8.5	9.6	2.7	13.1	13.4	8.2	10.3	11.3	10.1	13.9	10.7
2008	12.2	8.0	9.4	11.9	9.9	13.1	8.1	10.3	10.8	9.3	14.6	11.1
2009	12.6	8.3	9.4	11.9	13.5	14.7	10.3	12.2	12.8	10.1	15.0	13.9
2010	13.0	8.5	9.9	12.8	14.0	14.6	9.5	11.8	13.0	10.4	14.2	14.1
2011	12.7	8.5	9.8	12.1	13.6	14.2	10.7	12.1	12.7	10.4	12.6	13.7
2012	11.3	11.3	8.9	11.9	13.0	13.8	14.4	9.3	12.4	10.1	11.5	13.0
2013	12.8	10.2	9.8	12.5	13.6	14.2	14.0	9.0	12.9	10.9	13.2	13.7
2014	13.0	12.0	9.7	12.8	13.7	14.4	15.7	10.6	13.2	10.9	12.9	13.9
2015	13.4	12.3	9.7	12.8	15.4	14.9	14.8	12.2	13.8	10.9	13.0	14.7
2016	13.5	11.8	10.6	12.1	14.1	15.3	14.2	12.9	13.8	11.6	13.8	14.6
Average	**12.4**	**10.0**	**9.7**	**11.8**	**13.6**	**14.1**	**11.7**	**10.4**	**12.6**	**10.4**	**13.4**	**11.8**

Data source: National Meteorological Service Agency

Most of the meteorological stations in Central Rift Valley are class-4 type, which has only a rainfall data record. However, Ziway meteorological station has a record of most of the meteorological data. Hence, the average monthly data of relative humidity, sunshine hours and wind speed are indicated in Table below for Ziway meteorological station. The data is for the period from 1988 to 2016. However, the data for wind speed is from 2006 to 2016 because the record starts in 2006.

Table 22: Other Metrological Data

Month	Relative Humidity (%)	Sunshine Hours	Wind Speed (km/hr)
Jan	69	9.7	6.2
Feb	72	9.4	6.3
Mar	71	9.1	6.1
Apr	67	8.5	5.8
May	77	8.0	6.7
Jun	72	7.9	8.8
Jul	80	6.3	8.1
Aug	79	6.1	6.9
Sep	78	6.6	5
Oct	71	9.2	5.6
Nov	69	9.7	6.2
Dec	70	9.7	6.4

Data source: National Meteorological Service Agency

Also, according to the information obtained from participants of FGD and KII, the area is becoming vulnerable to climate change; as a result, it had to experience drought and continued to experience. The participants also indicated that the magnitude of temperature in the area is increasing from time to time while the seasonality of rain is becoming more unpredictable.

To substantiate the fact about climate variability, the study team posed a question of whether there is an indication of climate change/variability in the study areas. Thus, the perception of respondents about climate change confirms there is climate variability as shown below in table 23. Of the total respondent households, 90.9% replied that there is an indication of climate variability signals. Also, across the study kebeles, it is perceived that there is climate variability as detailed below in table 23.

Table 23: Perception of Respondents on Climate Change

Is there a change in the rainy season in the area?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Yes	44	15	11	35	32	31	21	189	90.9
No	7	2	2	1	3	3	1	19	9.1
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**	**100.0**

Based on the above fact, the respondent households' perception was captured as follows and the response was analyzed before the late 1980s and after the late 1980s. Previously (before the 1980s), one of the participants explained the trend of climate variability as follows.

> *''With little effort, we were getting high yield. But now, despite using improved inputs, we get less yield because of the climate change effect. Before the rainy season was constant, it was starting between March and April and Lasts up to September or October.''*

However, within the past two decades, during April and May crop sowing is not possible rather it is shifted to July or August because of the climate variability. The survey result also shows, as shown below in table 24, the same proportion of respondents reported that the normal rainy season starting time was either March (35.1%) or April (35.1%) and ending time was in September (53.4%). Others (37.5%) replied that the rain stops in October before the time of climate variability (table 25).

Table 24: The Start of Rainy Season before the Time of Climate Variability

When does the rainy season start?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
January	1	0	0	0	0	0	0	1	0.5
February	25	6	0	0	2	4	4	41	19.7
March	19	4	4	12	12	15	7	73	35.1
April	4	5	7	21	15	13	8	73	35.1
May	2	2	2	3	4	2	3	18	8.7
June	0	0	0	0	2	0	0	2	1.0
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**	**100.0**

Table 25: End of the Rainy Season before the time of Climate Variability

When does the rainy season stop?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
September	18	10	10	29	21	8	15	111	53.4
October	28	6	3	7	11	19	4	78	37.5
November	4	0	0	0	1	1	2	8	3.8
May	0	0	0	0	0	4	1	5	2.4
June	0	0	0	0	0	1	0	1	0.5
August	1	1	0	0	2	1	0	5	2.4
Total	**51**	**17**	**13**	**36**	**35**	**34**	**22**	**208**	**100.0**

According to the respondents, as of the late 1980s, the situation is changed completely. For example, as shown below in table 26, 33.5% of respondent households replied that after the time of climate variability, the rain starts in May. While 19.1% of respondents answered that it starts in April (table 26). On the other hand, though the views/ perceptions of respondent households across the study kebeles are different, the majority of respondents (29.3%) replied

that the rain stops in October and 23.4% of respondents replied that the rain stops in August (table 27).

Table 26: Start of the Rainy Season after the time of Climate Variability

When does the changed rainy season start?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
September	2	3	0	1	1	1	0	8	4.3
October	11	2	1	0	3	2	0	19	10.1
November	1	0	1	0	0	2	0	4	2.1
December	0	0	0	1	0	0	1	2	1.1
January	1	1	0	5	0	7	0	14	7.4
February	2	2	0	1	2	1	0	8	4.3
March	10	1	1	1	5	6	6	30	16.0
April	12	3	0	0	11	2	8	36	19.1
May	5	2	7	25	9	9	6	63	33.5
June	0	0	1	0	1	1	0	3	1.6
August	0	1	0	0	0	0	0	1	0.5
Total	44	15	11	34	32	31	21	188	100

Table 27: End of the Rainy Season After the time of Climate Variability

When does the changed rainy season stop	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
September	1	1	2	1	5	2	5	17	9.0
October	7	6	2	10	16	7	7	55	29.3
November	20	1	0	0	3	3	0	27	14.4
December	11	3	0	0	0	0	2	16	8.5
January	0	0	1	0	0	1	0	2	1.1
February	0	0	0	1	0	1	0	2	1.1
March	1	0	0	2	0	3	0	6	3.2
April	1	1	0	1	0	3	0	6	3.2
May	1	2	0	2	1	1	1	8	4.3
June	2	0	1	0	0	1	0	4	2.1
July	0	1	0	0	0	0	0	1	0.5
August	0	0	5	17	7	9	6	44	23.4
Total	44	15	11	34	32	31	21	188	100.0

4.10 Major Impacts of Climate Change

As shown below in table 27, respondents replied that the major climate change impacts to be an increase of water scarcity (15.4%), the decline of crop yield (14.1%), increasing frequency of drought (14.1%), Failure of some crops (12.8%), failure of total crops (12.6%), increasing of flooding/erosion (10.5%), food shortages (8.1%), deaths of livestock (7.2%), increase of crop diseases (5.2%).

Table 28: Climate Change Impacts

Climate change[a]	Responses		Percent of Cases
	N	Percent	
Increase of water scarcity	147	15.4	71.4
The decline of crop yield	135	14.1	65.5
Increasing the frequency of drought	135	14.1	65.5
Failure of some crops	122	12.8	59.2
Failure of total crops	120	12.6	58.3
Increasing of flooding/erosion	100	10.5	48.5
Food shortages	77	8.1	37.4
Deaths of livestock	69	7.2	33.5
Increase of crop diseases	50	5.2	24.3
Total	955	100.0	463.6

a. Dichotomy group tabulated at value 1.

Recently, researchers such as Araujo et al. (2016) have shown an increased interest to study climate variability and its influence. Thus, as their study result shows, although certainty in changes of rainfall pattern is much less, the results of climate models show that there is increasing concern that the temperature is predicted to rise in 40 years in the CRVB. Also, a study conducted by Gadissa et al. (2019), indicates that, in the past forty years, the temperature has increased by 1.5^0C and also expected to increase in the future due to global warming.

Rainfall is predicted to become more seasonal, with prolonged dry periods between rainfall events. Individual rainfall events are also likely to be more intense (Kundewicz et al. 2007). More water is likely to be 'lost' as runoff, and there will be a greater need to store water to mitigate these effects. Rainwater harvesting schemes may become less effective, as they are vulnerable to extended dry periods under existing climatic regimes.

Overall, more reliance may need to be placed on water supply technologies that utilize a water store (e.g. groundwater or dams). Increased intensity of rainfall will also pose a problem for drainage and sewerage disposal in urban and peri-urban areas. It is likely that low-capacity systems, or those that are in poor repair, will be overcome, leading to increased contamination (Hunter, 2003). In rural areas, where on-site sanitation (or no sanitation) co-exist alongside groundwater wells, increased flooding may overwhelm currently used sanitary protection measures, leading to damage or destruction of infrastructure and cross-contamination.

Also, the issue has grown in importance in light of recent climate variability. Surface water resources in Africa and South Asia are already strongly seasonal as a result of present climate variability. Variability in river flow is marked due to the migration of tropical rain belts in Africa and spring snowmelt in central Asia (Hulme 2001; Held et al. 2005; Tilahun 2006). Seasonal

variation is 'natural' variations; droughts and floods are already part of the existing climate variability experienced across the world (e.g. Verschuren et al. 2000). Soil moisture and small streams are most vulnerable to these changes, whereas deep groundwater drawing on many years' recharge is largely isolated from short-term fluctuations. Between these two extremes, larger rivers, lakes, and shallow groundwater can all be vulnerable to changes in climate, depending on local circumstances.

The potential impact of climate change on the availability of groundwater is poorly understood. This is partly because recharge processes are complex and poorly constrained – even without the complications of climate change (Döll and Fiedler 2008; Healy 2010). Many water supply services rely on groundwater, particularly in rural settings, so developing a better understanding of climate and groundwater links is vital (Calow and MacDonald 2009; Calow et al 2010). Climate change is likely to modify groundwater recharge patterns, as changes in precipitation and evaporation translate directly to shifts in soil moisture deficits and surface water runoff (Foster et al. 2008). Increases in rainfall intensity and evaporative demand will, more likely than not, result in the increased irregularity of groundwater recharge (Kundewicz et al. 2007).

However, groundwater recharge will also be affected by soil degradation and vegetation changes, both of which may be affected by climate and human drivers (Solomon et al. 2007). The resilience of groundwater to long-term (decadal) shifts in climate is governed by the available groundwater storage. Larger groundwater bodies contain groundwater storage several orders of magnitude greater than average annual recharge and will, therefore, respond very slowly to long-term changes (decadal) in recharge or short-term (inter-annual) shocks – for example the thick sandstone aquifers in northern Africa (MacDonald et al. 2011). Smaller groundwater bodies with lower storage will not be as resilient to long-term (decadal) changes in climate but may recover quickly from drought if recharged regularly (MacDonald et al. 2009, 2011).

For many people, the more important issue is the resilience of the water supplies dependent on groundwater, rather than the actual groundwater resource itself. Research from the behavior of water sources during droughts has shown that: 1) improved sources are much more reliable than unimproved sources (Bonsor et al. 2010), and 2) boreholes in higher-yielding (more permeable) aquifers are generally much more reliable than in lower-yielding aquifers (MacDonald et al. 2009). These observations indicate that the permeability of aquifers should be considered alongside storage and long-term recharge to the aquifer when investigating the resilience of water sources to changes in climate. Work by MacDonald et al. 2011 in Africa has indicated that for much of Africa, carefully sited and well-constructed boreholes will be able to sustain rural domestic water demand even with predicted climate

change. In some semi-arid and arid areas, groundwater-levels may be below the depth at which the groundwater can be easily exploited, but these areas are generally less densely populated than wetter areas (MacDonald et al. 2011).

4.10.1 The impact of floods on WASH Service Delivery

Flooding incidence was reported during the household surveys as well as during FGDs and KIIS in the study areas. This happens mostly when there is heavy rainfall due to the erratic rainfall pattern in the CRVB. Floods frequently trigger major destruction to basic facilities such as water supplies, sanitation, waste disposal systems, and other essential services. This causes a critical challenge to public health. Extreme rain and flooding can create conditions that increase the spread of fecal-oral diseases because floodwaters flush pathogens and pollutants into water supplies from flooded latrines and places used for open defecation.

Surveys such as that conducted by the Ethiopian Red Cross/Red Crescent (2005) have shown that on top of polluting water sources, floods also can damage shallow wells, boreholes fitted with windmills, and protected springs, and they can Wash away water pipes. The result is that people are unable to access safe drinking water unless temporary water supplies can be provided (ibid).

4.10.2 Impacts of Drought on WASH Service Delivery

The finding shows that there is a recurrent drought due to climate variability in the study areas. It is now well established that drought can impair WASH Service Delivery. A study conducted by (Kovats et al., 2003 in Open WASH modules, 2016) indicates that drought causes shortages of food and surface water, droughts have a significant effect on the availability of safe water resources. Drought instigates water scarcity, so people are more prospective to use insecure water sources such as polluted rivers, streams and lakes. During times of water scarcity, people may rescue any kind of water they can find for drinking and cooking, and stop using it for hygiene activities such as handwashing after excretion. The same source attempts to show that drought can also escalate the intensification of pathogenic organisms in rivers and lakes for the reason that the low-down volume of water cannot water down the pollutants to lower than the contagious prescribed amount.

4.11 Natural Resource Management

As shown below in table 29, the survey result shows that degradation of natural resources is mentioned as number one by 62.0% of respondents, scarcity of natural resources is ranked as the second major problem by 37.0% respondents and the issue of ownership of natural resources took the third place with natural resources related problems though it is not a significant problem compared to the other two. It is possible to conclude that all the study tools e.g., the literature review, the KII and FGD and the household Survey results indicate that natural resources related problems are critical in terms of degradation and scarcity. In this

context, natural resources refer to water, forest, and soil. The magnitude of the degradation of resources and the mal management of resources explained by the participants as follows:

> *''We were collecting an animal feed from fields before it was changed to cropland. The forest cover was also good especially during the time of Emperor H/Selassie I. Deforestation contributed to flee away from the wildlife. Even if the land was distributed for individual farmers during the Derg regime, the land management didn't get due attention by both the landholders and the development actors at all level except the campaign of soil and water conservation works and to some extent tree plantation on communal lands and individual holdings in a year base''.*

According to Pandurang et al., (2013), soil and water are natural resources which are essential for the survival of human being who depend on them for basic needs. However, one of the greatest challenges is the continued pressure and over-exploitation of these essential resources to meet the demands of an ever-increasing population. This, in turn, challenged the availability of freshwater in terms of quantity and quality due to hydrological cycle imbalance because of the depletion of these precious resources. In the study areas, the degradation and depletion of the natural resources particularly soil, water, and forest resources contributed to the decrease /shrink of freshwater resources that sequentially created a challenge to address the ever-increasing needs of proper WaSH Service Delivery among the needy community.

Table 29: Major Natural Resources Related Problems in the Study Areas

Problem Types	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Degradation	44	11	6	23	14	21	9	128	62.0
Scarcity	5	7	7	13	21	11	13	77	37.0
Ownership	2	0	0	0	0	1	0	3	1.0
Total	51	18	13	36	35	33	22	208	100.0

Concerning Faunas, Lesser Kudu, Bush Duiker, Rabbit, Hyena, Jackal, warthog, Vervet Monkey, Guinea fowl, etc., are reported to exist in the Woredas and in some study kebeles too. According to the FGD, however, the number of all the wildlife which exists in the area is declining from time to time due to the destruction of habitat. Thus, reforestation through all means (Enclosure, enrichment plantings, etc.) needs to be straightened. The following table (indicate observed Wildlife and tree species in the area.

Table 30: List of Available Flora and Fauna in the Study Areas

Local/ Common Name	Scientific Name	Sources I=indigenous E=Exotic	Status D=Dominant R=Rare T=Threatened En =Endangered	Remark
Flora				
Kega	Rosa abyssinica	I	R	
Dodota	Acacia gerrardii	I	R	
Badano	Grewia flavescent	I	D	
Dhadhacha	Acacia Abyssinica	I	D	
Kombolcha	Mytenus ovatus	I	R	
Birbirsa	Podocarpus glacilior	I	R	
Coffee	Coffee arabica	I	R	
Avocado	Persi americana	E	R	
Banana	Musa	I	R	
Kurkura	Ziziphus spina-christi	I	R	
Casimir	Casimiroa edulis	E	R	Mexican apple
Aroresa	Grewia mollis	I	R	
Bakanisa	Vernonia amygdalina	I	D	
Ajo		I		
Tumuga	Adhatoda schimperana	I	D	
Baargamoo Dima	Eucalyptus camaldulensis	E	R	
Lucinea	Lucinea Leucocephala	E	R	
Kinchib	Euphorbia tirucalli	I	D	Abundant around homestead
Shawshewe	Casuarina eqisetifolia	E	R	
Hidi	Solanum campylacanthum	E	D	
Kulkual/Beles	Ficus carica	I	D	
Nim	Azandiracha indica	E	R	
kundoberbere	Schinus Molle	I	R	
Peritoneum	Asparagus officinalis	E	D	A kind of weed introduced with aid cereals, most potent, strongest weed on the planet
Harcha/ Cheka	Sesbania sesban	I	D	
Oda	Ficus sycomorus	I	T	
Kobbo	Ricinus communis	I	D	
Fauna				
Gadamisa	Tragelaphus imberbis)	I	En	Lesser Kudu
Bosonu	T. sylvaticus	I	En	Bushbuck
Borofa	Nanger granti	I	En	Grant's gazelle
Kurupe	Sylvicapra grimmia	I	T	Bush Duiker
Illetti	Oryctolagus cuniculus	I	R	Rabbit
Golja	Phacochoerus africanus	I	D	Warthog
Qeerrensi	Panthera pardus	I	T	Leopard
Qamale	Chlorocebus pygerythrus	I	R	Vervet Monkey
Waraabessa	Hyaenidae	I	D	Hyena

Local/ Common Name	Scientific Name	Sources I=indigenous E=Exotic	Status D=Dominant R=Rare T=Threatened En =Endangered	Remark
Jedala	Canis adustus	I	R	Jackal
Tede	Erethizon dorsatum	I	R	Porcupine
Guchi	Struthio camelus	I	R	Ostrich
Sololia	Numdidae	I	D	Guinea fowl
Gogorri	Francolinus pondicerianus	I	D	Francolin
Dakiye	Anas platyrhynchos	I	R	Duck/Goose
Jawe	Cordylus giganteus	I	R	African dragon
Bofa	Serpentes	I	D	Snake

4.12 Capacity Building

Capacity building training facilitates not only personal ability to better understand to perform tasks but also improve cooperation and collaborations among individuals and groups. Of the total respondents (n=208), 85.1% (n=177) had training opportunities in one or more of the following training categories across all the study kebeles. As shown below in table 31, the training types received by the respondents were improved farming technologies, soil and water conservation, alternative livelihood, on-farm water management, water harvesting, operation and maintenance of water resource schemes and water-saving technology, respectively.

Table 31: Capacity Building Trainings

Training types[a]	Responses		Percent of Cases
	N	Percent	
Improved farming technologies	96	24.3	54.2
Soil and water conservation	92	23.3	52.0
Alternative livelihood	90	22.8	50.8
On-farm Water Management	59	14.9	33.3
Water Harvesting	25	6.3	14.1
Operation and maintenance of water resource schemes	17	4.3	9.6
Water-saving technology	16	4.1	9.0
Total	395	100.0	223.2
a. Dichotomy group tabulated at value 1.			

The nature of the training was a demonstration (61.4%), experience sharing visit (77.7%), and in-class training (20.5%). The training was given by more than one training provider including development agents 89.2%, expert from Woreda offices 70.5%, and NGOs 33.7%. This fact implies that the community in the area has an awareness of many aspects that have direct relevance to Natural resource management including water. Further effort should focus on strengthening the existing practice. Moreover, as shown below in table 32, the assessment to

identify community training interest indicates that the surveyed HHs have interest on the followings: Alternative livelihood (30.8%), Improved farming technologies (23.4%), Operation and maintenance of water resource schemes (9.1%), and Soil and water conservation (21.5%) and 15.3% of respondent households are interested in Water Harvesting/Water-saving technology / on-farm water Management training. Also as shown below in table 33, respondent households explained their interest in what training modality to be handled to conduct training in the future. Thus, 39.0% of respondents prefer experience sharing visits, 33.8% prefer demonstration, 18.0% indoor training, and 9.3% outdoor training

Table 32: Future needs for capacity building training

Training needs	Responses		Percent of Cases
	N	Percent	
Alternative livelihood	129	30.8	74.1
Improved farming technologies	98	23.4	56.3
Operation and maintenance of water resource schemes	38	9.1	21.8
Soil and water conservation	90	21.5	51.7
Water Harvesting/Water-saving technology / on-farm water Management	64	15.3	36.8
Total	419	100.0	240.8

a. Dichotomy group tabulated at value 1.

Table 33: Training modality that the community prefers

Training Modality	Responses		Percent of Cases
	N	Percent	
Demonstration	124	33.8	68.9
Experience sharing visits	143	39.0	79.4
In door training's	66	18.0	36.7
Outdoor Training	34	9.3	18.9
Total	367	100.0	203.9

a. Dichotomy group tabulated at value 1.

4.13 Access to Social Amenity

Social amenity includes availability and access to basic services including road, electricity, school, water supply, health services, etc. It also refers to the household's networks and bonds with other households or individuals in the community.

There are all-weather roads that connect the three Woredas with other adjacent Woredas as well as kebeles. The study kebeles are connected with dry weather roads. As a means of transportation, communities use a cart, Bajaj to a greater extent and occasionally vehicle in places where the road is suitable for vehicle driving.

At the kebele level, at least, there is one primary school and even more in those kebeles which are located near to towns. As discussed earlier, scarcity water challenges the education program and the number of dropouts is increasing from time to time due to the water scarcity in the villages and the school compounds as well. The source of drinking water for almost all the whole communities is groundwater in the form of community tap water though the availability differs across all the study kebeles.

Besides, at the kebele level there are health posts even further in some kebeles such as Toga and Awasho Denku there are health centers despite there is water scarcity to give service to the required level. Some of them discussed in detail in Annex A.

As shown below in table 34, regarding the source of energy, almost all of the community members from the study kebeles, (55.8%) use firewood as source of energy, 12.5% use crop residue, 16.8 % use animal dung and the rest 14.9% of respondents use electricity especially those kebeles located in the periphery of the town. The study result clearly shows firewood is the most usable energy sources and one can infer that the forest resource is at high risk. It has also a direct link with water resources. Loss of forest resources intensifies erosion that resulted in the reduction of percolation of runoff to the ground and sedimentation of lakes and rivers. As a means to loosen the dependence on biomass energy which is enhancing soil erosion and land degradation, providing access to electric energy and the promotion of energy-efficient stoves is crucial.

Table 34: Major Energy Sources in the Study Kebeles

Major sources of energy	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubet a Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Fire wood	48	14	8	2	23	3	18	116	55.8
Crop residue	2	1	5	6	8	2	2	26	12.5
Animal dung	0	0	0	11	5	17	2	35	16.8
Electricity	1	2	0	16	0	12	0	31	14.9
Total	51	17	13	35	36	34	22	208	100.0

Table 35: Main Sources of Wood Products in the Study Kebeles

Main sources of wood products?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Nearby common forestland	22	9	5	22	12	23	2	95	45.7
Buy from traders	14	4	4	9	11	6	19	67	32.2

Main sources of wood products?	Name of Kebele							Total	%
	Awasho Denku	Toga	Gubeta Arjo	Garbi Widdena Boramu	Ali Wayyo	Edo Gojala	Edo Jigessa		
Own woodlot	13	1	4	5	10	5	1	39	18.8
Other	2	3	0	0	2	0	0	7	3.4
Total	51	17	13	36	35	34	22	208	100.0

Furthermore, as shown above, in table 35, majority of the respondent households (45.7%) fulfils their requirement of wood products from the nearby common forestland, 32.2% of respondents buy from others to meet their demand of wood products, and 18.8% of respondents use their woodlot to fulfil their wood product requirements. From this study result, it is possible to say the tree planting practice at the HH level is far behind. Thus, much effort is expected from the respective Woredas where the study is conducted. The promotion of tree planting at the household level has a multiplier effect in terms of reduction of soil erosion, improvement of the microclimate and regulation especially climate variability, groundwater and reduce the burden on the remnant natural vegetation.

4.14 NGOs operating in the Area

According to the social and labour affairs office of the Woredas, many NGOs are operating in the area in addition to Wetland International. Their mission is varied and diverse. As the study team informed that their effort is scattered; because of this, the community complains that the outcomes from each NGO are not visible. There are many thematic areas to be implemented, e.g., Environmental/natural resource management, Potable water development, introducing and promoting improved agricultural practices, etc. in the three Woredas where the study is conducted. During the FGDs and KIIs at Woredas and kebeles level, it was reported that food security status is critical at the HHs level and needs the attention of all stakeholders working in the area. As per the participants, the produce they earn from agricultural activities is not sufficient due to the low yield resulted from the erratic rainfall pattern caused by the continued climate variability in the Woredas.

4.15 Lesson from Existing WASH Service Delivery program

Many WASH schemes in Ethiopia have performance problem including the study areas. Most schemes are functioning below their design capacity or they don't give service at all. This is mainly attributed to structural and institutional problems.

According to the KII in Edo Gojala Kebele of Adami Tulu Jido Kombolcha Woreda, the water schemes (hand pump) constructed in the school compound (Edo Kontela, 1-6) by One WASH program as shown below in figure 16, doesn't give the required service for the school community because of the displacement of the solar panel that was giving service to pump the water. According to the school principal, because of the scarcity of water in the school compound, the dropout rate of school children reached 12% of the total of 479 students who

are currently attending class. Therefore, one of the important lessons from this experience in whatever the case, it is an urgent need to include stakeholders effectively in the planning, design, and management of WASH water schemes. This includes extensive consultation with stakeholders, ensuring that opinions are well apprehended, empowering the community in managing schemes and ensuring that local people become key players.

Figure 16: A water scheme Constructed in Edo Kontela School Compound

Besides, it was possible to learn that dependence syndrome developing in the area, that the community is trying less to solve their problems, the use and are waiting for external/government to solve every problem. So, the development actors should be conscious to create awareness among the community to avoid a dependence syndrome.

Moreover, broken promises should be taken as a lesson, some actors (themselves or through consultants they hire to undertake some tasks) used to promise what they cannot actualize just to get the community on their side for the moment. This is eroding trust and cooperation from the community. Thus, Development actors should be very careful not to promise what cannot be fulfilled.

The absence or weak collaboration platform among the NGOs and GO at the grassroots level is the other aspect to be learned from WaSH Service Delivery related issues. This not only gives

a chance to waste resources but also creates a vacuum or overlapping space at the community level which leads to building resistance than cooperation. As discussed in the Summary of FGDs and KIIs (Annex A), this may lead to the emerging of conflict between upstream and downstream users. In this case, upstream people detain water from reaching the downstream users claiming that it's their only resource.

4.16 Interventions to be considered in the future

4.16.1 Integrated Watershed Management

The study findings show that water scarcity is aggravated by the lack of proper management of natural resources such as forest, water, and soil. It needs the attention of all development actors who are operating in the CRVB and the integrated watershed management approach needs to be promoted. As a consequence, the integrated watershed management directly contributes to alleviating the problem of water scarcity in the CRVB that can improve water access and thereby improve the WASH Service Delivery which is a severe problem in the CRVB in general and study Woredas/Kebeles in particular.

Recently, a considerable literature has grown up around the theme of Integrated Watershed Management (IWM). IWM is a holistic approach to managing watershed resources that integrates forestry, agriculture, pasture water management, and people, with an objective of sustainable management of natural resources (Pandit et al., 2007). Watershed management also refers to the process of creating and implementing plans, programs, and projects to sustain and enhance watershed functions that affect the plant, animal and human communities within a watershed boundary. Effective watershed management can prevent community water shortages, poor water quality, flooding and erosion (Taiwari and Sharma, 2015). It can also serve as a tool to enhance cooperation and collaboration between upstream n downstream users and among inhabitants in different micro watersheds.

The Integrated Watershed management endeavour should be extended to developing and managing rivers and riversides which are largely waste deposal sites that have propagated effect on the community residing along the lakes and rivers.

4.16.2 Ecohydrology

4.16.2.1 The concept of Ecohydrology

The UNESCO definition (Zalewski et al., 1997) of Ecohydrology is an integrated understanding of biological and hydrological processes at a catchment scale to create a scientific basis for a socially acceptable, cost-effective, and systemic approach to the sustainable management of freshwater resources. Despite the fact this has long been recognized as an approach in freshwaters, it is only recently within the last decade that the term has been used relating to wetland management.

Increased competition for the limited water resource has resulted in the rapid depletion of sources which in turn creates an unmanageable water scarcity problem. Such scarcity of resources also results in conflicts between upstream and downstream users of land, forest and water (Pandit et al., 2007; Taiwari and Pandurang et al, 2015).

4.16.2.2 Introduction and Promotion of Ecohydroly Approach

Environmental degradation can only be remedied by restoring some of the functions of the ecosystem, helping the partially restored system improve itself naturally, removing stressors, replacing habitats that have been lost and improving the robustness of the ecosystem to absorb human stresses. Some of the aquatic ecosystem functions can be restored by a combination of engineering, hydrology, ecology, and phytotechnology (i.e. using and harvesting plants to remove nutrients and contaminants from water, Lakes in the CRVB and Rivers like Bulbula could be the case in point) solutions to improve the healthiness of the wetland ecosystems.

Ecohydrology supports to ascertain the structure, function, and evolution of freshwater ecosystems. Rivers, lakes, reservoirs, wetlands, and underground ecosystems driven by groundwater flows can be included as freshwater ecosystems. Reinstating Ecohydrological links, targets to get well ecosystem function and service conveyance through intensifying the carrying capacity of ecosystems. Handling antique and unique ecosystems sequentially to escalate their service conveyance in terms of water resources and resistance to the overall change are the intentions of Ecohydrology rather than “preventing” ecosystems.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The current status of WASH Service Delivery is challenged by multiple factors such as Environmental degradation accompanied by low precipitation, recurrent drought, and erratic rainfall pattern. This in turn, challenged the food security status in the CRVB in general and study Woredas/Kebeles in particular. The other major problem for the WASH Service Delivery is an inefficient institutional arrangement. On one hand, there are functional water structures but when it is evaluated from the equity water distribution point of view, there is a gap (unfairness by water technical personnel). On the other hand, most of the water structures are idle or not functional because, either their parts are broken down or no budget to replace them. Besides, lack of chlorination after the construction of the water points led to water-borne diseases and water-related diseases such as skin diseases like scabies and eye disease like trachoma.

The other most important problem that challenges the WASH Service Delivery in the study areas or kebeles is pollution which is majorly divided into two categories, namely, point source pollution and non-point source pollution. Point source pollution is happening from industries, households, teaching institutions like colleges and the non-point sources are irrigation farms that use agrochemicals and other inputs. Because of this and other factors, Lake Ziway is no more in use for drinking. Not only this but also because of the high concentration of chemicals in Lake Ziway, a fishing activity that was supporting the livelihood of many fishermen is halted and the activity is shifted to Lake Langano.

Moreover, the trend analysis of climate change shows that there is an increasing trend in temperature and low precipitation associated with it. The perception of respondents about climate change confirms there is climate variability. This continued variability resulted in increased floods and drought, which imposed significant impacts on water resource availability. The cumulative effect of this phenomenon led the local community to poor WASH Service Delivery and equally contribute to food insecurity in the CRVB including the study areas.

On the other hand, drought instigates water scarcity, so people are more prospective to use insecure water sources such as polluted rivers, streams and lakes. Moreover, the finding indicates that deforestation and land degradation are the most depressive problems in the study area. Hence, environmental protection needs to be enhanced and promoted. Social capital and welfare of farmers are highly interlocked to agriculture, and land for this purpose must be managed appropriately in a sustainable manner.

A projection of water demand made considering the growth in irrigation, industrial developments, and rises in domestic water requirements due to an increase in population and

per capita water demands suggests that the total annual water demand will be far beyond the available water resources in the area. Continued practices of inefficient water use in the area will give a chance to worsen the shortage. The main water demand sectors in the basin are irrigation, industrial, domestic, livestock, and environmental flow requirement. The main challenge faced in the CRVB is, more than 95% of the water consumption is from irrigation. The current annual water demand is 566.73MCM.

The study finding also shows that water scarcity is associated with increased experience of overexploitation, pollution, siltation, and uncontrolled population growth are mentioned as key factors to exacerbate water scarcity that in turn, affected the WASH Service Delivery to pronounced magnitude. For the overexploitation, investment companies like floriculture farms and small-scale irrigation users whose number is greater than5000 are blameable. Among other things, lack of ESIA and ESMP for big investment projects create an opportunity for water bodies' pollution and high-water abstraction.

The finding also indicates that floods and drought had a triggering effect on poor WASH Service Delivery. For example, floods frequently trigger major destruction to basic facilities such as water supplies, sanitation, waste disposal systems, and other essential services. On the other hand, drought instigates water scarcity, so people are more prospective to use insecure water sources such as polluted rivers, streams and lakes.

Out of all forms of discussions during the study period, it was also noted that climate variability is already affecting the livelihoods of the local community and continued to affect. Extreme weather events also are affecting human health in terms of waterborne and water-related diseases, low agricultural production and productivity and economy of the local community.

Furthermore, the finding indicates that deforestation and land degradation are the most depressive problems in the study area. Hence, environmental protection needs to be enhanced and promoted. Social capital and welfare of farmers are highly interlocked to agriculture, and land for this purpose must be managed appropriately in a sustainable manner as well.

Generally, there is a need for stretching the diversity to relatively compensate for the constrained low level of agricultural production and incomes since the area is food insecure. In parallel, technical training and awareness of natural resource management are very essential. And to reduce and remove the adverse effect of deforestation, the distribution of improved cooking stoves must be considered as an immediate action to improve the efficiency of the household's energy and conserve the remaining forests in the study area.

Surprisingly, the result of the projection made for the coming 45 years shows that the available water is by far less than the projected demand in the scenario period. Hence, it will not satisfy

the demand in the coming 30 years even under advanced irrigation systems. So, it wisely to promote efficient water uses in the area for all use category.

5.2 Recommendations

- Lack of ESIA and ESMP for big investment projects aggravated the water pollution and paved them away to abstract water as much as they can. Thus, relevant sector offices, should give due attention and should consider ESIA and ESMP as a prerequisite before investment projects are implemented;
- To reduce and remove the adverse effects of deforestation, tree planting must be one of the important remedies in the restoration of degraded lands including wetlands. On the other hand, distribution of improved cooking stoves must be promoted to improve the efficiency of households' energy and conserve the remaining forests in the study areas;
- Climate Change issue is understood by everyone in the study site, and they are left desperate without technical and financial capability to cope up so that Climate Change Vulnerability and copying mechanism should be dealt with in detail to safeguard the local community from the severe impact of Climate Change;
- Due to disorganized institutional arrangement, functional water structures do not give service at their full capacity to the local community so that strengthening of institutional capacity is a critical issue to be addressed. On the other hand, most of the water structures are idle or not functional because, either their parts are broken down or no budget to replace them. Thus, proper budgeting for maintenance is a must to overcome the interruption of the WASH service Delivery;
- Lack of chlorination after the construction of the water points is reported that paves the way to water-borne diseases so that scheduled chlorination needs to be implemented in places where the community water taps are located;
- Unavailability of water in school compounds let to drop the quality of education because more students forced to halt their schooling rather, they are engaged in search/ fetch of water for their families. Moreover, students become dropout since they migrate with their families in search of water until the rainy season comes back. Efforts should be exerted by all concerned to reverse the situation.
- During FGDs at the kebele level, it was possible to know that the urban settlers are discharging wastes to the water bodies (lakes, rivers); thus, Lake and riverside development should be expanded.
- As has been witnessed during discussions with stakeholders, food insecurity, and malnutrition of children is common so that alternative income sources need to be addressed either by the government or NGOs operating in the CRVB.
- As per the projection made for the coming 45 years, the available water is by far less than the projected demand in the scenario period. Hence, it will not satisfy the demand

in the coming 30 years even under advanced irrigation systems. Thus, it is recommended to implement the IWM approach based on newly introduced ***Eco hydrology*** principles. Previous studies show that it has the potential to ascertain the structure, function, and evolution of freshwater ecosystems (rivers, lakes, reservoirs, wetlands, and underground ecosystems driven by groundwater flows).

- There is an incidence of conflict over water resources among the upstream and downstream users unless proactively and systematically approached the incidence may scale up. So, it is crucial to establish a platform that brings together the users (upstream and downstream, dwellers different micro watershed) and development actors.

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APPENDIXES

Appendix A: Summary of FGDs and KIIs

1 Woreda level KII and FGDs

1.1 ATJK Woreda

Woreda officials expounded that there is an intermittent water audit both in the town and the rural kebeles. The climate variability is affecting groundwater to the inordinate degree. Also, investments that are undergoing around or near Lake Ziway and Bulbula River are affecting the groundwater availability for livestock as well for domestic consumption. The rural community uses groundwater and pond for their household and livestock consumption. The groundwater is dug by the government and payment is managed by the water committee. High water abstraction from Lake Ziway is affecting the water balance. For example, SherEthipia abstracts 750m^3 of water per second. That rainfall irregularity and the WASH service delivery is under threat by water scarcity. There has been a decrease in the water table as well as flood management ditches have been filled with solid wastes dumped by the community. There is a poor solid and liquid waste management system.

According to the officials, the latrine coverage is very poor, which is only 56%. And most of the latrine is poorly constructed and is shared. Infectious diseases have been resurgent such as waterborne and water-related diseases. The most common water-borne diseases are reported to be diarrhea, Giardia, and typhus. Scabies is also the most common skin disease with water-related problems in addition to trachoma. The area is reported to be food insecure. Because of this, 26 kebeles in ATJK are in the productive Safety Net Program (PSNP) and 743 children get a supply of plampet to supplement their nutrient deficiency. Malaria is also a problem due to improper drainage and sewerage system. Last year, there were 300 malaria cases but this year, it doubled. Drought is another problem that exacerbates the scarcity of water during the long dry spell period.

The problem associated with groundwater is high-level fluoride. Deforestation for different purposes is aggravating the weather-related variability in the entire Woreda. Relating to pollution, SherEthiopia and small-scale irrigation users are contributing to the pollution of Lake Ziway and Bulbula River. Soil pollution is also another challenge due to the ever-increasing application of chemical fertilizers and agrochemicals. Moreover, aquatic animals like fish are highly affected by pollution. The newly emerged problem is water hycine on Lake Ziway. Overall, the wetlands are drying up. Lake Abiyita is the case in point due to the Soda Ash project.

The KII participants in the relevant Woreda sector offices, also notified that training was given by Wetlands International on how to keep and maintain the natural resources. They also informed the study team they had a joint discussion with Addis Ababa, Wolkite, and Arsi, Universities, SherEthiopia and Embassy of the Netherlands on how to maintain the wetlands in the surrounding areas. Nevertheless, when issues raised by participants concerning the pollution of the water bodies by SherEthiopia, no one gives due attention. The problem of pollution is associated with a lack of Environmental and Social Impact Assessment (ESIA)

before the investment projects are implemented. When this issue is raised individuals are blackmailed and considered as ''antagonistic of development''. Besides, it is disused that organizations such as the slaughterhouse, Soda Ash, Castle Winery investment projects have no ESIA and ESMP.

1.2 Arsi Negele Woreda

Despite there are efforts to improve the vegetation cover in the area, the seedling survival rate is found very low. However, area closure is an effective approach as there is adequate seed bank in the soil. Zero grazings should be promoted to control degradation since free grazing is contributing to soil erosion. Poor Policy enforcement is also contributing to resource degradation as there is no proper land use but practice such as cultivating forest land is aggravating soil erosion.

The surrounding mountains that are contributing water for the community and the nearby lakes are cleared off vegetation and there is a declining trend of groundwater recharge. It was stressed by discussants that without these mountains, there will be no sustainable water resources in the area. The local alcohol production in the area is facilitating the clearing of the forest from these mountains, thus, creating alternative energy sources for the alcohol production could reduce the burden on the mountain forest, particularly the burden on Abaro Mountain which is contributing to the water resources of the nearby lakes. It is discussed that Also, the size of springs that arises from Abaro Mountain is declining from time to time.

Urbanization is another factor affecting forest in the area and thereby the water resources availability and WASH Service are challenged correspondingly. As a result, land degradation is becoming severe, in some areas, there is no wood to construct a toilet, and there is no water to prevent water-borne disease (Malaria, Diarrhoea) that needs immediate action. There is 17ha of land managed through area closure in the low land area and 900 ha on the highland area of the Wereda. Disappeared wildlife is coming back to these areas. The people whose livelihood is based on the Areke production, also have no water but they are contributing to the disappearance of water sources by encouraging deforestation in the surrounding area. On top of deforestation, it is contributing to Poor WASH service, Land degradation, climate change.

They stressed that this is happening by human and the solution is also human. Population growth is also causing land degradation as there is an expansion of agricultural land People coming to Negele from all across the country and to support their lives. Some are engaged in illegal logging; some others are involved in charcoal production. So, the highland forest is threatened by lumber production and the low land forest is threatened by charcoaling. Awareness among the community should be strongly promoted to improve and also ensures WASH Service.

On the other hand, following reforestation and SWC efforts in some areas, the discharge of springs in those areas is improving. Conversely, there is a case where discharge is declining due to poor management (a spring whose discharge was 30 lit/s is declined to 12 li/s. The

other one has also declined from 12 lit/s to 2 lit/s). The worst is yet to come if action is not taken on time since the rivers are also declining and disappearing. The other problem raised by KII participants is tree planting like eucalyptus which is not environmentally friendly and farming on wetland areas is becoming common. Also, the urban areas are discharging waste to the water bodies, thus riverside development should be expanded. There are community nurseries in the Woreda, producing seedlings that are suitable to the three agro-ecologies of the Woreda (Kola, Woynadega, and Dega). There is a shortage of water resources and also accessibility in the area, expansion of public water points is crucial.

The community is getting water once in about every week time, there is a worry that the problem may be worsening, almost all the health centers in the Woreda have no water. This affects WASH service delivery. For instance, women are sent home without proper hygiene after delivery due to a shortage of water. There is always a queue at water points and it has the potential to trigger conflict among users. As clearly explained by participants of the Woreda sector office representatives, there is always conflict over irrigation water. There could be no sanitation without water; skin disease is highly expanding in the Woreda as a result. There is a campaign to promote sanitation in the Woreda.

1.3 Shashemene Zuria Woreda

Water scarcity is the major problem which increases the rate of dropout students from schools. Moreover, the unavailability of water in school decreases the quality of education because more students are halt attending classes rather, they engaged in search/ fetch water for their families.

In some kebeles, not only students but also students' families had no water for both human and animals in the area, to overcome the problem, they migrate to other areas until the rainy season comes back. During migration, students become dropout since they migrate with their families. Moreover, due to the absence/shortage of water in the schools, about 754 students are dropout in this academic year. Also, due to a shortage of water, students and their families are exposed to different diseases such as typhoid/typhus, cholera, etc. the problem of water in the Woreda is not only lack of availability, it is also associated with lack of accessibility. Attention is not given by the relevant stakeholders; for example, in Toga and Awasho kebeles, the pipeline was connected already but, no water at all. Even now, in Shashemene Woreda, the stress is continued because there are no natural resources and watershed management to sustain the sources of existing water and rehabilitation.

In the entire Woreda, climate change is increasing from time to time because of the degradation of natural resources such as forest, soil, and change of agro-ecology Zones. For example, the expansion of kola to Wayina Dega and Dega with high intensity of temperature. There is no enough watershed management regarding soil and water conservation and afforestation. People continued using the exiting forest for charcoal, construction, and cooking because of the absence of an alternative energy source for the people. To the extent, protected forest land around Sole degraded by illegal loggers whose address is not known clearly. Expansion of deforestation contributes to topsoil loss and in the reduction of the

productivity of the land. From time to time, the environment is changing due to high population growth in the Woreda and this made high stress on natural resources. Another big challenge in the Woreda is less water holding capacity of the soil. Since the soil type in the area is sandy soil, the moisture does not reach the root zone of the crop which leads to the decrease in productivity, total or partial failure of the crops before they reach the maturity stage. The Woreda has wetland areas and yet not protected. Even though the Woreda has enough water sources, participants have a feeling that groundwater highly exploited. For example, Selam Water Bottling Factory produces about 60, 000lit/day. According to them, sooner or later this will impose additional water scarcity burden among the upper and downstream community.

2 Kebele Level FGDs and KIIs

2.1 Garbi Widdena Kebele

Previously, there was a shortage of water for drinking but thanks to Christian Service International (CSI), a new water scheme is constructed. Before the animals have to travel about 7kms (Garbi river) single trip to drink water but at this time, since cattle trough was also constructed inside the compound of the water well near the reservoir, the domestic animals get water for drinking. In the case of the newly constructed water scheme, no chlorination since it is considered new by experts from the Woreda water office.

They explained that they didn't face any water-borne diseases so far. Along the Garbi River, some farmers are using small scale irrigation. Their number is 20 to 30 farming households. They pay 30 to 50 cents for 1 Jerrican depending on the size of the Jerrican. The community uses the water not only for human consumption but also for their livestock. The average consumption per day is, a sheep and a goat consume 10 liters of water, an ox and a cow 20 liters, calf 10 liters, a donkey 20 liters, a horse and a mule together consume 80 liters/day. 10 Chickens consume 1.5litres per day a dog consumes 1litre per day. Bee colonies consume 5 liters per two days per hive. During the dry period, the households informed that they use water for watering seedlings planted in their back/front yards. The consumption is 5 liters per/seedling/day. Individuals pay 30cents/head.

The households fetch water two times a day with no limit. The water scheme is constructed by CSI in September 2019. It gives service for both humans and livestock. Five kebeles namely, Halaku, Guranda, Boke, Gobasochu, and Garbi Widdena (Boramu and Ankerusa Villages) use this community water tap. 50m^3 reservoir and a Rotto with a capacity of 1400 liters of water are installed and it is filled two times a day. The depth of the well is 85m. The participants also explained that there is a water audit every two weeks.

There are a growing fear and concern among the community in relation to the water supply. They assume that it might be interrupted during the rainy season since the solar panel that gives service for pumping might be obstructed by the cloud. The communities' view who were fetching water was requested about the sustainability of the groundwater. Hence, they suggested that environmental protection like seedling plantation which are environmentally

and water-friendly species should be done at the periphery of the water well compound and around the fence to maintain the sustainability of the groundwater.

The other challenge in the kebele is climate variability that forced the community to experience irregular rainfall patterns, yield reduction, partial or total crop failure, new disease on plants, animals and the human population.

Concerning environmental degradation, they explained that wetlands whom they know in their childhood time are disappearing due to agricultural expansion, sedimentation, industrial expansion, deforestation due to population growth, overexploitation of fish and pollution from industries and smallholders who use agrochemicals. The development agent who is working in the kebele explained that over 5000 irrigation users apply agrochemicals. The fish resource in Lake Ziway is polluted with heavy metals and due to this, fishing is halted from this Lake rather those who are engaged in fishing turned their face to Lake Langano. As a new phenomenon, they told sadly, currently, they are observing defective births among humans and animals which is shocking for the entire community.

Moreover, the study team had a chance to visit one primary school located in the kebele. Currently, the school community uses water from the Widdena community water tap. The school was constructed in 2008 and 500 students are attending their schooling. The school compound denuded of trees except few eucalyptus and local acacia tree species. The KII participants discussed the hand pumps mounted in front of the school's main gate and near the village which is not functional due to the spare part shortage. Even if the spare part is available in Addis Ababa, a shortage of money is a challenge to buy the spare parts. As discussed earlier and narrated in subsection 4.14, most of the water schemes are functioning below their design capacity or they don't give service at all. Thus, taking this as a lesson learned, it is advisable to device a mechanism on how to tackle such type of problems that erode the trust of the community. The hand-pumps were giving service for both the surrounding and school communities before two years.

2.2 Edo Gojala Kebele

There is no enough potable water for domestic consumption. They claimed that they only get 2 Jericans per two days per household though the cash collector at the community water tap explained that there is no limit to fetch water from the community tap water located in the kebele. They also claimed that their children are forced to be absent from school attending to fetch water from distances. Livestock use Lake Ziway. Water is becoming scarce due to chemical pollution and depletion of natural resources such as forests and soil. In our locality, it was planned to construct an additional potable water scheme but not implemented as promised. Because of this, the difficulty in accessing potable water becomes a critical challenge.

ShereEthiopia is blamed by the participants for the pollution of Lake Ziway and Bulbula River. They claimed that because of the company's pollution, the fish resource is depleting. ''Before we used to get water from nearby distances but now, we are forced to travel long distances. The groundwater we use is not clean and we have seen worms while we pour it on the glass.

There is no scheduled chlorination to treat the water we use for domestic consumption. Children are suffering from water-borne diseases such as Giardia. The hand-dug well in the village is dried out and its parts are broken down. In connection with the water pollution, they reported that they invited the Media and asked the Federal government to see the problem of water pollution by SherEthiopia. Participants of the FGD also explained that in the ATJK Woreda, there are NGOs but their role/contribution is limited to safeguard Lake Ziway and the Bulbula River. There was a meeting between elders and SherEthiopia but no solution came out of it.

The participants also shared their views on environmental degradation which is the result of anthropogenic effects to a greater extent. Before, the collection of animal feed from nearby communal lands was not a problem. However, at this time. These lands are being changed to cropland. The forest cover was also good especially before 4 decades ago i.e. during the reign of Emperor H/Selassie I. The weather was also good to grow crops. The rain was lasting up to October but now it is becoming a critical problem even to grow maize because of the unpredictable manner of the rainfall. During April and May, maize sowing is not possible rather it is shifted to July or August because of the climate variability.

They requested and expressed their view to the study team; the government extension approach should give due attention to alternative livelihoods to improve the living condition of the local community. According to their view, the continuous deforestation practice in the area contributed to flee away a different variety of wildlife species and contribute to the irregularity of rainfall patterns and an increase in temperature. Besides, the participants enlightened their worry about the destruction of the natural waterways by the expressway which is under construction. As said by participants, it exposes them to erosion by hindering the natural waterway.

2.3 Ali Wayyo Kebele

Participants of the FGD in Ali Wayyo Kebele reported that there is a shortage of water in the area, due to this there is suffering from a shortage and a queue for one day in advance is common to get water. What is unique in this kebele is, no water sources in the Kebele, i.e. no river, no spring, and no pond. Leave alone sanitation, the community reported that they don't have water for drinking.

Schools, health centers, and religious institutions have no water. The community travels about 9 km to reach the Huluka River, 6km to reach Negele town and 15km to reach Shala Lake to get water. However, the water from Lake Shala is not potable because of its saline nature. The community pays up to 10ETB and most commonly 4ETB for 1 Jerican of water which is 50cents in a normal situation and when it is available locally.

There is a water reservoir constructed in the Kebele though it is out service for the last 5years due to the denial of upstream users which are in other Kebele. The participants complained that different study group comes to their area at different times and asks the status of water. Nevertheless, no one came back with a solution that alleviates the water problem that makes vulnerable the local community for a generation. There is extensive forest clearance in the

area for charcoal and firewood, some tree species such as Podo is already disappeared, correspondingly water is also disappearing; the community has no health problem related to water, the only problem they have is an absence of water. There are 5 mosques, two schools, 1 Orthodox Church in the Kebele and all have no water.

2.4 Gubeta Arjo

There were 4 water points pulled from Guno Dale Area in the year 2019/2020 but not functional for the last 4 years. According to the participants, the installation of the pipeline has a technical problem. It worked during the initial time and later supported through pumping and finally, everything stopped all of a sudden. Even though there are also other 4 new water points pulled from Chufa spring, these are also not functional as it is disconnected by upstream users. It takes about 1 and 1/2 hours to reach the alternative water source which is a river and the Negale town. People are aware that disregarding all others, the shade of a tree is beneficial. In the Kebele, there are 5035 inhabitants accommodated in 511HH. Similarly, like that of Ali Wayyo Kebele, there is no water source in the Kebele; the worst scenario is that the developed water points are not functional and even when they got maintained and became functional, the service is not efficient and not dependable.

However, every household has a toilet, properly dispose of solid waste (collect in a pit and burn it). People use solar, kerosene, firewood, crop residue as a source of energy. There is a very large valley created by sudden land crack about two years ago and baring access to an alternative water source. There is a practice of area closure in the Kebele. 336 youths are organized and given 52ha to manage through area closure. There are 387 Productive Safety Net Program (PSNP) beneficiaries and 55 direct aid receivers in the Kebele. Thus, most of them cannot buy Roto and collect rainwater. The community pays 40 cents (if the water points are functional) and 4ETB for a Jerican of water if purchased from private owners.

There are 3schools, 1 health post, 1 veterinary post, 1 FTC in the Kebele, unfortunately, all have no water. There are community members who own about 20 cattle and 20 shoats. Nevertheless, the size of livestock is decreasing from time to time for three reasons; people have been selling the cattle as means of survival, the grazing area is shrinking; also, there is no water for the livestock. Common livestock diseases in the area are Furtu, Gororsa, Anthrax, Chinintu.

Deforestation is continuing in the area for two reasons; expansion of agricultural land and charcoal making. There is an initiative for tree planting in the area but the survival rate is very low. The settlement pattern of the community which is very scattered is also contributing to the challenge of service improvement.

2.5 III.Edo Jigessa

Dedeba River is the only dependable source of water in the area located about 2 hours, one-way travel from the kebele centre. There is one public water point in the kebele and there is always a long Queue at this water point. In the event, this water point fails to function. Thus, people, are forced to buy a jerrican of water up to 15ETB and travel up to Kuyara in search of

water. There is one new public water point at the kebele centre but has never been functional. The planed source of water for this water point was from the Heben Arsi area, but the people up there refused to give their water. The people in the kebele used to get water from the Awade River, but currently, the river dried up and become a waste disposal site for the urban people. There were attempts to floodwater harvesting in the kebele but it was not effective due to the sandy soil of the area.

The location of the kebele is becoming a problem as it is between the urban and rural areas and points of argument among administrators of the two areas. Shortage of potable water, lack of access road, lack of electric power and inadequacy and poor status of schools are the major problems of the kebele in order of their priority. There have been soil and water conservation activities in the area but has brought no change as it is not properly managed. Urban Arsi area is the source of wood and water (tap water) for the area. Typhus, Typhoid and Acute Watery Diarrhea (AWD) are common human diseases in the area. Currently, 187 HHs are participating in PSNP. Most people in the kebele get water from a Negale town located about 5km from the kebele centre. Source of water for the livestock is always been river (Awade river during the wet season and Dedeba River during dry season). However, the status of these rivers is decorating during recent time, Awade is polluted and Dedeba is decreasing in volume.

Due to deforestation (for construction, firewood) in the area desertification is expanding, however, the government is organizing jobless youth to protect the forest resources since recent times. There are one primary (1-6) school, One FTC, one Health Post and one public water point in the kebele. The kebele is becoming an urban waste disposal site since recent years. Most households have toilets though it is not to the standard. A family of 8 members consumes 3jercans of water per day. Although the kebele is closer to urban area most households of the kebele are not connected to the electric city and some pay 50ETB per bulb for those who are connected. Usually, rain starts in May and ends in September in the area. The average landholding of a household in a kebele is 3ha.

2.6 i. Awasho Kebele

The current source of water for the Kebele was constructed in 2011 by the organization named LSDC. There are 350 HHs connected to the water supply line. In total, there are 6 public water points, users pay 50cents for every 20/25 litters they fetch. One HH fetches 1 to 10 Jericans per day depending on his/her wealth status and family size. There is no sufficient water in the area and the community is not supplied with enough water. The Community depends on Agamsa (nearby river) for their livestock and cloth washing. Concerning pit latrine, almost every HH has pit latrine. Most HHs are also using their domestic solid waste as manure by spreading it on their nearby farmlands. There has been awareness creation training on private/self-hygiene and environmental sanitation, including handwashing, and use of a toilet.

Selam water bottling plant in the area is discharging its liquid waste into the Agamsa River. However, it provided one water point to the community and also was refilling their reservoir once when their pump was broken down. Power supply for pumping water to the reservoir

(50,000m^3) remained a standing problem as its interruption is very frequent. Although there is a visible prevalence of climate change effects and the natural resources management is poor, the problem on WASH services in the area is largely associated with management, not with environmental degradation and climate change. There is an increase of student enrolment, last year enrolment was about 646 but this year it is increased to 768, the increment is associated with new settlers in the area. The water supply and seat for the student are among the major problems mentioned by one of the teachers who served the school for a long time. The problem with WASH services in the school is largely associated with management, not with environmental degradation and climate change.

Overall, in the kebele, water scarcity is a challenge. Sometimes, to get water, one has to wait for long days even for weeks. Water comes once in two weeks; people have no choice rather than using river water which exposes them to different diseases. There are three common tap water service giving centres, all of them are not working properly as before. The water potential is decreasing from time to time. The causes of reduction according to the KII/FGD in the water potential are associated with the high production of the Selam bottling industry because the source is the same point for both the community and the company. In the previous years, the water point was giving service for 10000 people.

People are suffering from water-borne diseases due to a shortage of water and sanitation. Due to the shortage of water in the area, diseases such as Cholera, Typhoid are affecting the community up to death. Also, an intestinal parasite like Amoeba and acute diarrhoea are common water-borne diseases in the area despite the latter is no more happening in the area. However, before, there was no malaria case in the area but now it is becoming a common disease.

Another problem in the kebele is malnutrition, children are exposed to malnutrition; the reason explained by participants was a shortage of water to prepare food. As explained by participants of the discussion, the health centre had given awareness training to the community on sanitation especially on toilet use. The training addressed 75% of households in Awasho Denku kebele.

There is a water shortage in the area for a long time ago. To cope with the problem, roof water harvesting is becoming a common practice in the area. There is always a long queue in the area to get water. On average, a HH fetches 3 Jericans per day. Water from the tap is used only for drinking and cooking. The community depends on river water for all sanitary aspects including cloth Washing and supply their livestock. The river also dries during prolonged drought in the area, and the community is always disparate and those who can afford to buy water at a rate of about 10birr per Jerrican from water traders and at 4 ETB from a community member who by chance have private water point.

Almost everyone in the Kebele has toilet but since it is made of wood and soil, it collapses after a while. Because, it is not made from durable materials; according to the participants,

even it cannot serve for a year. Cost effect toilet with a slab is proposed for use by the community and an NGO is facilitating a loan for the same to be recovered in about two years.

There is a nearby forest (named Selam) on mountain/hillsides but it is shrinking from time to time due to logging continued in the area until the current time. Even though there is an effort of replanting the mountainsides, the survival rate of the seedlings was very low and there is no one who can manage it. As a result, the wildlife living in the forest is also disappearing. In this area, a few years ago, the time gap between dry and wet season was hardly recognizable, and farmers used to cultivate their land up to three times, but now everything is reversed and hard to predict what is happening. Participants are aware of the climate variability what is known as *climate change.* The common tree plants available in the area include Kasimir, Avocado, Podo, Croton, Cordia, coffee, banana, etc., on private holdings except for Podo. Podo usually is let to grow on communal lands.

There is a water bottling plant (Selam Water Bottling Company) in a nearby area in which the community believes that it is competing with its water. They assume that those (technical Personnel) who are working at the community tap might be bribed to hold or delay the release of water from the sources so that the community will be forced to buy bottled water. The problem of WASH in the area is highly associated with bureaucracy and the hard-headedness of the people involved in the management and provision of the service. The furthest distance that the community members travel is 30 to 45 minutes to reach the water point.

2.7 ii.Toga

There is a serious water supply problem in the area. Even when there is water time of release is not proper and no power. Sometimes, the water comes after ten days at midnight and disappears in the morning so that people sometimes are sleepless and made conflict. In a normal situation, the HHs pay 50 cents for 20/25 litter but when there is no water from the community water point, they buy the same volume by 5 to 15ETB for a single Jerrican of water from water traders who bring water from the nearby towns. Women are bored of traveling long distances to fetch water, which is also challenging their relationship with their soul mates. The community is disparate about the never lasting problem related to clean water resources; their frequent report of the problem to the government officials didn't bring any change.

For both humans and cattle, the source of water is from Washa Wondo through the Shashemene municipality which has a small volume that cannot satisfy the need of the community in the area. Some years ago, there was a groundwater that they use for different purposes such as for drinking, cattle, garden crop, cooking, and others. But now, due to its high contents of fluoride, the groundwater became out of service because of its effects on human health. The pump was taken to other areas without any substitution even though they can use this water for different purposes except drinking and cooking. Calves and small shoats are kept at home and are served water there. When the tap water disappears for a long time, the community used to travel about 45minutesfor a single trip to the nearby rivers and springs to get water. HH water consumption is between 2 to 20 Jericans per day/household.

As an alternative, there is potential water in the nearby (1-3km) area like the Bichana water project, but it didn't get attention from any government body to solve the community's water problem. In this area, there is a school which was constructed in 1997 GC on a land area of 71,000m^2; in the school compound, water supply is interrupted since the last four months, though the pipeline was installed. However, no water is coming out from the pipeline since its installation. Thus, proper sanitation is questionable without water and most of the students are using the school compound for toilet purposes and exposed themselves for different diseases.

Currently, there are 646 students enrolled in the school, last year it was 723 and the number of students reduced due to lack of interest in education in searching for water for their families. There is a separate toilet for boys and girls in the school but sanitation of the toilet is poor due to lack of water access. In the area, there is no practice of rainwater harvesting; the reason given was the soil is sandy and cannot store water. Overall, the poor WASH service in the area is affecting students' performance; sometimes, some of them don't arrive at school on time.

Pertinent to the health centre that exists in the area, the service is challenged due to a shortage of water. There was acute diarrhoea in the area which was controlled years ago. It revived again due to poor sanitation in the area which is attributed to the unavailability of water in the area. In general, the problem of WASH in the area is highly associated with bureaucracy and the hard-headedness of the people involved in the management and provision of the service.

Appendix-B: List of FGD Participants

No.	Name of Participant	Gender	Woreda	Kebele	Remark
1	Muwata Kulle	M	ATJK	Edo Gojala	Youth
2	Edatu Kiya	F	ATJK	Edo Gojala	
3	Sheka Keweti	F	ATJK	Edo Gojala	
4	Urgesa Tusure	M	ATJK	Edo Gojala	
5	Bashir Banke	M	ATJK	Edo Gojala	Youth
6	Abdella Daboo	M	ATJK	Edo Gojala	Elder
7	Tusure Ilboro	M	ATJK	Edo Gojala	
8	Negewo Dima	M	ATJK	Edo Gojala	
9	Belete Hirpo	M	ATJK	Garbi Widdena	Kebele Chairperson
10	Abebe Kumbi	M	ATJK	Garbi Widdena	
11	Denebo bati	M	ATJK	Garbi Widdena	
12	Kedir Abe	M	ATJK	Garbi Widdena	
13	Roba Abe	M	ATJK	Garbi Widdena	
14	Asemo Dedefi	M	ATJK	Garbi Widdena	
15	Muwata Kulle	M	ATJK	Edo Gojala	Youth
16	Edatu Kiya	F	ATJK	Edo Gojala	
17	Sheka Keweti	F	ATJK	Edo Gojala	

No.	Name of Participant	Gender	Woreda	Kebele	Remark
18	Urgesa Tusure	M	ATJK	Edo Gojala	
19	Bashir Banke	M	ATJK	Edo Gojala	Youth
20	Abdella Daboo	M	ATJK	Edo Gojala	Elder
21	Tusure Ilboro	M	ATJK	Edo Gojala	
22	Negewo Dima	M	ATJK	Edo Gojala	
23	Guyo Ingida	M	Shashemene Zuria	Toga	
24	Chaltu Tashite	F	Shashemene Zuria	Toga	
25	Mihret Tadesa	F	Shashemene Zuria	Toga	
26	Masho H/Michael	M	Shashemene Zuria	Toga	
27	Meserat Larego	F	Shashemene Zuria	Toga	
28	Kumbar Shunati	M	Shashemene Zuria	Toga	
29	Jamal Haji	M	Shashemene Zuria	Toga	
30	Workina Tibeso	M	Shashemene Zuria	Toga	
31	Imama Bikisa	M	Shashemene Zuria	Toga	
32	Mama Gamada	M	Shashemene Zuria	Toga	
33	Kasim Haji	M	Shashemene Zuria	Toga	
34	Korme Bushura	M	Shashemene Zuria	Toga	
35	Zeleka Koyara	M	Shashemene Zuria	Toga	
36	Mamo Majo	M	Shashemene Zuria	Toga	
37	Bune Bari	M	Shashemene Zuria	Toga	
38	Ramat Adama	F	Shashemene Zuria	Toga	
39	Badaso Shumba	M	Shashemene Zuria	Toga	
40	Aman Bilika	M	Shashemene Zuria	Toga	
41	Kadir Dasiso	M	Shashemene Zuria	Toga	
42	Sanbato Biliqa	M	Shashemene Zuria	Toga	
43	Amane Badane	F	Shashemene Zuria	Awasho Denku	
44	Kemerya Hashim	F	Shashemene Zuria	Awasho Denku	
45	Tafach Muluneh	F	Shashemene Zuria	Awasho Denku	
46	Kadir Amo	M	Shashemene Zuria	Awasho Denku	
47	Tariku Gutu	F	Shashemene Zuria	Awasho Denku	
48	Belete gemechu	M	Shashemene Zuria	Awasho Denku	
49	Masho Abu	M	Shashemene Zuria	Awasho Denku	
50	Hasen Washo	M	Arsi Negele	Gubeta Arjo	
51	Amanuel Abreham	M	Arsi Negele	Gubeta Arjo	
52	Tesho Hamdo	M	Arsi Negele	Gubeta Arjo	
53	Bekele Wako	M	Arsi Negele	Gubeta Arjo	
54	Weytu Tufa	F	Arsi Negele	Gubeta Arjo	
55	Dekebo Dalu	M	Arsi Negele	Gubeta Arjo	
56	Fatuma Burka	F	Arsi Negele	Gubeta Arjo	
57	Abata Aguto	M	Arsi Negele	Gubeta Arjo	
58	Mieso Gemeda	M	Arsi Negele	Gubeta Arjo	
59	Damena Abdela	M	Arsi Negele	Ali Wayyo	
60	Sintayehu Belano	M	Arsi Negele	Ali Wayyo	

No.	Name of Participant	Gender	Woreda	Kebele	Remark
61	Tseganesh G/Kidn	M	Arsi Negele	Ali Wayyo	
62	Deftero Tuharo	M	Arsi Negele	Ali Wayyo	
63	Abera Handabo	M	Arsi Negele	Ali Wayyo	
64	Arega Genemo	M	Arsi Negele	Ali Wayyo	OneWASH Leader
65	Abdela Mohamed	M	Arsi Negele	Ali Wayyo	
66	Tibis Sewaro	M	Arsi Negele	Ali Wayyo	
67	Mohamed Tura	M	Arsi Negele	Ali Wayyo	
68	Abiyu Godabo	M	Arsi Negele	Ali Wayyo	
69	Mohamed Anose	M	Arsi Negele	Ali Wayyo	
70	Safawo Kabato	M	Arsi Negele	Edo Jigessa	
71	Badhu Galgalu	F	Arsi Negele	Edo Jigessa	
72	Bontu Huluqo	F	Arsi Negele	Edo Jigessa	
73	Qufo Shaliyo	M	Arsi Negele	Edo Jigessa	
74	Waritu Xabo	M	Arsi Negele	Edo Jigessa	
75	Tome Waritu	F	Arsi Negele	Edo Jigessa	
76	Kadir Wako	M	Arsi Negele	Edo Jigessa	
77	Gobana Waree	M	Arsi Negele	Edo Jigessa	
78	Edaso Nuno	M	Arsi Negele	Edo Jigessa	

Appendix-C: List of KII Participants

No.	Name of Participant	Gender	Woreda	Organization/Kebele	Remark
1	Jamal Hussien	M	ATJK	RVLBDO	Officer
2	Hussien Garuma	M	ATJK	Water Office	Expert
3	Jamal	M	ATJK	Health Office	Expert
4	Nugusha Jabo	M	ATJK	Forest and Climate Change Office	Expert
5	Sadia Shifa	F	ATJK	Edo Gojala	Cash collector of the community water tap
6	Tejitu Nego	F	ATJK	Edo Gojala	Resident
7	Kiya Kedir	M	ATJK	Edo Gojala	School Principal
8	Negewo Dima	M	ATJK	Edo Gojala	
9	Shamsu Furro	M	ATJK	Garbi Widdena	Cash collector of the community water tap
10	Ibrahim Tusuma	M	ATJK	Garbi Widdena	School Principal
11	Hassen Gabiti	M	Shashemene Zuria	Awasho Denku	WaSH committee manager
12	Kasaye Tedae	M	Shashemene Zuria	Awasho Denku	Teacher
13	Besso Kedir	M	Shashemene Zuria	Awasho Denku	Health Worker
14	Tadele Oda	M	Shashemene Zuria	Awasho Denku	Kebele Manager
15	Fedlu Sule	M	Shashemene Zuria	Awasho Denku	Development Agent
16	Kadiro Adama	M	Shashemene Zuria	Toga	Elder
17	Abu Kadir	M	Shashemene Zuria	Toga	School Principal

No.	Name of Participant	Gender	Woreda	Organization/Kebele	Remark
18	Miso Tibeso	M	Shashemene Zuria	Toga	Lab technician (Toga Health center)
19	Alemu Senbero	M	Shashemene Zuria	Toga	WaSH Community facilitator
20	Kadiro Adama	M	Shashemene Zuria	Toga	Elder
21	Feyisa Samuel	M	Shashemene Zuria	Environmental and Climate change office	Expert
22	Ayele Seyoum	M	Shashemene Zuria	Developmental and crop protection office	Expert
23	Nuritu Hussien	F	Shashemene Zuria	Environmental and Climate change office	Environmental Expert
24	Geno Hussien	M	Shashemene Zuria	Water Office	Water and Sanitation Expert
25	Kedir Bakalo	M	Shashemene Zuria	Health Office	Health Officer
26	Safao Edao	M	Shashemene Zuria	Education Office	Educational Planning and Project Coordinator
27	Kufa Gemeda	M	Arsi Negele	Environment & Climate change	Expert
28	Adam Wayou	M	Arsi Negele	Agriculture Office	Expert
29	Usman Balcha	M	Arsi Negele	Agriculture Office	Expert
30	Husien Kedir	M	Arsi Negele	Health Office	Expert
31	Worku Bushura	M	Arsi Negele	Health Office	Expert
32	Tsegaye Ayano	M	Arsi Negele	ANCEDA	Local NGO
33	Dekabo Dale	M	Arsi Negele	ANCEDA	Local NGO
34	Geleto Teshito	M	Arsi Negele	Water office	Expert
35	Adam Aliyi	M	Arsi Negele	Land Administration	Expert
36	Safo Kabato	M	Arsi Negele	Edo Jigessa	Zone leader
37	Budo Gelgelo	M	Arsi Negele	Edo Jigessa	Elder
38	Edaso Nuno	M	Arsi Negele	Edo Jigessa	
39	Ahmed Hussein	M	Arsi Negele	Edo Jigessa	
40	Faysa Morke	M	Arsi Negele	Edo Jigessa	

Appendix-D: Data Collection Tools

HH Survey Questionnaires

My name is ----------. I am collecting data on behalf of Motion Consultancy and Training P.L.C. You are selected as a resident of this Kebele and as a key stakeholder of the wetland international project. I will interview you to collect information on the Effect of Water Scarcity, Climate Change and Environmental Degradation on WASH Services Delivery. *The interview will take approximately 30 minutes and your participation is voluntary.*

This study is purely for developmental purposes. The information you provide is extremely paramount. Giving me this information will not harm you and the information will be kept confidential. Your name and other personal identities will not be reported with the research findings. The Survey Team may contact you again only if it is necessary to complete the information at a later point in time. If you have any questions about the research, do not hesitate to contact the consulting management team or Wetland International. I thank you in advance for your genuine cooperation.

1. Date _____HH Code _____Name of Respondent _____
2. Location: X _____ Y _____
3. Name of enumerator_____ Signature_____
4. Supervisor: Name _____Signature_____

Part I: HH Information

1. Name of the HH members	2. Relation to HH head	3. Age	4. Gender	5. Marital status	6. Mirage Type	7.Education level (for members older than 7 years old)	8. Family size	9. HH health status for the last one year

Codes

2)0=household head; 1=spouse); 2 son/daughter; 3=son/daughter in law; 4=grandchild; 5=mother/father; 6=mother/father in law; 7=brother or sister; 8=brother/sister in law; 9=uncle/aunt; 10=nephew/niece; 11=step child; 12=other family; 13=not related (e.g., hired).

4) 1=male; 2=female

5) 1= single; 2= married, 3= widow; 4 =divorced;

6. 1=Monogamy, 2= Polygamy

7) 1=yes; 2= no, married and has his own family; 3= no, is away for schooling; 4=no, is away for seasonal labour migration; 5) no, is away for living faraway place; 6=other, specify:

8) 1=Illiterate; 2=Read and write; 3=primary education (grade 1-8); 4=secondary school (grade 9-10); 5=preparatory (11 &12 grades); 6= college and above; 7=other, specify:

10) 1= Healthy; 2=bedridden; 3= disable, specify type of disability;

11) 1=domestic work; 2=out of house work such as farming, herding; 3=out of house work such as salaried employed and daily labourer; 4=other, specify:

Part II: Survey Questionnaires

1. General

S/N	Questions	Alternative Responses
1	Name	
2	Religion	1. Orthodox, 2. Muslim, 3. Protestant, 4. Others, Specify
3	Languages spoken in the Family	1. Afan Oromo, 2. Amharic, 3. Tigrigna, 4. 1 & 2, 5. Others, Specify
4	Was the household head born in this Kebele/locality?	1. Yes, 2. No
5	4.1 If the answer is no to the above question, how long the HH head lived in this area (in years)?	

2. Crop Production

S/N	Questions	Alternative Responses
1	Main Occupation	1. Farming, 2. Trade, 3. Salaried employment, 4. Daily labourer, 5. Other, specify
2	Number of harvests from a plot of land in a year	1. Once 2. Twice
3	Do you practice horticulture?	1. Yes, 2. No
4	4.1 If yes, what kind?	
5	Do you have irrigation farming practice?	1. Yes, 2. No
6	Which of the following agricultural inputs do you use on your farm?	1. Fertilizer/Compost, 2. Pesticide 3. Improved variety seeds, 4. Others, specify 5. No input used

3. Livestock

S/N	Questions	Alternative Responses	
1	Do you keep livestock?	1. Yes, 2. No	
	1.1 If your answer is yes to the above question, Type, and number	Livestock Type	Number
		1.Cattle	
		2. Shoat	
		3. Equines	
		4. Chicken	
		5. Beehives	
		6. Others, specify	
2	What is the main source of feed for livestock?	1. Grazing, 2. Crop residue, 3. Grazing and Crop residue, 4. Others (specify	
	2.1 If Grazing is the main source, where do your livestock graze?	1. Common land, 2. Private land, 3. Both common and private land, 4. Move to other places (outside the village), 5. other, specify	
3	Do your practices zero grazing	1. Yes, 2. No	

S/N	Questions	Alternative Responses
4	The main source of water for livestock	1. River, 2. Traditional well 3. Pond 4. Springs, 5. Other

4. Farming Practice

S/N	Questions	Alternative Responses
1	What type of farming you are practicing?	1 Rainfed, 2. Irrigated, 3. Both, specify proportion in %
	1.1 If you practice Irrigated Farming, what is the size of the irrigated farm in ha	
2	1.2 If you practice Irrigation what is/are the methods to use water economically	1. High-efficiency irrigation, 2. Centre pivot movable sprinkler pipes, 3. Drip Irrigation 4. Other, specify
3	What are the major problems of irrigated farming?	1. Market, 2. Water scarcity, 3. Skill/technology, 4. Other, specify

5. Water Scarcity and WASH

S/N	Questions	Alternative Responses
1	What is/are the water sources for irrigation activities?	1.Rivers, 2. Lakes, 3. Springs, 4. Groundwater, 5. Other, specify
2	From the above list, which water source is mostly used for irrigation purposes?	1.Rivers, 2. Lakes, 3. Springs, 4. Groundwater, 5. Other, specify
3	If your answer is rivers, which river is mostly used?	1.Meki river, 2. Bulbula river, 3. Ketar river, 4. Other, specify
4	If your answer is Lakes which lake is mostly used?	1.Lake Abiyata Shala, 2. Lake Ziway, 3. Lake Langano, 4. Other, specify
5	Who are irrigation users at large?	1.Private investors who are engaged in flower and horticulture, 2. Smallholders, 3. Cooperatives, 4. Other, specify
6	Is there a decrease or increase in lakes' water levels?	1.Yes, 2. No
7	If your answer is yes, why is it happening?	1.Overutilization 2. Siltation, 3. Erratic rainy seasons, 4. Pollution, 5. Other, specify
8	At present, how is the extent and intensity of fluoride in your area?	1. It affects a small area with high intensity, 2. It affects a small area with low intensity, 3. It affects a large area with high intensity, 4. It affects a large area with low intensity, 5. does not exist
9	At present, how is the extent and intensity of chemical spill from flower and horticulture farms in your area?	1. It affects a small area with high intensity, 2. It affects a small area with low intensity, 3. It affects a large area with high intensity, 4. It affects a large area with low intensity, 5. does not exist

S/N	Questions	Alternative Responses
10	What are the sources of water pollution that affects WASH service delivery?	1.Fertilizers and biocides used in various irrigation schemes upstream along the lakes and the nearby greenhouses, 2. Fertilizers and biocides used in various irrigation schemes upstream along the rivers and the nearby greenhouses, 3. Private farms located along the rivers
11	From where do you get water during periods of drought	1. Rivers, 2. Lakes, 3. Ground waters, 4. Springs, 5. others, specify
12	From the above lists, which water source is mostly used during periods of drought?	1.Rivers, 2. Lakes, 3. Groundwaters, 4. Springs 5. Others, specify
13	Source of Drinking water	1. Taped, 2. Stream/river (unprotected), 3. Protected stream 4. Well, 5. Other, specify
14	Distance from the source of water in time	1. <1 hour, 2.1-2 hours, 3.3 hours and more
15	Did your household experience interruptions/ breakdowns in the drinking water supply from the main source during the last six months	1. Yes, 2. No, 3.I don't know
16	During these interruptions/ breakdowns, how many days was drinking water not available from the main source? Total number of days in a year	
17	Do you Practice water harvesting?	1. Yes, 2. No
18	14.1 If yes, type of water harvesting	1. Private pond, 2. Communal pond, 3. Private roof water harvesting, 4. Other, Specify

6. Climate Change and WASH

1	Do you think that there is climate change and variability (such as a change in temperature and rainfall pattern) in your locality compared to the climate before 20 or 30 years?	1. Yes, 2. No 3. I don't know
2	If your answer is yes, how do you perceive it?	1.Increase in precipitation; 2. The decrease in precipitation; 3. Increase in temperature; 4. A decrease in temperature; 5. Change in timing of precipitation; 6. Recurrent drought; 7. Other, specify (multiple responses are possible)
3	Your opinion on the trend of rainfall?	1.Regular and increasing 2. Irregular and declining, 3. The same
4	In the past years, which one did you notice in your area?	2. Decreasing or shrinking of the water body, 2. Severe storming or flooding, 3. Severe drought

		or irregularity of a rainy season, 4. Other, specify (multiple responses is possible)
5	If observed one or more of the incidences mentioned under question 2 above, what do you think are the reasons?	1. Population pressure, 2. Unwise use of natural resources, 3. Tragedy of common, 4. Others, specify (multiple responses is possible)
6	Do you have access to information regarding climate change and variability?	1.yes 2. No
7	In which month does the major rainy season of your locality start normally?	
8	Have you ever observed a variation of rainfall than this normal time?	1.Yes 2. No
9	If your answer is yes, how do you describe the changes?	1. Starts earlier than the normal time, 2. Starts later than the normal time, 3. Different in each year
10	What are the major impacts of climate change and variability you have observed in your locality or household?	1. Increase of water scarcity, 2. The decline of crop yield, 3. The increasing frequency of drought, 4. Failure of some crops, 5. Failure of total crops, 6. Increasing of flooding/erosion, 7. Food shortage, 8. Deaths of livestock, 9. Increase of crop diseases 10. Increase of livestock diseases

7. Environmental Degradation and WASH

S/N	Questions	Alternative Responses
1	What are the major Natural resources related problems in the area?	1.Scarcity, 2. Degradation, 3. Ownership, 4. Other, Specify
2	What do you usually do to improve soil fertility in your land?	1. Soil conservation 2. Fallowing 3. Applying organic fertilizer 4. Intercropping 5. Crop rotation 6. Applying inorganic fertilizer, 7. Others, specify
3	Do you have an organization for managing communal Natural resources (Water, grazing land and forest)?	1. Yes, 2. No
4	4.1 If yes, specify	
5	Have you taken part in community development programs?	1. Yes, 2. No
6	6.1If yes, specify	1. Afforestation, 2. Soil and water conservation (terracing, soil bund, etc.), 3. Social services (water supply, education, health, etc.), 4. Water Harvesting, 6. Other, Specify

S/N	Questions	Alternative Responses
7	Are there neighbour Kebeles that share the natural resources in your Kebele	1. Yes, 2. No
8	If yes, what are the shared Natural resources	1.Water, 2. Forest and forest, 3. Pastureland, 4. Other, specify
9	What are your main sources of wood products?	1. Own woodlot, 2. Nearby common forestland 3.buy from traders, 5. other, specify
10	What are the major sources of energy?	1. Firewood, 2. Crop residue, 3. Kerosene, 4. Animal dung 5. Electricity, 6. Others, specify

8. Capacity Building to Farmers

S/N	Questions	Alternative Responses				
1	Did you or your family member attend Training/Awareness creation programs	1. Yes, 2. No				
	1.1 If your answer above is yes, what were the types of training you attended during the past years	1. Water Harvesting/Water-saving technology/0n farm water Management, 2. Alternative livelihood, 3. Operation and maintenance of water resource schemes, 4. Soil and water conservation, 5. Improved farming technologies, 6. Other, specify (Multiple responses is possible)				
	1.2 If your answer is yes, what is the nature of the training	1. The demonstration, 2. Experience sharing visits, 3. Indoor training, 4. Other, Specify				
	1.3 If your answer is yes, who provided the training?	1. DA, Experts from Worda offices, 3. NGOs 4. Others, Specify				
	1.4 If your answer is No, can you propose your future interest					
2	How many RDA are there in the Keeble corresponding to each rural extension	Crop Production	Livestock	Natural resources	Health	Other (specify)

9. Community-Based Associations

S/N	Questions	Alternative Responses
1	What are the major cooperatives/Associations in the Kebele?	1. WUA, 2. Farmers Cooperatives, 3. Self-help Group, 4. Saving and Credit Group, 5. Other, Specify
2	Are you (a member of your household) a member of any of the cooperatives/Associations?	1. Yes, 2. No
	2.1If yes, specify the cooperative/Association you are member to	2. WUA, 2. Farmers Cooperatives, 3. Self-help Group, 4. Saving and Credit Group, 5. If more than one specifies, 6. Other, Specify

S/N	Questions	Alternative Responses
	2.2If yes, what were your reasons for joining? Please rank the most important reasons,	2. Open to anybody to be joined, 2. Increased access to water utilization, 3. Access to training, 4. Access to other benefits, Specify
3	What are the major problems of the associations you/HH member are a member of	1. Office and facility 2. Lack of bylaws and guidelines 3. Lack of Management skill 4. Lack of technical skill 5. Others, Specify
4	How satisfied you are with your life after you were a member of the cooperative/WUA?	1. Very unsatisfied, 2. Unsatisfied, 3. Neither unsatisfied nor satisfied, 4. Satisfied; 5. Very Satisfied

10. Access to Social Amenity

S/N	Questions	Alternative Responses
1	What is your means of transportation?	1. The vehicle, 2. Transport animals, 3. Cart 4. Other (specify)
	1.1 Walking distance of the school from your home in hours	1. <1 hour, 2.1-2 hours, 3.3 hours and more
2	Source of Drinking water	2. Taped, 2. Stream/river (unprotected), 3. Protected stream 4. Well, 5. Other, specify
	2.1Distance from the source of water in time	2. <1 hour, 2.1-2 hours, 3.3 hours and more
3	Types of Human health service	1. No, 2. The health centre, 3. Clinic,5. Hospital
	3.1 Walking distance of the health service from your home in hours	1. <1 Hour, 2.1-2 Hours, 3. Hours and more
4	Shelter/house	1. Owned 2. rented
	4.1 If rented, rental price, in ETB	
	4.2 Type of house	1. corrugated iron sheet, 2. house with grass roof, 3. other, specify
	4.3 Type of wall and floor	1. Muddy wall and floor, 2. Cemented wall and floor 3. Wood wall and muddy floor, 4. other
5	Toilet facility	1. Yes, 2. Open field, 3. Pit latrine without slab 4. Pit latrine with slab 5. Flush toilet
	5.1If yes, type of toilet	1. Common/public 2. Private
	5.2If yes, type of roof and wall	1. Built with wood and iron sheet, 3. wood and plastic cover, 3. Not covered/protected
6	What are the most critical problems in your area in order of priority?	1. Lack of market, 2. Lack of agricultural inputs such as fertilizer, 3. Lack of agricultural processing machines 4. Lack of improved variety of seed 5. Shortage of land 6. Fluctuation/shortage of rainfall, 7. Others, specify

Key Informant Interview Checklist

Part I: Basic Information of the Interviewee

1.	Name	
2.	Age	

3.	Sex	
4.	Educational level	
5.	Main Occupation	

Part II: Interview Guide for Officials, Experts, Community Leaders and members of WUA

1. State and status of the WASH delivery service in your area
2. State and status of irrigated agriculture in the area and its impact on the WASH delivery service
3. Was there any incidence of conflict over potable water use, how it was solved?
4. Are there water users' associations in the area, do they have bylaws?
5. What are community values and concerns regarding natural resources?
6. How is the rate of land degradation/deforestation?
7. What are the major causes of land degradation/deforestation?
8. Are there community-based institutions that are effectively engaged in the management of land, water, and other resources? If yes, mention and discuss their trends
9. Are there training and capacity building provided for all community in the basic skills required in sustainably managing natural resources? If yes, mention what and by whom
10. Do households and communities have sustainable and equitable access to critical natural resource stocks and flows? (Which groups have access to which types of natural resources)?
11. What do you think about the role of the WUA in the WASH project management?
12. What do you contribute to the improvement of the WASH delivery service in the future?
13. How do you evaluate dimensions of water scarcity such as physical scarcity, economic water scarcity, organizational scarcity, and accountability in this area?
14. How do you evaluate water accessibility, availability, and quality in this area?
15. How are the practice of water accounting and water audits in this area?

FGD Checklist/Guiding Questions

1. What is the main source of water for the community?
2. In case of scarcity of water in this area, how the scarcity is managed?
3. What are the available irrigation facilities? who developed the irrigation infrastructure? and who operate and manage them?
4. Natural resources status, challenges, their functions and conservation practices?
5. The status of modern and irrigated agriculture
6. Is there water scarcity, what are the water-saving practices in the area?
7. What do you contribute to the realization of WASH projects in the future?
8. Are you willing to share the experience and resources gained to adjacent Woredas/Kebeles?

9. What could be the contribution of the WASH projects in the development of your livelihood?

Secondary Data Collection Format

Land Use and Agro-Ecology

1. Zone/Worda/Kebele major land use

No	Major land use	Area	%	Topography	Area	Agroecology	%
1	Irrigation cultivation			Plain			
2	Rain-fed cultivation			Mountain			
3	Scrubland						
4	Woodland						
5	Natural forest land						
6	Waterbody						
7	Bare or wasteland						
8	Riverine forest, woodland						
9	Others (specify, if any)						

I. Major Crops

1. Major cereal crops produced in the Worda/Kebele

No	Major Crop	Area/average for the last three years	%	Remark
1				
2				
3				
	Others (specify, if any)			

2. Major horticultural crops produced in the Worda/Kebele

No	Major Crop	Area/average for the last three years	%	Remark
1				
2				
3				
	Others (specify, if any)			

II. Livestock in the Worde/Kebele

No	Type	population	Productivity (Milk [li], honey[kg])	Remark
1				
2				
3				
	Others (specify, if any)			

III. Climate

1. The altitudinal range of the area _____, Mean annual rainfall _____, Potential evapo-transpiration _____, Mean annual temperature _____, Mean annual rainfall range _____, Rainy season _____, Hottest months _____, Coldest months _____

IV. Demographic/Population

1. Population of the Woreda//Kebele_____ Male_____ Female _____HH of Woreda/Town/Kebele _____Male_____ Female_____
2. Population of the Woreda/Kebele by religion and ethnic group

No	Religion	Number	%	Ethnic Group	Number	%
1						
2						
3						

V. Education

1. Number of schools available in the Woreda/Kebele

Type	Government	Non-Gov't	Others	Water availability in school
KG				
1-4				
5-8				
1-8				
9-10				
10+3 (TVET)				
College				
University				
Others				

2. Number of education personnel working in the Woreda/Kebele

Ser. no	Qualification	Male	Female	Total	Remark
1					
2					
3					

VI. Health

1. Number of Health institutions existing in the Woreda/ Kebele

Type	Number of health facilities		Number of beds	Water availability in health service
	Governmental	Private		
Hospital				
Health stations				
health post				
Clinics				
Drug shops/Pharmacy				

2. Number of health personnel working in the Woreda/ Kebele

No	Health personnel	Male	Female	Total	Remark
1	Medical doctor				
2	Nurse				
3	Health officer				
4	Sanitarian				
5	Health extension worker				
6	Health assistant				

No	Health personnel	Male	Female	Total	Remark
7	Laboratory technician				

VII. Water Supply and Sanitation

1. Type and Number of water sources in the Woreda/ Kebele

No	Type/sources	2017		2018		2019	
		Source	Users	Source	Users	Source	Users
1	Public tap						
5	Pond						
6	Hand-dug wells						
7	Shallow wells						
8	Spring						
9	Others						
Total							

2. Potable water coverage of the Woreda/Kebele_____

VIII. NGOs

1. NGOs and activities

Name of NGO	Activities involved

IX. Economic Issues

1. Business & Trade Development

No	Business type	No of business operating in the Woreda/ Kebele	Remark
1			
2			
3			

2. Type of industries (Food Processing) in the Woreda

S/N	Name of industry	Area of operation	Number of employees	Current status
1				
2				
3				

3. Major natural resources in the Woreda/Kebele?

S/N	Name natural resource	Location	Features	Current status
1				
2				
3				

X. VEGETATION

1) Major vegetation types in the Woreda//Kebele?

Sr. no	Vegetation type	Distribution			Remark
		Poor	Fair	Good	
1	Riparian woodland				
2	Bushland				

Sr. no	Vegetation type	Distribution			Remark
		Poor	Fair	Good	
3	Shrubland				
4	Wetland				
5	Bare land				
6	Others (specify below)				

2) Lists of woody plant species in the Woreda//Kebele?

S/N	Common name	Scientific name	Current status (rare, abundant, Endangered, endemic
1			
2			
3			

XI. Lists of Wildlife in the Woreda/Kebele?

S/N	Lists of species-Common name	Scientific name	Current status (rare, abundant, Endangered, endemic
1			
2			
3			

XII. Lists of Water Bodies in the Woreda/Kebele?

S/N	Name/River/lake/other	Location	seasonality	Current status
1				
2				
3				

XIII. Major Market Place in the Woreda

S/N	Name of the Market Place	Type/Elaboration	Distance
1			
2			
3			

XIV. Major Problems in the Woreda/Kebele?

S/N	Problem	Elaboration	Priority
1			
2			
3			