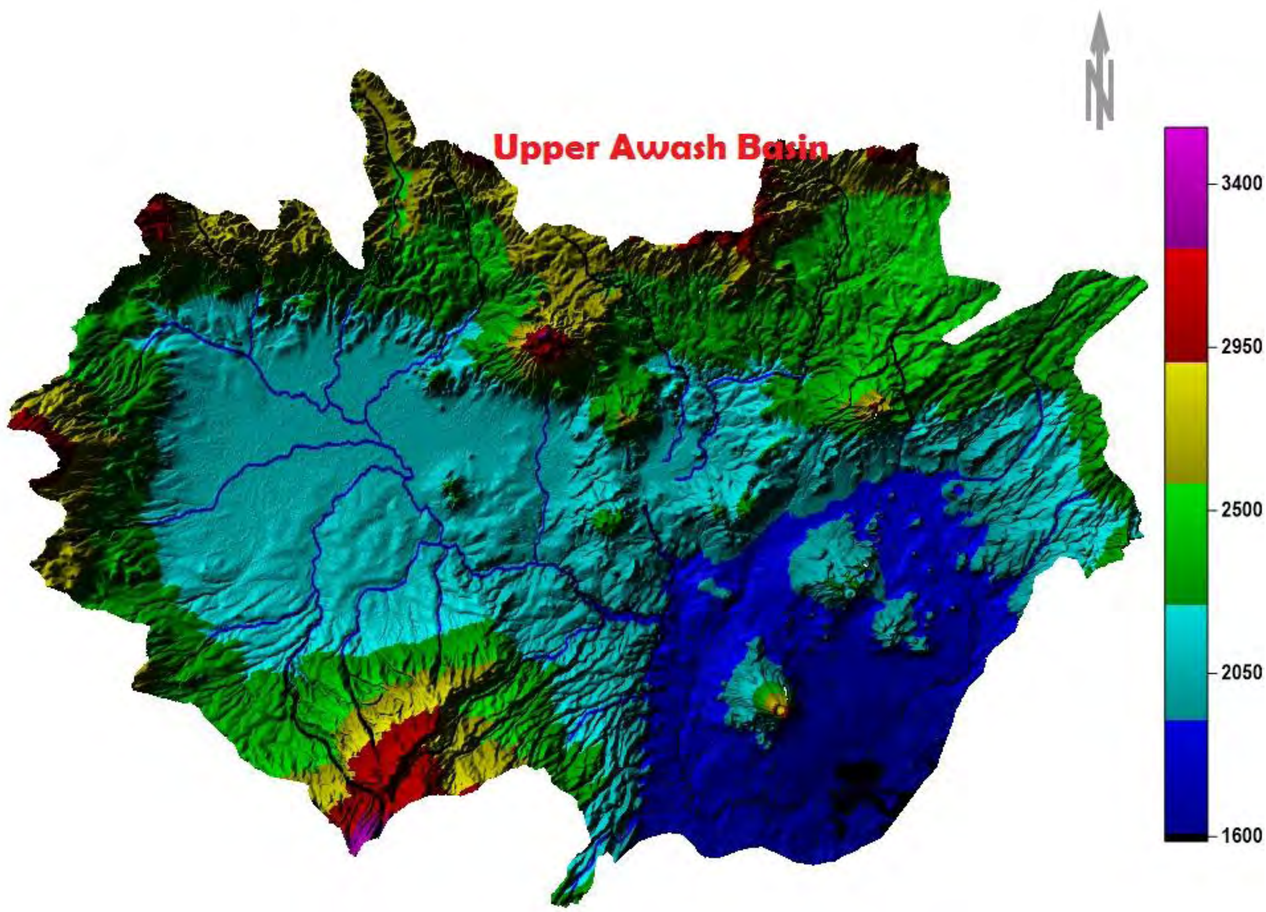
ADDIS ABABA UNIVERSITY SCHOOL OF EARTH SCIENCES

Evaluation of Recharge and Shallow Groundwater Dynamics in the Upper Awash Basin, Central Ethiopia

Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment for the Degree of Master of Science in Hydrogeology



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May, 2017

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This is to certify that the thesis prepared by Abel Abebe, entitled: Evaluation of Recharge and Shallow Groundwater Dynamics in the Upper Awash Basin, Central Ethiopia submitted in partial fulfillment of the requirements for the Degree of Master of Science in Hydrogeology complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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By my signature below, I declare and confirm that this thesis is my own work. I have followed all ethical and technical principles of research in the preparation, data collection, data analysis and compilation of this thesis. Any scholarly article that is included in the thesis has been given acknowledgment through reference.

Abel Abebe **Signature: -------------------------**

Date: May, 2017

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Abstract

The increasing demand placed on groundwater has encouraged distinguishing of this resource, which would be the foundation of exploration, management, and conservation. In this study, quantitative analysis of groundwater resources of upper awash basin and shallow groundwater dynamics has been made. Therefore, the main objective of the present research study was evaluation of groundwater recharge using river discharge records and water balance techniques. Hence, for recharge evaluation using baseflow the most important rivers selected from the upper awash basin were Awash River at Bello, Awash River at Hombole, Mojo, Akaki, Berga, Holleta and Teji River catchments have been identified as the crucial area for assessing the recharge procedure. As a result, the annual recharge of the basin using baseflow separation is 130.5mm, which is 12.8% of annual rainfall recharged the aquifer. Baseflow index (contribution of groundwater to rivers) is highest during the dry season and lowest at the time of rainy season in contrast greater precipitation and smaller evapotranspiration rates during the summer months create greater baseflow in the basin. Consequently, baseflow of Akaki catchment which is upper basaltic aquifer and the Holleta catchment which is lower basaltic aquifer have high baseflow of 23% and 31% whereas, Teji River, Awash Hombole, Awash Melkakunture, Awash Bello and Hombole have 14%, 13%, 1% and18% correspondingly.

Additionally, using the water balance technique, the annual recharge of the basin found to be 238.02mm, which is 23.4% of annual rainfall is percolated to the aquifer. However, groundwater recharge evaluated by water balance in the upper awash basin takes place in three months June to August. From the shallow aquifer system, in the upper awash basin, several parameters observed from groundwater table contour map like local groundwater flows, divergent and convergent zone, local groundwater divide. According to the shallow groundwater table contour map areas which groundwater converge are discharge zones and are located in north-eastern part, in Becho plain, Akaki well field and southern part of Adaa plain areas i.e. at this convergent zone, water comes from almost all direction of the study area; and areas which are divergent zones are located in the north-west and south-east part of the study area.

Key words: Baseflow Separation, Ethiopia, Groundwater Well Inventory, Shallow Groundwater Dynamics, Upper Awash Basin, Water Balance

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Abbreviations (Acronyms)

AET	Actual evapotranspiration
BH	Boreholes
EMA	Ethiopian mapping agency
ENMA	Ethiopian National Meteorological Agency
GSE	Geological Survey of Ethiopia
GIS	Geographic Information Systems
GPS	Global Positioning System
HD	Hand dug wells
HP	Hand pump wells
ITCZ	Inter-Tropical Convergence Zone
MRF	Mean River flow
MER	Main Ethiopian Rift
SRO	Surface runoff
Sq.Km	Square Kilometer
SWL	Static Water level
PET	Potential evapotranspiration
WRMP	Water Resource Management Policy
WWDSE	Water Works Design Supervision Enterprise
UTM	Universal Transverse Mercator

CHAPTER ONE

INTRODUCTION

1.1 Background

Evaluation of recharge and shallow groundwater dynamics of an aquifer is an important approach for investigating actual groundwater management scenario. Groundwater is a very large significant part of the natural water resources system. The occurrence, dynamics, origin, movement and chemical composition of groundwater is dependent on geology, lithology, geomorphology, landforms, drainage density, rainfall, geological structures or lineaments, slope, land use, land cover and soil cover of groundwater system. In the whole world, pressing requirements for water supplies are significantly become a greater with radical and very high number of population growth, different opinion over agricultural land and pastures, change over climate, environmental protection and governing laws and directives made and keep at the same level by an authority for water use and share out the water resources. It is the main principal source of water supply development in Ethiopia covering about 85% (Getachew Abdi, 2004).

The Upper Awash basin is well-known by one of Ethiopia's aquifers providing water supply for different cities including the capital Addis Ababa; for towns like Debrezeit, Mojo, Koka, Tulubolo, Holleta, Sebeta and other smaller towns found in the area. Therefore, groundwater is extracted from aquifers and distributed through pumping wells and presented to the community for uses in domestic, agricultural, and industrial spheres. Additionally, necessary pumping of groundwater and at the same time not enough, recharge has given to an action of rapid depletion of groundwater level in many places in the investigation area. The natural groundwater flow system has been turn on the other way round very much in case over-withdrawal or exploitation of groundwater, consequently in order to do more advanced and make effective use of groundwater resources fairly and prepare systematically water managing and aims to preserve policies for government.

It is fundamental to arrange systematically and take away research on shallow groundwater resources evaluation, arrangement on a firm the identity of the shallow groundwater dynamics of upper awash basin aquifer and groundwater environmental guarantying.

Therefore, groundwater dynamics is the fact of an interconnected series of nature influenced by different kinds of influencing circumstances in specific environments (Chen *et al.*, 1988).
As a result, it is the central important work and the key point to monitor and research the evaluation of groundwater recharge and the dynamics of shallow groundwater in upper awash basin. Due to groundwater standard is also become progressively lower day by day, bringing it not suitable for consumption. Advancement of real groundwater management plan so developed, determined by distinctive characterization of the aquifer and ambient spatiotemporal monitoring of groundwater.

In addition, the process of establishing the identity of critical regions can be carried out on the argument of spatial variation of recharge frequency values and the shallow groundwater flow dynamics. The sources of recharge to a groundwater system comprise of both natural and human or anthropogenic give rise to this phenomena. The natural sources have recharge from precipitation, lakes, ponds, and rivers containing perennial, seasonal, and ephemeral flows, and from other aquifers. Human bring about sources of recharge comprise irrigation losses from canals and fields, leaking water mains, sewers, septic tanks, and over-irrigation of parks, gardens, and other public desirable feature of a building (Sophocleous, 2004). A wide number of dealings found for evaluating groundwater recharge, direct measurement, water balance, Darcian approach, tracer techniques and empirical relations, which have been designed to be entitled the existing fact of physical processes of the recharge. This study aims to begin deal with groundwater recharge and shallow groundwater dynamics by evaluating groundwater recharge based on obtained meteorological, hydrological and hydrogeological data; by using baseflow separation and water balance methods for effective use of the groundwater resource of the upper awash basin.

Currently there is no encompassing institutional and an extremely important supporting underlying structure for groundwater control or treatment, but the central importance truth of the Water Resource Management Policy (WRMP) of (1999), may be taken as a piece of guidance. As a result, evaluating groundwater recharge and analyzing the dynamic distinctive aspect of shallow groundwater in upper Awash River basin area is very important to understand the evolution, fundamental principle of groundwater resources from a large regional view.

1.2 Previous Studies

In the upper awash basin and in neighboring areas, there are different geological and hydrogeological detailed investigations have been conducted. Although in the existing before time large number of hydrogeological studies carried out in the upper awash basin and their adjacent regions have been evaluated and some of them are suitable for this systematic investigation are briefly summarized.

Hussen Endre (2006), had carried out including a detailed investigation on the title of Water resource potential evaluation of Berga river catchment, West Shewa Zone, Oromia regional state entitled in the upper awash basin area the main source of recharge is from direct precipitation. Hydrogeological detailed investigations that have been carried out in connection with the water supply of the towns of Debrezeyt and Mojo under the twelve towns Water Supply Project (Ministry of Water Resources (MOWR), 1980). As stated in MOWR (1980), based on this detailed investigation, wells were drilled in the adjacent of the two towns and the boreholes are shallow and have a maximum depth of 90m. The lithological log of these wells is an indication of that lacustrine sediments form advantageous aquifers. The Lacustrine deposits have a desired thickness differ in size from 50 to 80 meters and are situated under by vesicular basalt. These wells portray in particular way the lacustrine aquifer of the south eastern segment of the Upper Awash basin.

The Addis Ababa Water Supply and Sewerage Authority (AAWSA) have undergone (carried out) three process of carrying out investigations. This stages I and II were targeted for most part at the completion of the Legedadi Reservoir and be associated works. Stage III is targeted at planning, designing and contracting water supply facilities containing as part of the whole groundwater investigation for the city up to the year 2020. Those happening early groundwater investigations be connected to the water supply of the city of Addis Ababa were list of events documented in the activity participation of AAWSA (2000), which were hydrological and hydrogeological detailed investigation that give rise to the development of regional numerical groundwater flow model for the Akaki catchment and for the central Dukem plain up to the Awash River. Although, (Andarge Yitbarek 2009) carried out an investigation on the title of Hydrogeological and hydrochemical underlying structure of complex volcanic system in the Upper Awash River basin, Central Ethiopia: with remarkably in large above average distinction on inter-basins groundwater transfer between Blue Nile and Awash rivers. He evaluated groundwater recharges by a method of baseflow separation is 18.4 and 22.6 mm of the main Awash River at Melka kunture and Hombole representing a catchment area and Andualem Eshetu (2008), carried out an investigation on the title of Water resource potential evaluation of Teji river catchment, south west shewa zone, Oromia regional state. In the investigation area the main source of recharge is from direct precipitation. The annual recharge in the catchment was 325.39 mm, which was 29.5% of annual precipitation using water balance and base flow separation.

According to, (Seifu Kebede *etal.* 2005) carried out hydrogeological investigation getting nearer to understandingly aware of groundwater where it rises and move steadily along selected transverse section in Ethiopian volcanic aquifers. This devotion of time to some extent reaches to decision on the origin and hydrodynamics of groundwater's draining the western watershed of the attention to develop knowledge from the area of investigation. This study make available for use more detail that ground waters are receiving recharge from not long ago rains that falls on plateau areas and fast groundwater movement to and fro through geological structures such as faults.

1.3 Statement of the problem

The increasing demand and pressures on groundwater resources, accurate and reliable evaluation of groundwater recharge and shallow groundwater flow are essential for sustainable groundwater management. Despite the fact that, Ethiopia is impertinent to have a large quantity of fresh groundwater resources; the country is even now not made detailed studies in evaluating the recharge of groundwater and dynamics of the shallow groundwater resources in spatial distribution. Making practical and effective use of this resource begin a course of action without a basic skill to understand of the hydrological conditions and recharge system begin to be a adverse problem in the water resource management. In such conditions, developments of the resource rely on conventionally to come up with the annual groundwater recharge and the shallow groundwater dynamics of aquifers in the upper awash basin. Therefore, it is the fundamental work and the key point to study and investigate the evaluation of groundwater recharge & the dynamics of shallow groundwater.

1.4 Objectives of the research

1.4.1 General objective

Evaluating the groundwater recharge using different techniques and recognize the dynamics of shallow groundwater for sustainable management and exploitation of the groundwater resource.

1.4.2 Specific objectives

- Evaluation of total amount of groundwater recharges using baseflow separation and Water balance method.
- Establish the characteristics of the most of great significance of hydrological and metrological parameters
- Identify the sources of groundwater recharge
- Groundwater table contour map for shallow groundwater flow prepared to understand shallow groundwater flow dynamics

1.5 Approach and methodology

The study comprised three stages; desk study, fieldwork, and data analysis and interpretation coupled with report writing. The desk study includes literature search and review and/or collection of available data. The sources of data used in this stage comprise published and unpublished reports, both local and international. Prior to field excursion data acquisition, preliminary surveys were conducted, including literature review, justifying of physical distinctive attribute from satellite images, geological explanations, shallow groundwater well data analysis, view in particular outlook; the geomorphologic and environmental features.

The field study includes; measurement of static water level, well inventory of site features and data collection from acquiring sources were carried out to get the constant outcome. The study also requires collection of meteorological data from National metrological Agency like rainfall, temperature, sunshine hour, wind speed and relative humidity data. All other existing data like topo sheets and well compilation report have been collected from appropriate offices and used for an explanation.

The hydrological data (river discharge) of Awash River and the surrounding river gauges data were brought to study at separate positions. Inside the target of the delineated area, the correct location, static water level and elevation for bore holes, dug wells and springs were recorded to some extent in the field using Dip- meter, GPS and photo camera.

Evaluation of recharge and dynamics shallow groundwater of complex volcanic system can be investigated through application of numerous disciplines. Therefore, shallow groundwater contour maps and the shallow groundwater flow directions have been produced from static water level measurements. Thus, a determined effort has been made to apply separate disciplines and give rise to results from every dataset to mark out the hydrogeological system, evaluate groundwater recharge in different method, and decipher the flow dynamics of the shallow groundwater of the study area representing the most likely field condition. Software's used for this study are, ArcGIS, ERDAS, Global Mapper, Google Earth, Surfer 10, RAP (River Package Analysis), and Microsoft offices (word and excel) were used as an assisting tool in this research study.

1.6 Techniques of recharge estimation

Based on the numerous literatures, (Scanlon *et al*., 2002) perceived that recharge techniques differ in terms of the typical quantity measured the variety of recharge values that can be regarded, and the spatial and temporal scales that the recharge represents. The spatial and temporal scale represented by recharge rates varies with the different techniques. Unsaturated-zone techniques frequently provide point or local-scale evaluates of the recharge, while, recharge techniques based on saturated-zone studies provide recharge estimates from local- to regional-scale. Furthermore, tracer and physical methods regularly provide point to local estimates with numerical modeling techniques giving local to regional estimates. Therefore, large-scale integrated recharge estimates are often very useful in water-resource assessments, whereas detailed point to local-scale investigations are valuable for understanding aquifer vulnerability to potential contaminations. In this study Groundwater recharge is evaluated by two methods: Water balance and baseflow separation.

1.6.1 Baseflow separation methods using excel spreadsheet

A. Fixed interval method

In this method the minimum flow in the interval, I, is taken to be the baseflow for all of the days in the interval. The interval is repeatedly moved by I days along the period of n record (Petty john *et al.*, 1979).

B. Sliding interval method

In this method the minimum flow is found over the period of one-half of the interval, I, minus one day either side of the day under consideration. This minimum flow is then assigned as the baseflow to that day, i.e. the median day in the interval. The interval is then repeatedly moved by one day along the period of the record (Petty john *et al.*, 1979).

C. Local minimum method

In this method, the flow on the central day of the period one-half of the interval, I, minus one day either side of the day under consideration is checked to determine if it is the lowest flow in the interval. If it is then it is specified as a local minimum (and the baseflow on the median day) and connected by straight lines to the previous and next local minima. The baseflow on the days between the local minima is calculated by linear interpolation and constrained to equal the total flow on any day when the baseflow exceeds the total flow (Petty john *et al.*, 1979).

D. Institute of Hydrology (IH) low flow method

The algorithm calculates the minima of five-day non-overlapping consecutive periods and subsequently searches for the turning points in this sequence of minima. The turning points are then connected to obtain the baseflow hydrograph, which is constrained to equal the observed hydrograph ordinate on any day when the separated hydrograph exceeds the observed (Gustard, 1992). The procedure for calculating the baseflow is as follows:

- Divide the mean daily flow data into non-overlapping blocks of five days and calculate the minima for each of these blocks, and let them be called Q_1, Q_2, Q_3…Qn
- Consider in turn (Q_1, Q_2, Q_3), (Q_2, Q_3, Q_4), (Q_{i-1}, Q_i, Q_{i+1}) etc., if $Q_{i-1} > 0.9Q_i < Q_{i+1}$), then the central value is an ordinate for the baseflow line. Continue this procedure until

all the data have been analyzed to provide a derived set of baseflow ordinates QB_1, QB_2, QB_3...QBn, which will have different time periods between them.

- By linear interpolation between each QBi value, estimate each daily value of QB_i ... QBn
- If then $QB_i > Q$ then set $QB = Q$ The period of surface runoff is calculated from the empirical equation,

$$N = \left(\frac{A}{2.59}\right)^{0.2} \qquad (1)$$

Where, the interval, **I**, used in the baseflow separation method is the odd integer between 3 and 11 nearest to **2N**.

1.6.2 Recharge estimation using water balance method

The term water balance was first used by C. Warren Thornthwaite and explains Water balance is a balance between the incoming water in the form of precipitation and the outflow of water in the form of evapotranspiration, groundwater recharge and runoff. In some cases there might be a change in storage (Soil moisture, Groundwater or water bodies).

The general formula of water balance is given by

$$P + Gi = AET + Ro + Go + I \pm \Delta S \qquad (2)$$

Therefore, to apply the water balance technique we are required to estimate most of the hydrometeorological and hydrological element. Such as; precipitation, evaporation, evapotranspiration Groundwater recharges, surface Runoff, etc.

1.7 Overview of the thesis

This thesis is arranged by chapters starting with the introduction, methodologies and describes the source of data and discussion on methods followed in order to analyze data and to produce groundwater recharges and shallow groundwater dynamics in chapter one. The general overview of the study area is discussed in Chapter two which presents location, climate, physiography, drainage and land use and land cover of the study area. Chapter three covers regional geology of which concerns more on geological setting, structural arrangement, local geology and hydrogeological characterization of study area. Chapter four presents hydrometrological data analysis and interpretation of the study area. Chapter five presents the results from the analysis and the discussion of the results from analysis of the data. Chapter six presents the conclusion and suggestion or recommendation for future research in this area.

CHAPTER TWO

OVERVIEW OF THE STUDY AREA

2.1 Location of study area

The Upper Awash basin is located in central Ethiopia on the western border of the Main Ethiopian Rift (MER). The study area is confined within the limits of 8º15'-9º15'N latitude and 38 º-39 º 15' E longitudes. The region allocated for this study of the upper awash basin is 10,841 km^2.

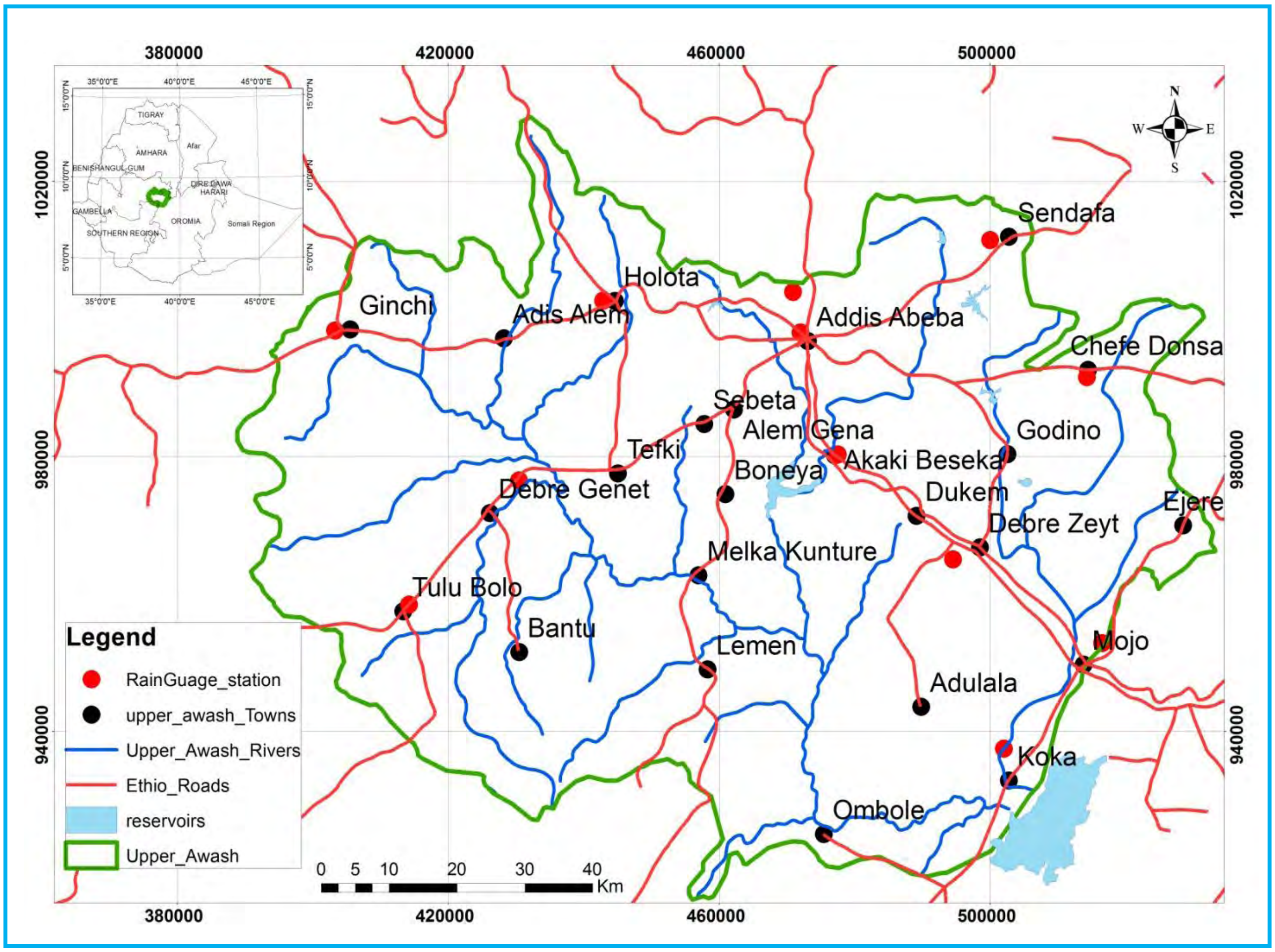


Fig 2.1 Location map of study area

2.2 Climate

The climate of the upper awash basin domain is to a large degree changed as a result the large topographic differences. It is humid in the elevated areas and arid to semiarid in the escarpment and rift valley floor. The Inter-Tropical Convergence Zone (ITCZ) has the capability to have a consequence on the rainfall establishment over the upper awash basin area. This area of low pressure shows the coming stuck together of dry tropical easterlies and the moist equatorial easterlies. The geographic scattering of rainfall over the mountainous land areas is bring in partial changes by orographic effects and is importantly has a relationship with altitude. The seasonal rainfall distribution inside the study area effects of the annual migration of the ITCZ. Throughout the course of continuance from October to February when northeasterly winds proceed firmly, long periods of dry weather are experienced and between February and the ends of April the weather come into existence more lacking stability and coming together of slightly wet southeasterly air stream give rise to small rains, frequently indicated to the “Belg Rains”.

The important rainfall is into June to September when inconsiderable wet winds from the Atlantic and Indian oceans come together from distinct directions over the Ethiopian Highlands (Daniel Gemechu, 1977). The mean annual rainfall in the upper awash basin is ranges from more than 1256mm in the Intoto highlands and around 1090mm in the escarpments and around 815mm in the Koka rift valley part of the study area. The mean annual temperature varies from 13 to 20.1^{o}C. Based on the mean monthly temperature distribution, December is the coldest and May the warmest months.

2.3 Physiography

Upper Awash basin is dominated by chain of volcanic mountains forming the watershed divide. Isolated acidic volcanic ridges are also common features known by compartmentalizing the basin acting as local divides. It is bounded in the north by the east-west trending rift escarpment (Ambo fault belt) and the Intoto mountain range, in the west by Weliso and Guraghe highlands, in the east by Kesem river basin and in the south by the Koka reservoir. The physiography of the basin is shaped by volcano-tectonic and erosional processes. The basin is characterized by very steep slope in the northern, eastern and western part, undulating topography in the central and gentle to flat in the southern part. The elevation drops more than 1400m in about a 100 km length from north to south. The major volcanic centers and ridges with in the basin are Wechecha, Furi, Guji, Bedegebaba, Ziquala and Yerer (Fig. 2.2)

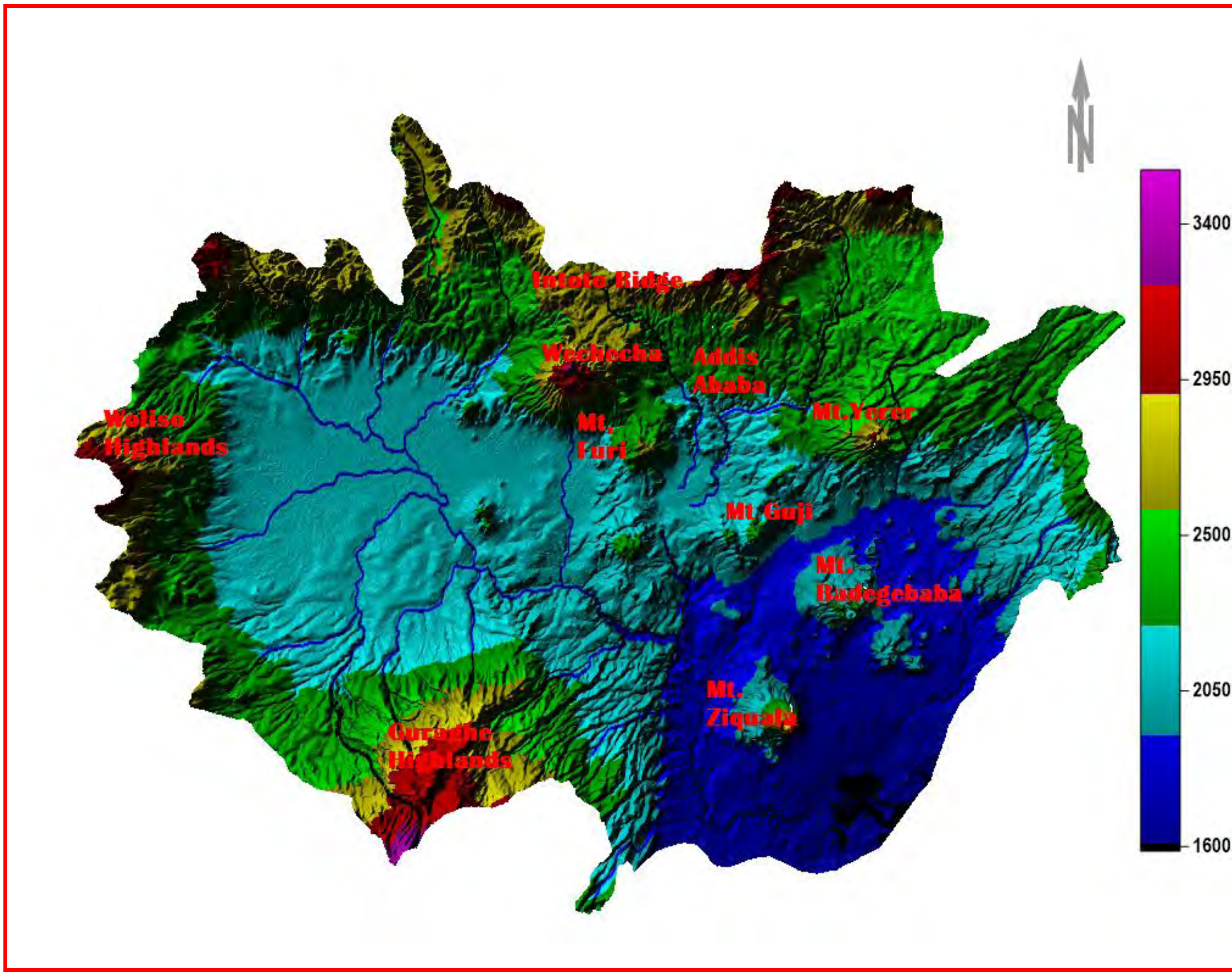


Fig 2.2 Physiographic map produced from DEM

2.4 Drainage

The Awash River begins from the large height from the surrounding level variation in range at an altitude of 2,900m in the western most region of the basin near Ginchi and flows south-east direction. Afterwards it destroyed in to the Becho plain which makes an alluvial plain with regular amount of altitude of 2,060m and then after the Becho plain, it moves through the hilly and mountainous areas of the Koka reservoir position of some 135 km downstream of Teji Bridge (Nippon Koei, 1996).

Awash River and its streams flowing in to the larger river i.e. Awash River and its tributaries form dendritic drainage pattern and Awash River move steadily in a NW – SE general direction. The streams like Ginchi, Berga, Holeta, Bantu, Lemen Akaki and Mojo are the significant tributaries of Awash River.

There are also manmade and natural crater lakes in Upper Awash basin. There are artificial lakes such as; Dire, Gefersa and Legedadi were built for water available to the city of Addis Ababa; Abasamuel and Koka were built for hydro-electric power production. The crater lakes are mass in one place in the southern portion of the investigation area located in Debrezeyt town.

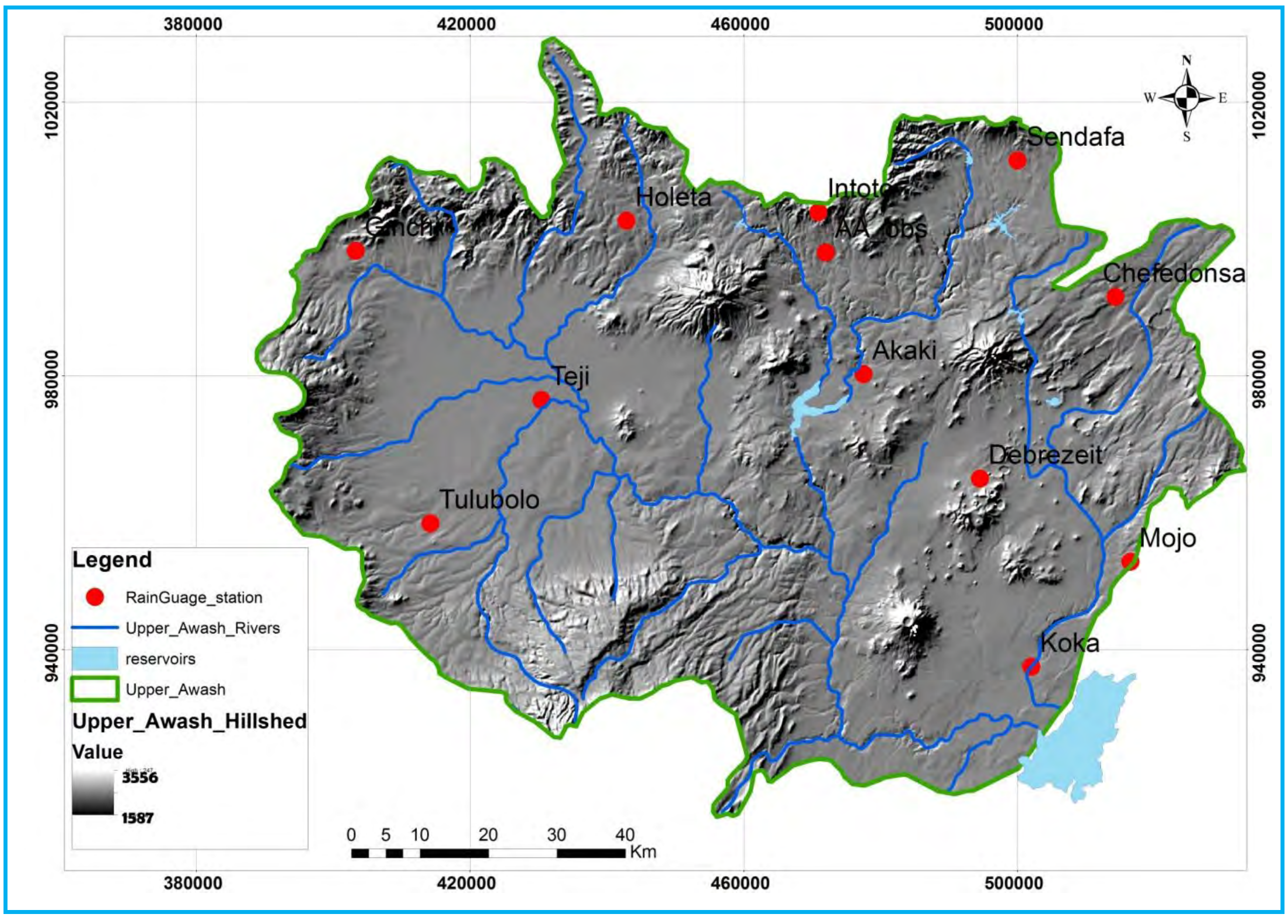


Fig 2.3 Drainage map of study area with hydro-metrological and River gauging stations

2.5 Land use /land cover of study area

Majority of the land uses of the upper awash basin is agricultural land, urban, forest and reservoirs. Consequently the urban land use pattern is farther separated into designed to live in, people living areas, a house used for growing flowers, parks, markets, industrial, petrol stations, parking lots, garages, cemeteries and sporting grounds. The greater in number industries are tanning, textile, paint, food and beverages, plastics, chemicals, pharmaceuticals and paper.

The majority of the mountains in the study field are held within by forest land. The agricultural land use covers more than average width and largely gentle slopping regions. The most significant crops that grew in the area of upper awash basin are Teff, wheat, barley, beans, oilseeds and etc. Land use is one of the major of great significant circumstance that affects surface erosion, runoff, and evapotranspiration in the basin and also Poor land use practices, inappropriate management systems and deficiency of suitable soil restoration of natural environment specified have played an important part in giving rise to an action land wearing down problems in the country. Because of the uneven surface terrain, the quantity of soil erosion and land degradation in Ethiopia is very high.

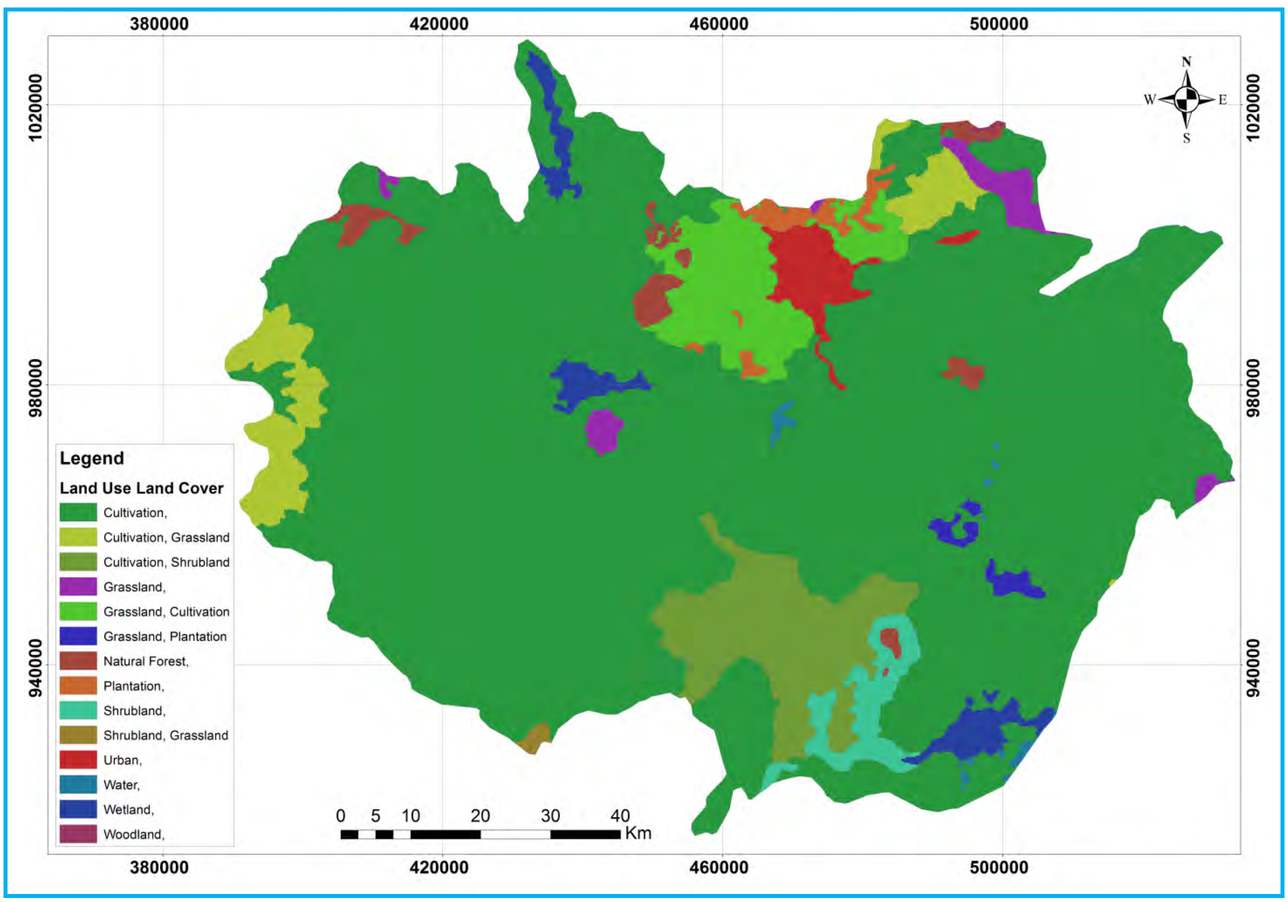


Fig2.4 Land use and land cover map of study area (modified from WWDSE, 2008)

CHAPTER THREE

REGIONAL GEOLOGY

3.1 Geological setting

Ethiopia can be divided in to four major physiographic regions, widely known as the western plateau, southeastern plateau, the main rift and the afar depression. The Ethiopian plateau is underlain at depth by Precambrian rocks of the Afro-Arabian Shield (Mohr, 1967). The Precambrian basement is covered for the most part by glacial and marine sediments of Permian to Paleogene period and Tertiary volcanic rocks with related sediments. Crustal motion started in the beginning of Mesozoic era, about 225 million years ago. During the late Triassic and early Jurassic periods, a regional epirogenic sinking of the crust commenced causing a progressive transgression of the ocean from the south east that is, from the Indian Ocean coast of present day Somalia in the general direction of Lake Tana in the North West Ethiopia. This downward crystal movement, concomitant with a sedimentation process, started a cycle of marine transgression and recession of Mesozoic sea. Therefore, within this large epicontinental sea, extensive layers of sediments were deposited to form hundreds of meters of rocks consisting of sandstone, shale, gypsum, limestone and other varieties of sedimentary rocks (V. Kazmin, 1979). The crustal movement was reversed into the upward motion during the late Jurassic period, which brought the crust's surface up to sea level by marine regression in late Cretaceous period. The regional uplift resulted in wide spread crustal fracturing during the early Tertiary period (Mohr, 1967). The crystalline and sedimentary rock layers were fissured mostly along or in the vicinity of the zone of maximum uplift, thus allowing outpouring of molten lava to cover the older rock layers. Major fault displacement along the Rift Valley was initiated during middle Tertiary period (V. Kazmin, 1979). Significant volcanic activity was associated with the formation of graben and young volcanic rocks cover the old Tertiary volcanic in many depressions.

Present day tectonic activity occurs along the Rift Valley as evidenced by numerous earthquakes. More recent volcanism associated with tectonic development activity being concentrated within this structure along the edge of the adjoining plateau (Mohr, 1967).

The regional geology of upper awash basin is situated to different rock categories that have different age of formation. From those Mesozoic sedimentary successions, Tertiary and Quaternary age group of acidic, basic volcanic rocks, Quaternary Lacustrine and alluvial deposits composes the regional geologic formation of the study area. The Upper Awash basin is truly enclosed within the north-central plateau and the adjoining escarpment and rift valley. The adjoining central plateau is carries off the water due west of the Blue Nile River drainage system and due northeast by the Awash River drainage system. The Precambrian basement upon which all the younger arrangements were deposited hold within the oldest rocks in the country, with ages of over 600 million years. The Precambrian contains a broad variety of sedimentary, volcanic and intrusive rocks which have been metamorphosed to different magnitude. Faulting was occurred at the same time by spreading over large area volcanic activities and the two activities, which are to some extent show connection, have highly resolute the form of the all the visible features of the land in the western half of in the Afar Depression and Ethiopia (V. Kazmin, 1979).

To greater extent recent volcanism make conceptual relationship with the advancement of the Rift Valley, a condition being focused within this structure and along the edge of the adjacent plateau. A volcanic phenomenon has extended firmly into the recent time in the Afar area within regular eruptive centers. The constituents of the lavas stimulated to alter composition ranges from basalt to siliceous category. Of all sediments the youngest depositions are of Quaternary age. These comprise sand, clay, conglomerate and reef limestone, which gather together in the northern end of the Main Ethiopian Rift Valley and Afar depression (V. Kazmin, 1975).

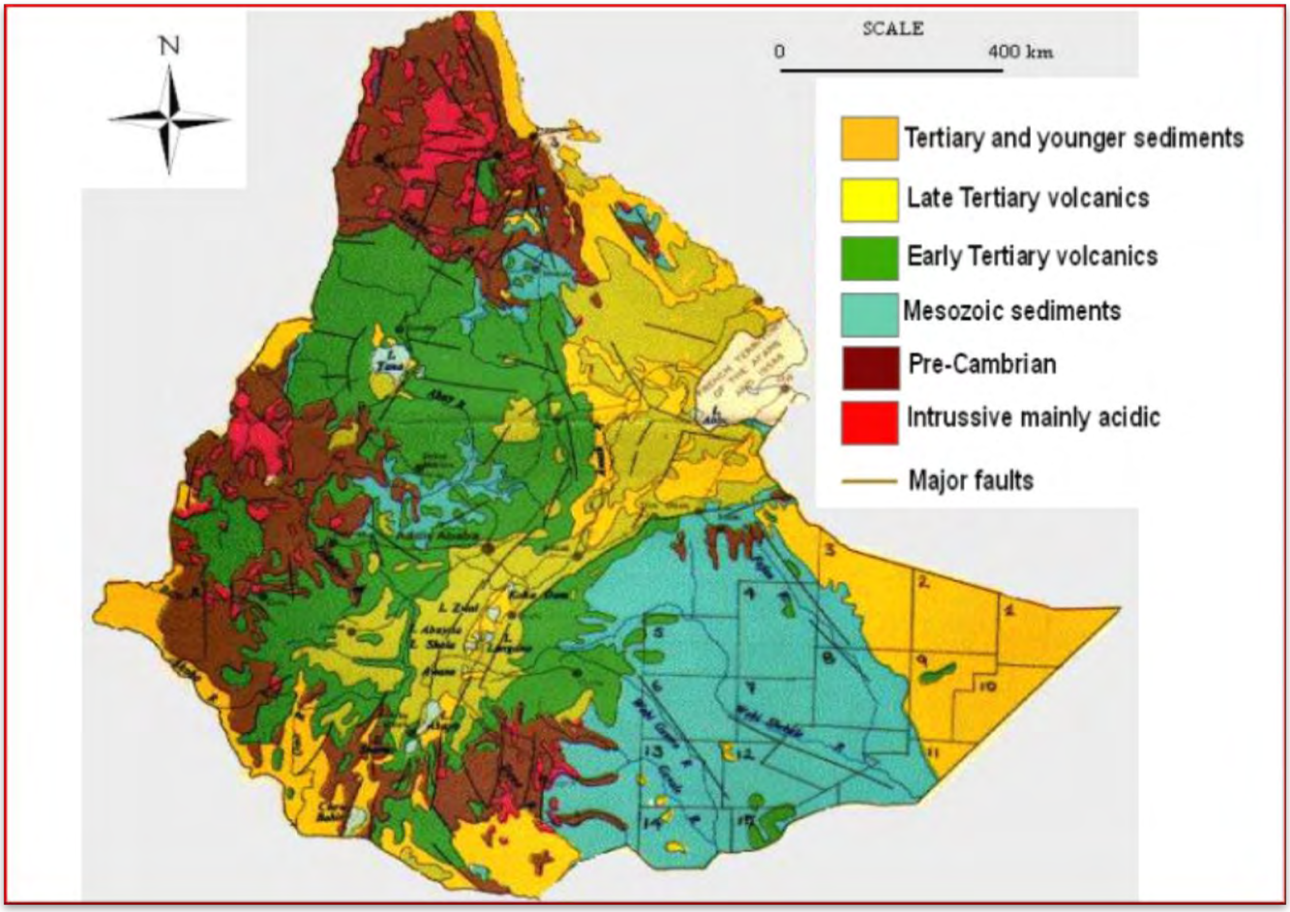


Fig 3.1Ethiopian Geological Map (Kazmin, 1979)

The conceptual connection between fissure volcanic conditions gave rise to the force out of the Trap Series succession (plateau volcanism) which is considered to be the up-doming (Mohr, 1967). The regional geologic setting of upper awash basin is place in a particular position to distinct rock units having a separate time of formation. A set of this Mesozoic sedimentary succession, Tertiary and Quaternary age groups of acidic and basic volcanic rocks and Quaternary Lacustrine and alluvial deposits constitute the regional geologic arrangement of the study area.

3.1.1 Mesozoic sedimentary succession

The Mesozoic sedimentary rocks comprise Adigrat Sandstone, Amba Aradam Sandstone, Antalo limestone and Mugher mudstone.

These sediments have the form of the transgression and regression of the Indian Ocean during Triassic to Cretaceous. This Mesozoic sedimentary succession is unconformably overly the crystalline basement rocks. Mesozoic sedimentary succession is exposed closed to kella, where unconformably overlay the crystalline basement rock (Mohr, 1967). The succession from lowest top lower most Triassic Adigrat sandstone, has a maximum exposed thickness of about 150m, it consists of reddish brown to medium fine grained sandstones, has high strength, fine to medium grained, light grey to dark grey color. According to (Kazmin, 1975) the highest in place unit, the Jurassic Antalo limestone, has high strength, yellowish grey in color with about 50 meters thick beds and maximum exposed thickness of 25 meters.

3.1.2 Tertiary volcanic rocks

This tertiary volcanic rock comprises of Addis Ababa Basalt, Addis Ababa Ignimbrite, Nazret Unit, and Central Volcanic Unit. The Tertiary volcanic composed of basalts and silicic of Miocene to Pliocene age. They unconformably line over top of the Mesozoic sediments. The Central Ethiopian plateau geology is controlling influence over by Tertiary volcanic made up of Aiba basalts, Alaji Rhyolites and basalts, Tarmaber basalts and Balchi Rhyolites (B. Zanettin *et al.*, 1974).

3.1.2.1 Addis Ababa basalt

This subdivision is fine to coarse grained basalt constitute of olivine and plagioclase phenocrysts. In major component of the visible rocks observed in the area it is relatively thin (20m) lava flow overlying the ignimbrite. The length of time of the this basalt unit is 7.5-4.5 Ma (Chernet *et al.*, 1998 and Morton *et al.*, 1979)

3.1.2.2 Addis Ababa ignimbrite

This rock unit is exposed in greater extent in part of the flat surface area around Addis Ababa and the Becho plane. It is made up of welded Tuff (ignimbrite) and non-welded pyroclastic fall (Ash and Tuff). In the area of Lega dadi plane and melka kunture area the thickness of this unit stretches up to 200m (exploration drilling data). The age of this Addis Ababa ignimbrite rock unit is 5.11-3.26 Ma (Morton *et al.*, 1979).

3.1.2.3 Nazret group

Nazret rock unit composed of a thick succession of not welded tuffs, ignimbrite, ash flows, Rhyolites and trachytes out cropping for the most part on the rift floor reach a thickness of above 250m and to some degree in the rift escarpments and on the adjacent plateau border. As stated by (Kazmin and Seifmicheal Berhe, 1975) this class name was unofficially used for lower(older) welded Tuff (give an account of to Wechecha trachyte volcanism), Aphanitic Basalt (caused to be visible vertically curved columnar jointing close association with sub horizontal sheet jointing) and upper welded tuff (be connected to Yerer volcanism). This unit is mainly exposed in the southeastern part of the area and forms rift floor. It comprised of a particular order of welded per-alkaline rhyolitic ignimbrite (Morton *et al.,* 1979).

The great distribution of rhyolitic domes is information indicating at hand to say silicic centers controlling influence over at the latest processes of Nazret volcanism which was occurring at the same time as by the Arba Gugu shield volcano and Chilalo and Badda volcanoes which happened during the before expected time and after the expected stages of Nazret volcanism separately (Morton *et al.,* 1979). The Nazret rock unit, division buried uncomformably on the Addis Ababa Basalts and there is Bofa Basalt on the uppermost of the Nazret volcanic succession. This group has a close similarity to the young age of Addis Ababa Basalt and to the oldest age of Bofa Basalt within a specified age of 5.4 to 3.11ma (Morton *et al* 1979).

3.1.2.4 Akaki basalt

The Akaki basalt unit is visible (outcropped) at Daleti, Abasamuel Dam, Akaki, Dukem area. It is coarse grained porphyritic olivine basalt. This basalt unit is highly vesicular and the vesicles or pore spaces are filled with carbonate minerals or secondary materials. Scoria and basalt quarried in Akaki and Dukem for construction purpose. The layer of this Akaki basalt unit around Akaki is 202m (drilling data). The age of the Akaki basalt is 2.9-2.0 Ma (Tesfaye Chernet et al 1998 and Morton *et al.,* 1979).

3.1.2.5 Central volcanoes unit

The central volcanic unit comprises Wechecha, Furi and Yerer Trachyte, Entoto ridge and Becho area Rhyolites, Tulu Rie Basalt and Chefa Donsa Unit. The Central Volcanoes rock units are for

the most part are trachytic lavas visible at Wechecha, Furi, Yerer, Western and Southwestern narrow hill top of the investigation area forming an lift to higher ridges or mountain peaks.
The Yerer trachyte is elevated about 1000 m from the surrounding plane area. The south and southern western narrow hill, tops is a watershed divide between the Omo-Gibe and Awash River basins. It is grayish color fine to medium grained trachyte with lower composition of ash falls and ignimbrite. The age of the central volcanoes rock unit is 10-3 Ma (Kazmin, 1979). It is also porphyritic in texture with phenocrysts of feldspar up to 1cm towards the other side. In fresh hand specimen it is grayish in color. Petrographic investigation studied by Tsegaye Abebe *et al.*, (1999) shows that Trachytes of Wechecha and Furi are comprised of plagioclase and sanidine phenocrysts predominating the trachyte, alkaline pyroxene and rare olivine. The crystals embedded in porphyritic rocks differ in size from glassy to microcrystalline and is be a part of by mostly by alkali feldspar, pyroxene, amphiboles and opaque minerals. The ages of the trachytes are different with Wechecha 4.6-3.7 Ma, Furi 4.0-3.7 Ma (Tesfaye Chernet *et al*., 1998), Yerer 3.9-3.3 Ma (Morton *et al.*, 1979).

The Entoto Ridge is one part of central volcanoes unit which forms watershed divide of Abay and Awash River basins. The Entoto ridge forms steep slope in the direction of the Abay basin steep to gentle slope towards the awash river basin. Data (anything known) on the ages of the Rhyolites are not obtained; however from the crosscutting relationship they can be younger than the adjoining ignimbrite. The Wechecha trachytic rock unit is outcropped in the north and north east part of the mapped area and being composed of western rift shoulder central silicic volcanoes such as Wechecha, Furi and Yerer (Morton *et al.*, 1979). The central volcano is preferentially trending in the direction of E-W. It has medium to coarse-grained, light gray to dark-grey and very high strength and microscopically it is constituents of K-feldspar (Tsgaye Abebe *et al.*, 1999). Tulu Rie Basalt is also one part of the central volcanoes unit outcropped in the southeastern part of the investigation area and forms NE trending escarpments. It is lava flow coarse grained basalt with olivine and plagioclase phenocrysts with very infrequent clinopyroxene. The age of this rock is 2.7 to 1.44 Ma (Morton *et al.*, 1979).

The Chefa Donsa volcanic rock units are visible at the surface in the east, north east south and west of not usual parts of Debrezeit. They are composed of fall deposits (ash, Tuff and pumice) and poorly welded ignimbrites of rhyolitic constituents. Therefore in the Dukem and Mojo river valleys they are outcropped under the lacustrine deposit. The age of this Chefa Donsa rock unit varies in between 2.24 to 1.71 Ma (Morton *et al.*, 1979).

3.1.3 Quaternary volcanic rocks

This Quaternary volcanic rock contains Gash Megal Rhyolites, Woliso Ambo Basalts, Ziquala trachyte, and Bishoftu Volcanic unit.

3.1.3.1 Bishoftu volcanic unit

This Bishoftu volcanic rock unit configured a NNE trending belt outcropping for the most part in the central level surface areas of Debrezeyt (Tsegaye Abebe *et al.*, 1999). In the Bishoftu Volcanic splashed over the surface and cinder cones with conceptual connection with tabular basaltic lava flows and phreato-magmatic deposits are dignified in appearance. The basalt in this area is vesicular and coarse grained with olivine phenocrysts (Tsegaye Abebe *et al.*, 1999). The phreato-magmatic deposits are for the most part composed of surges and highly broken off deposits make conceptual connections with maars and Tuff ring. Bora-Bericha Rhyolites rock units is also outcrops in the north east around Debrezeyt area and eastern part of the investigation area (Tsegaye Abebe *et al.*, 1999). The Bora-Bericha Rhyolites rock consists of younger rift floor volcanoes such as Bedegebabe, Gedemsa, Bericha, Bora and Tullu-Moye (Morton *et al*., 1979). Products of these centers are for the most part are per-alkaline trachytes. This rhyolitic rock unit has high strength, light gray to pink in color constituents of alkali feldspar, quartz and mica (Tsegaye Abebe *et al.*, 1999).

3.1.3.2 Ziquala trachyte

This rock unit is exceptional, well maintained in its original cone standing about 1300m from the surrounding flat surface area, situated in the southern part of the detailed investigation area. It has a highest point of hill caldera 1.5 km wide and existing only in part become full of water (Morton *et al.*, 1979). This Ziquala trachyte is grayish pink in color, coarse grained and petro-graphically constituents of anorthoclase, sanidine, minor clinopyroxene phenocrysts and glassy alkali-feldspar embedded in a porphyritic rock (Tsegaye Abebe *et al.*, 1999). The age of the Ziquala trachyte is 1.28-0.85 Ma (Morton *etal*., 1979).

3.1.3.3 Woliso Ambo basalts

The Woliso Ambo basalt rock unit is exposed at the western and northern extreme parts of the mapped area. It is lava flows make up of porphyritic basalt with relatively greater size crystals of plagioclase, olivine and pyroxene, basalt breccias' and little Tuff. (Tsegaye Abebe *et al.,* 1999). In the area of Woliso it is Scoraceous basalt and in the Abay Master Plan report, this is unit is mapped as a basalt lava flows join together to volcanic centers (QVCB) and its age is Pliocene to present.

3.1.3.4 Gash Megal rhyolites

This Gash Megal rock unit outcropped in a most important part of the detailed investigation area at the west of the Main Ethiopian Rift a point at which steep slope descends from highland area, on the top of Guraghe escarpment. This rock unit has medium strength, fine to medium grained, light gray color. This rock unit is constituents of feldspar, quartz, and Muscovite minerals (Tsegaye Abebe *et al.,* 1999).

3.1.3.5 Chafe-Donsa pyroclastic deposit

This rock unit outcropped in the North -East central part of the study area. It has low strength, light to dark gray color, fine grained unwelded to poorly welded, fine volcanic ash flows and fall deposit composed of mainly Rhyolites and mainly exposed in the rift floor (Morton *et al.,* 1979). Microscopically, it is composed of k-feldspar, quartz, plagioclase and hornblende having vitrophyric texture.

3.1.4 Quaternary lacustrine and alluvial deposit

3.1.4.1 Lacustrine deposits

The Lacustrine deposit is to higher degree dignified in appearance in the Adaa plain of the Lakes region. The Lacustrine sedimentations are the consequence of deposition in this large ancestral lake (Mohr, 1967) and (Tsegaye Abebe, *et al.,* 1999). The age of the lacustrine rift sediments is occurring at the same time with the Wonji volcanic (Morton *et al.,* 1979). They are fine grained outcrops in most cases brown-yellowish, thinly arranged into strata and often hold within volcanic matrix; whose thickness varies from 5 to 8m. The thick layer of strata is written in the groundwater well drilling reports. They are for the most part of volcanoclastic sediments and tuffs with silts, clays and diatomites; silts and clays are the dominant once. Exposure of this the Eastern part of study area along the rift floor. The covers the largest area and forms flat topography and occur below an elevation of 1900 m.a.s.l. It consists of loose, light to yellowish grey color, sand and silt size sediments of volcanic origin such as pumice and volcanic ash plus obsidian, Rhyolites and basaltic rock fragments (Morton *et al.*, 1979).

3.1.4.2 Alluvial cover

Alluvial deposits are also common in the Rift, in connection with flood plains and at some places mixed with volcano clastics (Tsegaye Abebe, *et al.*, 1999). The alluvial cover mainly outcropped above the Tertiary volcanic on the plateaus, Becho Plain, Mojo and its surrounding areas and composed of regolith reddish brown soils, talus and alluvium with maximum thickness of about 7 m (from area hand dug well data).

3.2 Structural setting of upper awash basin

The East African Rift System (EARS), configured as a consequence of the hard but liable to break easily African continental ‘plate’ as a reaction to elastic forces that are speeded up by very slow creep of rocks hundreds of kilometers deep in the Earth, is a region of continental break-up that provide the comparative movement between the African and Somalian Plates. In the EARS, the Main Ethiopian Rift (MER) constitutes an understanding of the area as it brings together the afar sunken place to the Kenya Rift. The MER is described distinctively by a fault arrangement (sequence) trending in the direction of a NE-SW border fault system and an N-S to N20°E-trending system, comprised of step-up right-stepping faults obliquely influencing the rift floor Wonji Fault Belt (Tsegaye Abebe, 1995; Tsegaye Abebe et al., 1998).

Upper Awash basin is located at the intersection of two important regional structures, that is to say the NNE-SSW trending MER and the East-West trending Addis Ababa-Nekemt volcanic lineament (Andarge Yitbarek, 2009). According to Andarge Yitbarek, 2009 the volcanic rocks of the upper awash basin have subjected to large area faulting often experienced a general direction of NE – SW, E-W and at places NW-SE also the majority of the linear features along the general direction of the rift.

As cited in (Andarge Yitbarek, 2009) the Addis Ababa-Nekemit fault has a moved downwards to the south in the Addis Ababa area and the Intoto silicic rocks are enclosed within this fault (Haileyesus Girmay and Getaneh Assefa, 1989). Additionally, important fault trending in the direction of NE-SW (Morton, 1974, Haileyesus Girmay and Getaneh Assefa, 1989) is the Filwoha fault which is down-thrown to the south of Addis situated at central Addis Ababa and many hot springs and thermal wells be found along this fault. Groundwater recharges and flows in the aquifers of the upper awash basin most likely controlled by the geometry of the faulted aquifers dipping direction of the underlying lithology, porosity and permeability of the different lithologies. In the project area the oldest and underlying sedimentary rocks are dipping in the southeast direction. The volcanic rocks resting over these sedimentary secessions have also following the dipping direction of the underlying sedimentary rocks. These volcanic rocks in the area are highly affected by four different faults and fracture systems and solution cavities below the surface facilitate flow through the aquifers. According to (WWDSE, 2008) there are four types of fault features are distinguished throughout the interpretation of satellite imagery lineaments data. The widespread brittle deformation consisting of fractures and dislocations are also observed during the field survey.

3.2.1 North West fault system

The NW fault system, the oldest fault system have extended history affects all the rock type in the western escarpment. They are crustal scale served as a conduit for the extensive volcanic formation in the area and their age may go up to early Paleozoic, but becomes reactivated latter with the main tectonic event in the region (Tsegaye Abebe, 1995; Tsegaye Abebe et al., 1998). The trend of the Bede Gebaba -Wechecha volcanic belt can be associated with this NW fault system.

3.2.2 East West fault system

The EW fault system, which is the upper boundary of the Ethiopian rift margin, is running approximately E-W north of the Addis Ababa Ambo road. They are major fault on the western plateau part and densely affected the Tarmaber basalt in the area.

3.2.3 Northeast Southwest fault system

The NE-SW fault system runs parallel to the principal system of fissures in rift floor north east of Debrezeit and Modjo and extending to Nazeret. This fault system is densely affecting the volcanic rocks and served as a conduit to younger eruption (Tulu Rie basalt). The fault system of the rift margin exhibit step like block faults.

3.2.4 North-South fault system

The NS fault system is the recent fault system which serves as a conduit for young volcanic (Addis Ababa basalt).

3.3 Local geology

3.3.1 Ignimbrite

This rock unit expose in large part of the upper awash basin area in the Teji, Tulubolo, Asgori, Mojo and Koka area. In the Becho area it occurs intercalating with the other; the comparatively thick deposit of unwelded tuffs and volcanic ash are most of the time blanketed by ignimbrite sheets of up to about 20 m thick. This rock unit is grayish to white color, poorly welded. They are overlaid by thin residual soil made of the same rock units and alluvial deposit. In the Koka and Mojo area this units are grayish red in color, moderately to highly weathered rock units are medium to course grained with a kind of sheet flow structures and show eutaxitic texture with oblate glassy fragments (WWDSE, 2008). Rock fragments and crystals, generally broken, are abundant; alkali feldspars, quartz, aegirine and amphiboles are the most common crystals. They constitute the upper part of Nazret Group in the Koka area and Addis Ababa group in Becho area (Kazmin and Seifemichael Berhe, 1978).

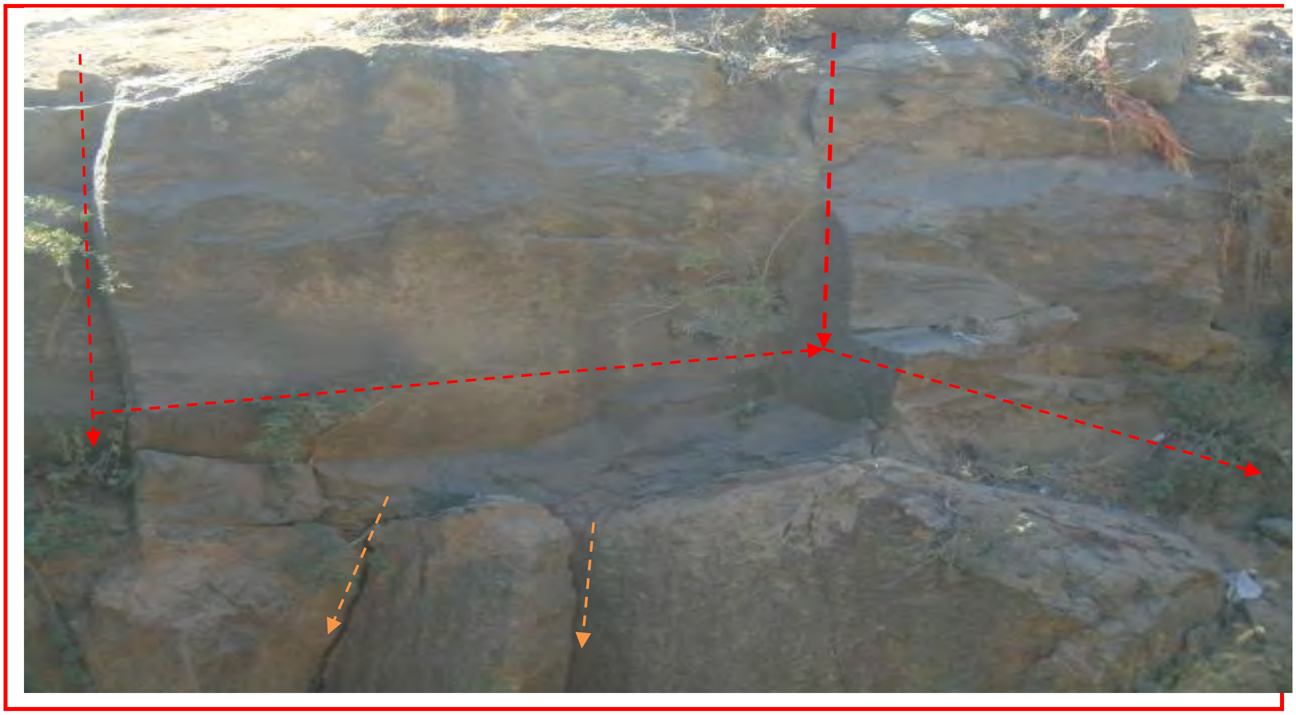


Plate 3.1 Columnar joint in ignimbrite rock unit in Mojo River side

These columnar joints exposed in many places in the upper awash basin such as river side exposure in Mojo, hillside exposure in Teji, Bishoftu, and Holleta are observed outcrops which have a great role in groundwater recharge.

3.3.2 Alluvial deposits and lacustrine cover

The lacustrine deposits are interbedded with Pliocene-Pleistocene ignimbrite in the rift areas on the closest vicinity of Lake Koka (Mohr, 1966). They are fine grained deposits generally brown-yellowish, thinly stratified, very friable, and less compacted and often contained volcanic matrix; whose thickness ranges from 5 to 8m (WWDSE, 2008).The alluvial cover mainly outcropped above the Tertiary volcanics on the plateaus and Becho Plain and in the Mojo area and consisting of regolith, reddish brown soils, talus and alluvium with maximum thickness of about 7 m (WWDSE, 2008). The lacustrine deposit is particularly distinguished in the Adaa plain of the Lakes region. They are fine grained deposits generally brown-yellowish, thinly stratified and often contained volcanic matrix; whose thickness ranges from 5 to 8m. More thickness is reported in the groundwater well drilling reports. In these successions volcanic layers are frequent and become predominant and coarse grained near by the maars.

Plate 3.2 Black cotton soil in Becho area

The alluvial cover mainly found above the Tertiary volcanics on the plateaus and Becho Plain and consisting of regolith, reddish brown soils, talus and alluvium with maximum thickness of about 7 m (Becho area hand dug well data).

3.3.3 Basaltic flows and domes

Basaltic lava flows that are found in the northern, eastern and central part of the Mojo and Debrezeit area are dispersed in the form of younger spatter and cone volcanic centers. These basalts are highly fractured and in several places they are scoraceous. The geologic materials found in this area are very fine-grained rocks of volcanic origin with some silty sand and pebble beds.

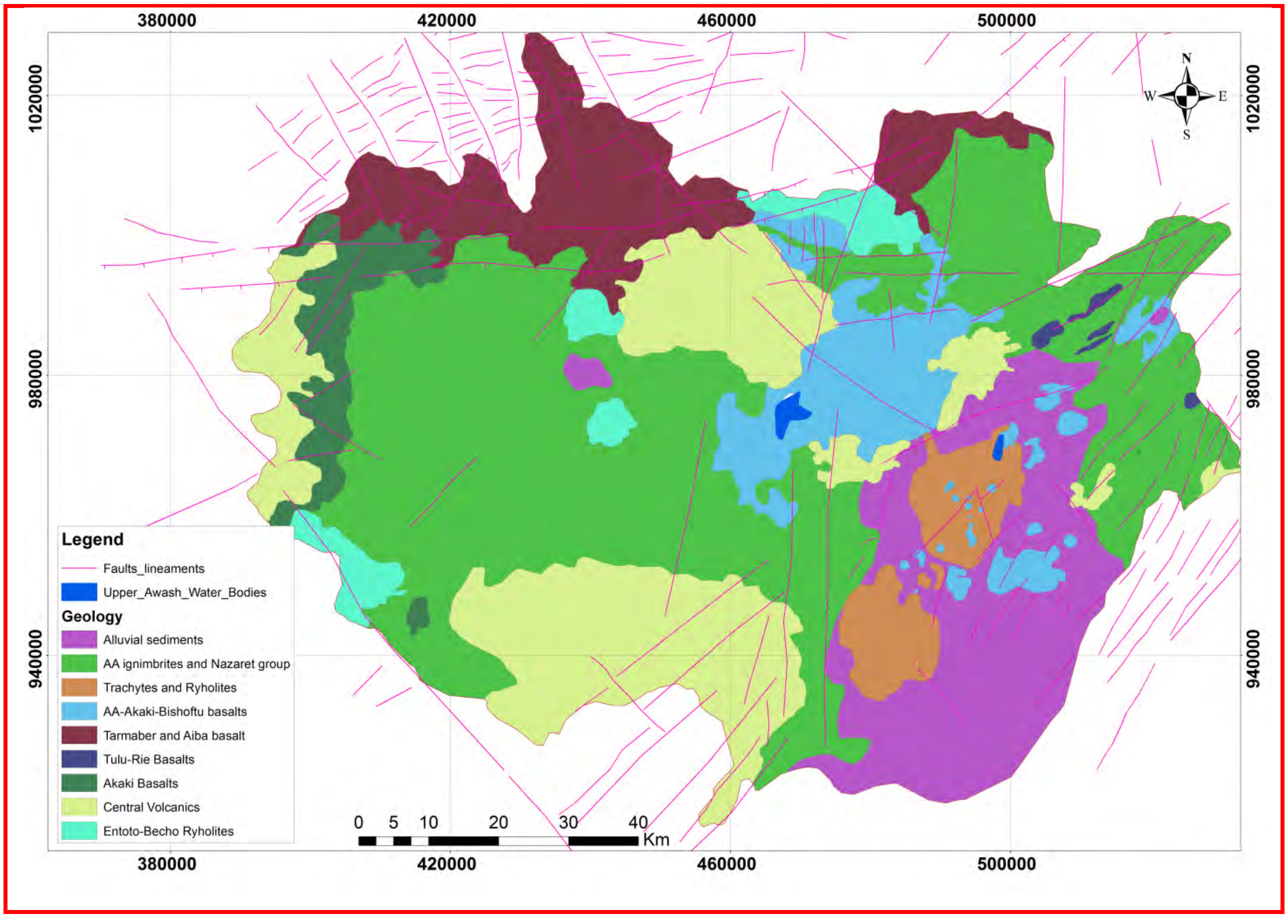


Fig 3.2 Geological Map of Upper Awash basin (modified from WWDSE, 2008)

3.4 Hydrogeology of upper awash basin

The volcanic rocks of central Ethiopia in principal and that of the investigation region in especially intense are hydrogeologically consisting of different parts. Thoroughly comprehension of the physical underlying structure of these rocks within which groundwater assign to a particular places and moving is a basically essential to the hydrogeology of these rocks. According (Andarge Yitbarek *etal.* 2008) reveals that the occurrence of two basaltic aquifer systems (upper and lower) in the northern half of the upper awash basin (upstream of Melkakunture and Dukem areas). These basaltic aquifers are separated by thick impermeable acidic volcanics. The upper basaltic aquifer is lie on top other by ignimbrites and tuffs in Becho and Legedadi region. It forms confined and unconfined aquifer system, locally the lateral extension is destroyed by trachytic and rhyolitic volcanic centers and narrow hill tops. The lower aquifer is confined in disposition.

The lower basaltic aquifer is distinctively described by intensely weathered and fractured scoraceous lava flows and at the same time the upper basaltic aquifer is fine to coarse grained, porphyritic, and in a location vesicular inherently. The lower basaltic aquifer has a higher transmissivity and storage coefficient than the upper basaltic aquifer and, as a result, wells tapping the groundwater system of the lower basaltic aquifer have higher yields than wells tapping the upper basaltic aquifer.

Acidic volcanics like rhyolites, trachytes, ignimbrites and Pyroclastics frequently behave as local aquicludes by dividing into categories the upper basaltic aquifer. In whatever way, in particular position these units are presented to uphold low yielding water wells into weathered and fractured zones (WWDSE, 2008). The volcanic rocks of the upper awash basin have be subjected to extensive faulting frequently experiencing a general direction of NE – SW, E-W and at particular position the trend is NW-SE. The upper awash basin is situated at the intersection of the two significant regional structures that is to say the NE-SW trending Main Ethiopian Rift (MER) and the E-W trending Addis Ababa-Nekemit volcanic linear feature on the earth's surface. The density of faults and lineaments are greater in amount to the southeast in the direction of the rift valley (WWDSE, 2008).

The shallow aquifer mechanism in upper Awash basin is recharged by local precipitation and rainwater that thoroughly moves through the weathered covering or soil and that is not captured and transpired by plants can percolate towards the unsaturated area to recharge the aquifers. The deep aquifer mechanisms are recharged in the high mountains or areas of large height from surrounding earth's level and plains of Addis Ababa area and its surroundings. Depending on the stratigraphic connection built from the drilling analysis of the boreholes along and field visit of geological structures, it can be arrive to the fact that aquifers in separate regions have been brought together to each other completely the permeable and porous scoraceous basaltic formation. It is acceptable that in upper awash basin central point or the transition and rift valley segment of the investigation region, this formation is displaced downwards by the regional east-west running Ambo Fault.

The scoraceous lower basalt rock unit in proximity with the tectonic structures is for that reason responsible in carrying to the place the recharge from the adjoining Blue Nile area of level high ground to the upper Awash aquifer mechanisms.

In most cases, depth to static water level increases from north to south not including in some regions to which geologic structures and local obstacles disrupt aquifers, depth to static water level and flow (WWDSE, 2008). The highest water level depth was measured in the southern portion of the upper awash basin near the main rift.

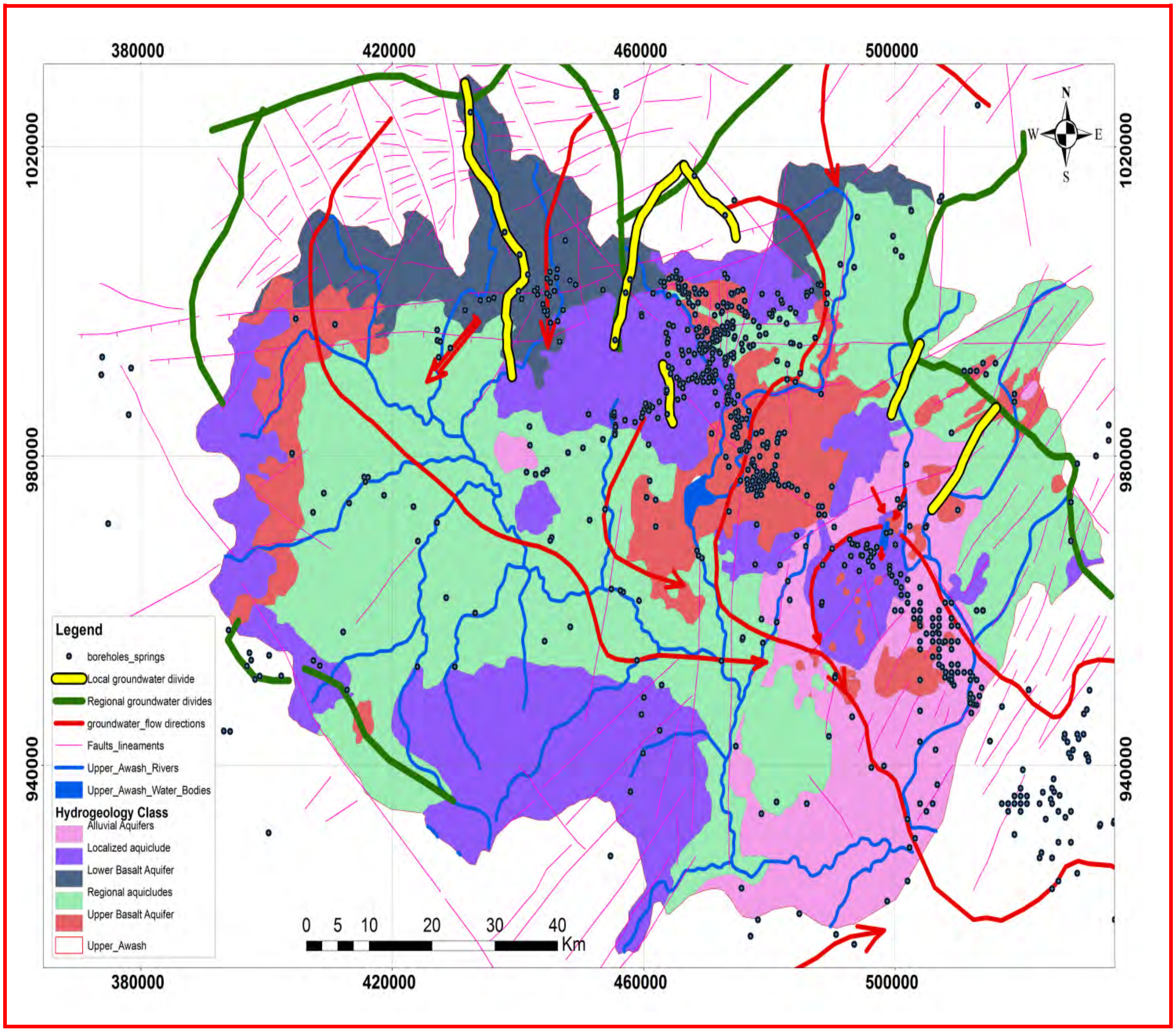


Fig 3.3 Simplified hydrogeological map of upper awash basin (modified from WWDSE, 2008)

The aquifers of Ada'a plain are lacustrine sediments, scoria, scoraceous basalt and vesicular basalts (volcanic aquifers). The thickness of lacustrine sediment can extend up to 100m, lie underneath by scoraceous basalt. The lacustrine sediments shows great deal of variation in their permeability, those exhibiting the greatest permeability are the ones comprised of volcanic sands, water laid volcanic sands for example those around DebreZeit and also fine grained sediments with inter-bedding of massive tuffs and fine ash are also experienced(WWDSE, 2008).

The volcanic aquifers bear primary porosities such as vesicles, and secondary porosities like faults, fractures and fissures created into existence because of tectonic happening and weathering regions (WWDSE, 2008). In most events in the volcanic rocks ground water movement through formation, occurrence is necessitated with those porosities, meanwhile in the alluvial and lacustrine aquifers; it is in the interstitial spaces in amongst the sediments.

According to (Halcrow, 1989) in the rift floor the geological complexity, has brought into existence a highly divided groundwater distribution in spite of the fact that the regional groundwater flow is from the escarpments into the valley and north east wards to Lake Abe. The primary consideration for shallow groundwater could be the barrier circumstances of the acidic volcanic rock formation of Bedegebabe. As stated in (Seifu Kebede, 1999) conducting geochemical and isotopic mass balance, the lake water outflow as groundwater was found to be very low this could be that the Bedegebabe ridge has effect that impedes the free movement of groundwater flow in South West direction and the second zone, is found South West of Bedegebabe. According to WWDSE, (2009) Inception report the surface elevation of this region is lower than the first region and also the groundwater depth is deep and goes up to100m and at some places still deeper.

The major significant lineaments influencing the groundwater flow and occurrence in volcanic rock formation are vertical permeability because of primary and secondary fractures or horizontal permeability or because of layer having passage ways because of the lava flow and gas expansion length of solidification or due to happening of not permeable layers and dykes. In the volcanic rock terrain, it is capable to get possible aquifer intercalated with comparatively not pervious rock units. In these aquifers ground water occurs under confined circumstances and inter-bedding of massive rock formation with fractured and porous media also gives rise to multi-layer aquifer arrangements. The aquifer characteristics in the upper awash basin are restricted by the litho-stratigraphy of the volcanic rocks and the geological structures that make difference to them. By the reason of the complex nature of the lava flow, the volcanic rocks have favorably variable primary porosity. After long time, these volcanic rocks have been subjected to extensive weathering and fracturing related to tectonics cause to experience secondary porosities

(WWDSE, 2008). These volcanic aquifers can be believed to be as a double porosity medium because of the fact that both the matrix and the fracture porosity provide to the movement to and fro and storage of groundwater. The aquifers in upper awash basin can be divided broadly into two divisions; primary porosity aquifers and double porosity aquifers. The first division consists of aquifers related to Quaternary alluvial and lacustrine deposits and the second wide in area division belongs to the basaltic volcanics and again subdivided in to upper and lower basaltic aquifers separated by less permeable, along fractured and weathered zones and/or impermeable in other respects, of acidic volcanics. As stated in WWDSE, (2008), the alluvial and lacustrine aquifers are located dominantly in the southeast around Debrezeit and Modjo towns, and locally in the northwestern part of the Becho plain and along the main perennial river courses

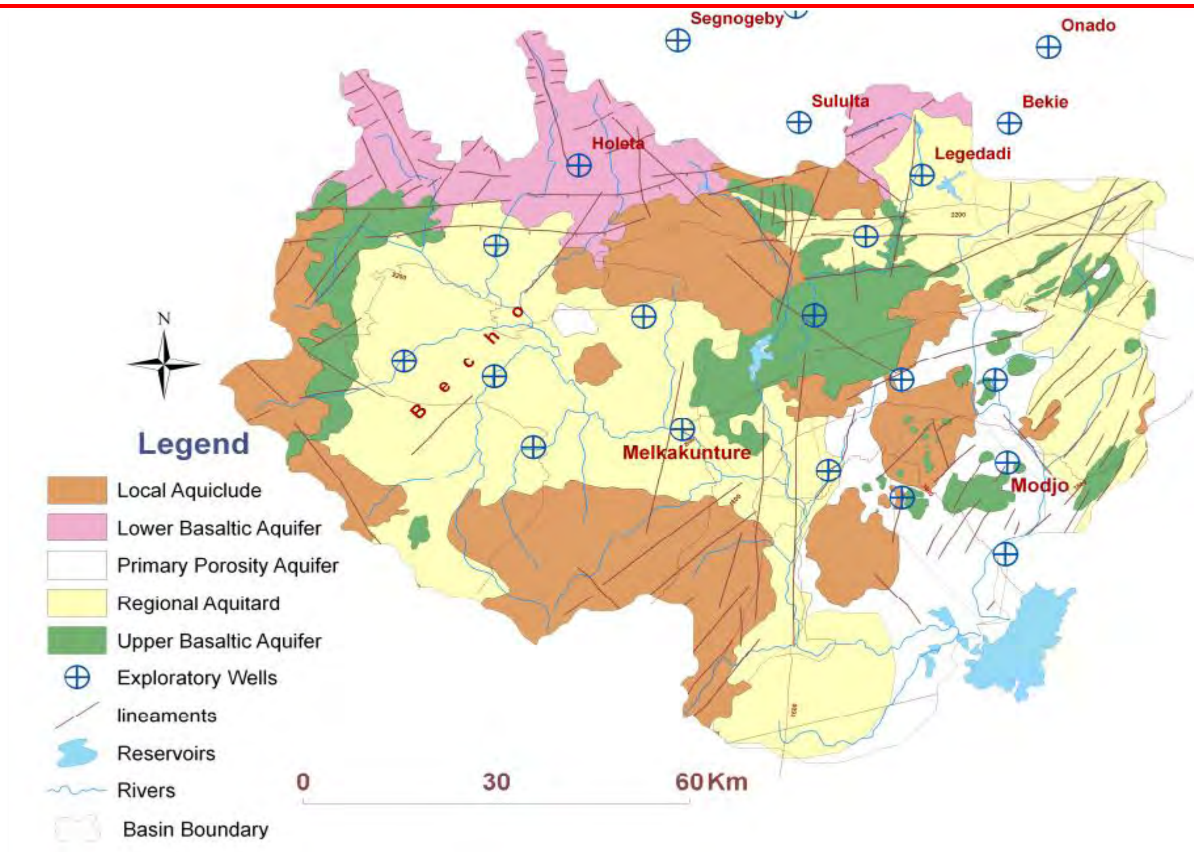


Fig 3.4 Hydrostratigraphy map of upper awash basin (Adapted from Andarge, 2008)

The alluvial and lacustrine deposits located in Debrezeit and Modjo have thickness up to 80 meters and comprised of coarse sediments. Depth to static water level varies from 2 to 30 meters for shallow groundwater. The alluvial aquifers in the southern segment are with direct hydraulic connection with the underlying basaltic main aquifer (WWDSE, 2008). Support from exploratory drilling hydrostratigraphic relationships, system of shallow groundwater recharge and circulation the formations encountered from top to bottom (younger to older) are the comparatively principal scoraceous and/or vesicular Tarmaber basalt, underlain by Alaji Rhyolites comprised of rhyolites and ignimbrites followed by the columnar jointed Amba Aiba and highly weathered Ashangi basalts correspondingly.

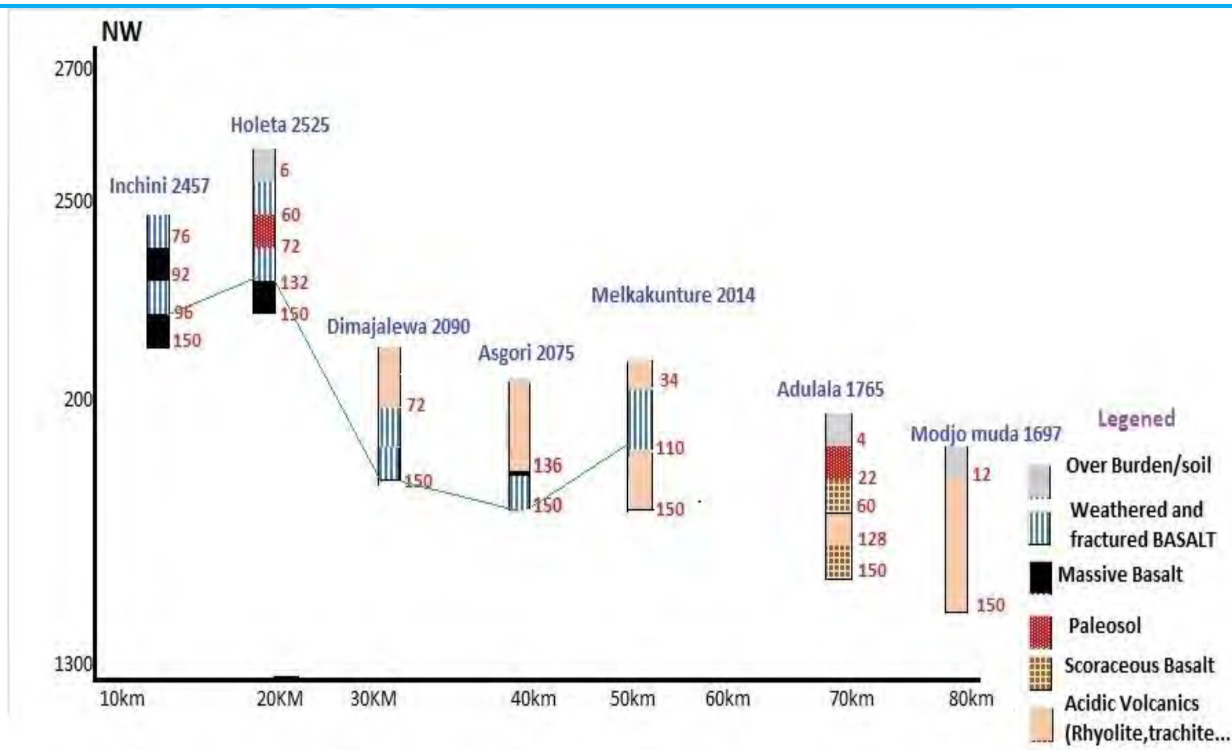


Fig 3.5 Hole-to-Hole lithologic sections from Inchini to Mojo (modified Andarge Yitbarek, 2008)

By support of the stratigraphic relationship correlated from the drilling data of the boreholes (Figures3.7 and 3.8) along with the respective geological structure setup, groundwater movement could be connected laterally through the permeable and porous, weathered and fractured basaltic unit. The lower aquifer is confined and the upper is confined at some places and unconfined in others.

On the other hand, drilling in the southern part of upper awash basin showed that the upper and lower aquifer forms one unconfined regional aquifer system south of Melkakunture and Dukem areas may be due to the intensive faulting and fracturing in this part of the study area.

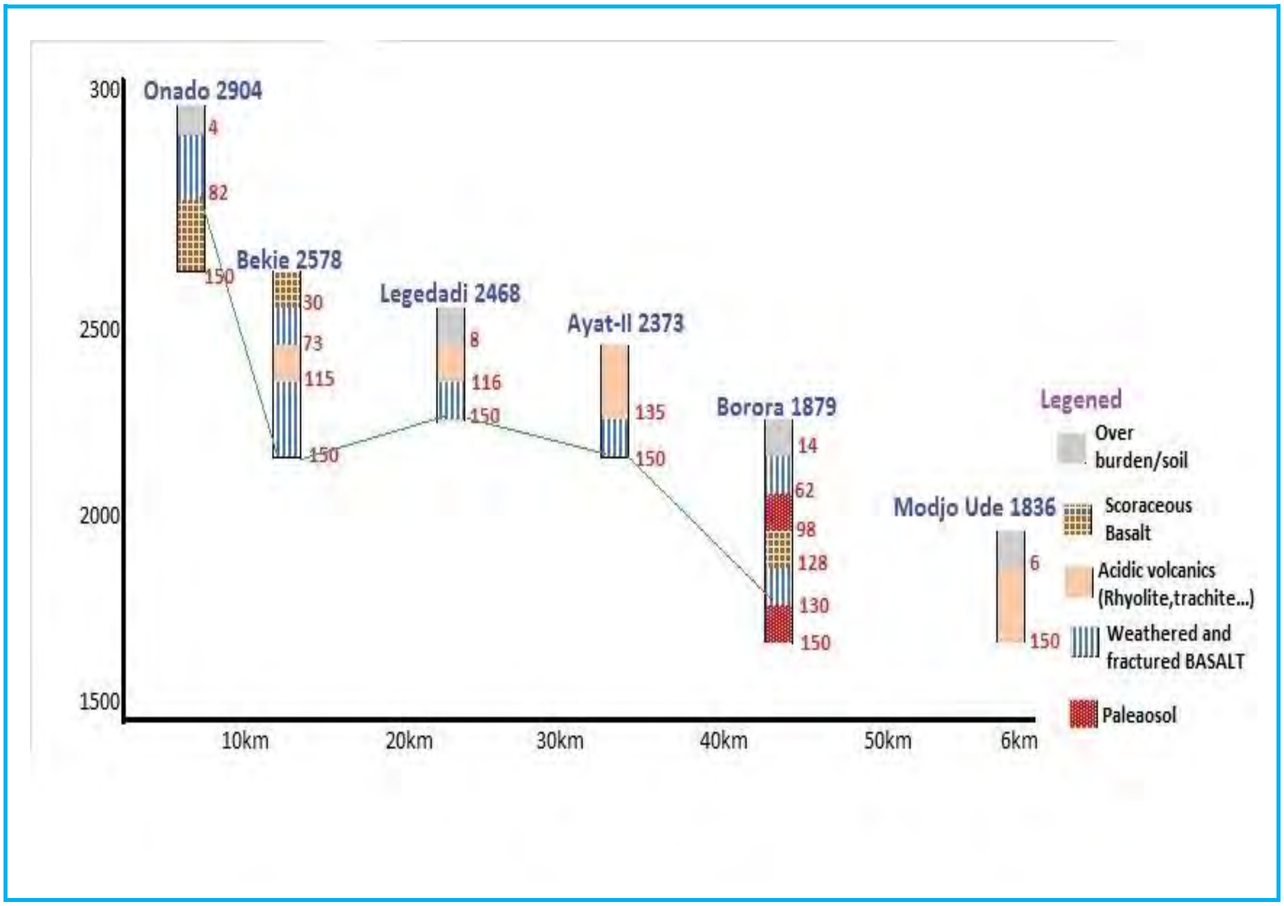


Fig 3.6 Hole-to-Hole lithologic sections from Onado to Mojo (modified Andarge Yitbarek, 2008)

According to (WWDSE, 2008) the volcanic rocks can be classified in to three important regions according to the extent of fracturing and their hydrostratigraphic place where they are sited.

1. Upper basaltic aquifer: - This rock unit is comprised of Quaternary flows of Weliso-Ambo basalts, Akaki basalts, scoria and spatter cones, and Tertiary-Neogene basalts of Addis Ababa region. The upper basalt aquifer has of great distribution in the region and in the north central segment located at Addis Ababa, Akaki and found overlain by ignimbrites and tuffs in Becho and Legedadi region. It forms confined and unconfined aquifer system, locally destroyed by trachytic and rhyolitic volcanic centers and ridges. The static water level in this aquifer is highly variable and at places artesian conditions to a maximum of 150 meters below ground surface.

2. Lower basaltic aquifer: - This volcanic rock unit is comprised of lower Tertiary Tarmaber and Aiba basalts, dominantly scoraceous. According to (Andarge Yitbarek, 2008) the exploratory wells drilled in Becho, Holeta, Melkakunture, and Legedadi areas penetrated this lower basaltic aquifer under thick impermeable ignimbrites (up to 225m). The water level significantly rises from its first striking depth (220m rise at Asgori well). The Static water level differs from artesian condition to a depth of 67.5 meters lower level than the ground surface.

3. Localized and regional aquicludes: - Quaternary Bedegebaba rhyolites, Ziquala trachytes and Tertiary Intoto-Becho rhyolites, Central Volcanics of Wechecha, Furi and Yerer possesses low permeability, not including along weathered and fractured regions and act as local aquicludes by dividing into categories the upper basaltic aquifer. The Chefedonsa Pyroclastics, Nazaret group Welded ignimbrites and Addis Ababa ignimbrites of low productivity along the weathered and fractured regions and/or impermeable in different circumstances, act as aquicludes by separating the upper and lower basaltic aquifers in the north-western, north-central and north-eastern segment of the basin.

CHAPTER FOUR

HYDROMETROLOGICAL DESCRIPTIONS

4.1 Introduction

Climate comprises the average of atmospheric pressure, temperature, humidity, wind, rainfall and consisting of many other meteorological elements over a long portion of time in a specified area. The factors which have a great effect on characteristics of climate become numerous; and also the significant factors are; latitude, altitude, the density and type of vegetation cover and rainfall. The Climatic elements have an on each other in complex condition by which an easily done series of action that is triggered to begin others to take place. All of these climate elements and their great interaction with physical aspects cause to occur in the hydrological series of actions such as rainfall, runoff, recharge, stream flow and dynamics of shallow groundwater. The main reason of the calculating the value of meteorological basic elements and river hydrograph is to estimate these hydrological processes of the upper awash basin.

There are above 50 meteorological stations in the upper Awash River basin and the monthly meteorological data was obtained from the National Meteorological Agency of Ethiopia (NMAE) at 13 separate stations most suitable on data availability and position with respect to the study area. These stations were most suitable based on the length of data length of time, particular position and relative measured standard of their facts and statistics used for analysis. In some of the stations in the upper awash basin, the climate records were not run in full extent as a result some desired result were carried out using the linear correlation between the nearest stations.

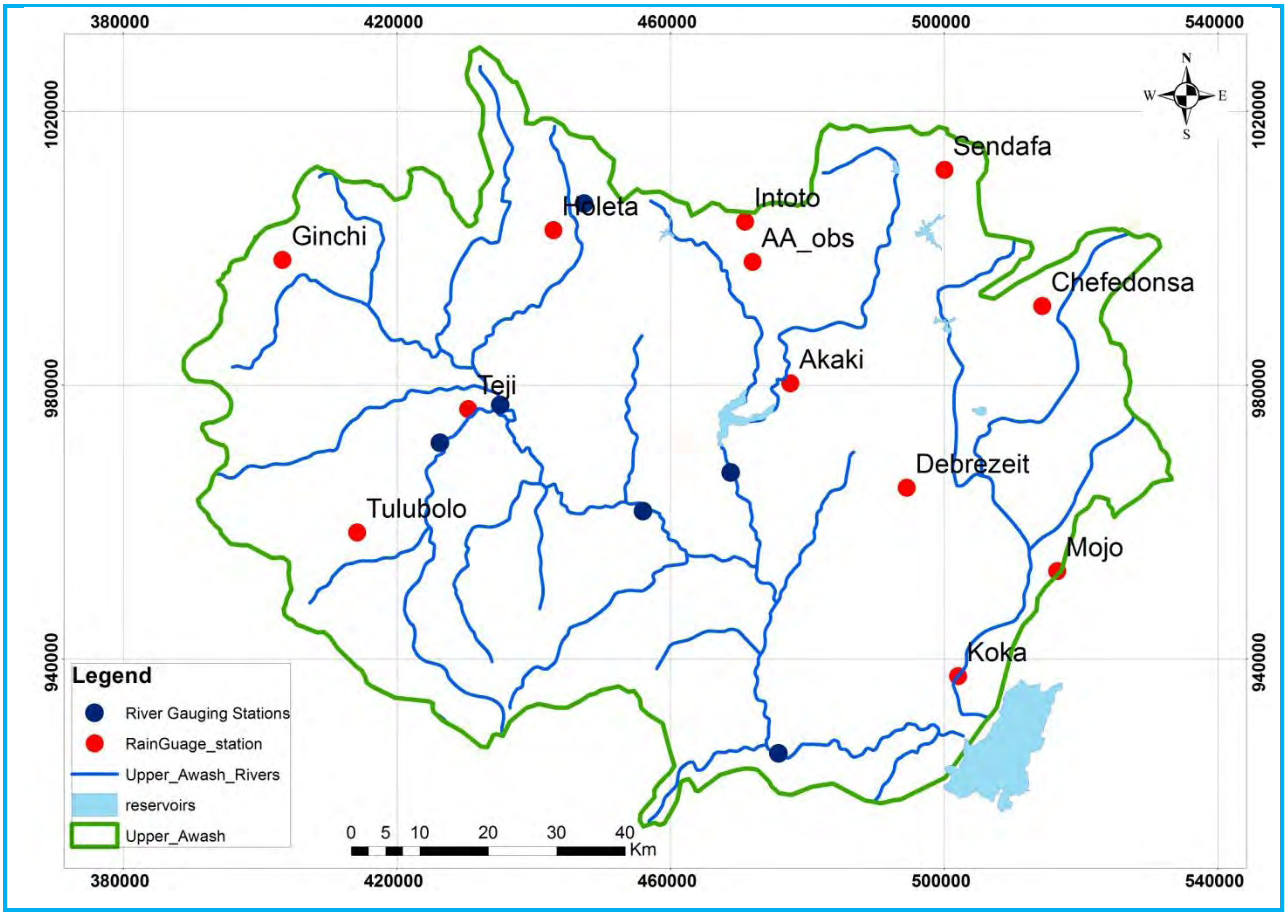


Fig 4.1 Location map of hydro-meteorological stations in the upper awash basin

4.1.1 Precipitation data analysis

The intensity of rainfall in Ethiopia is influenced by the position where the opposing north-east and south-east trade winds come together from distinct directions, so called the inter-tropical convergent zone (ITCZ). Seasonal variation of precipitation is of great significant aspect of hydrology for the cause it is a decisive factor for the river flow, groundwater dynamics and groundwater recharge. As cited in (Wakgari Furi, 2010), the ITCZ is a zone of far above ground atmospheric pressure where the rising air triggers heavy rainfall and high air temperature (Valadon, 1992, Angel, 2006). In its fluctuation between north and south of the equator, the ITCZ causes to move over Ethiopia two times a year and this movement from one place to other gives rise to slight difference in the wind flow arrangements over the country with the onset and withdrawal of winds from north and south (Camberlin, 1998).

4.1.1.1 Rainfall pattern of the study area

Rainfall is the to the greatest extent widely measured meteorological element in the upper awash basin. Examining of systematically rainfall records of rainfall from metrological rain gauges demonstrates two recognizable rainy seasons common to the study area. The principal rainy season frequently extends from mid June through September and the short rainy season takes place in March until mid May while the remaining months are in most cases drier.

Table 4.1 Mean annual rainfall of selected meteorological stations (Data from NMA)

Stations	UTM Easting	UTM Northing	Elevation (m)	MARF (mm)
A.A Observatory	471983	997946	2405	1220.6
Akaki	477500	980200	2090	1027
Chefedonsa	514290	991475	1600	851.8
Debrezeit	494500	964941	1850	861
Ginchi	403279	998222	2290	1204.4
Holeta	442854	100256	2380	1102.4
Intoto	470880	100382	2920	1258
Koka	502010	937436	1598	815.7
Mojo	516504	952784	1870	857.7
Sendafa	500000	101137	2560	1145.9
Tulubolo	414187	958396	2100	958.6
Teji	38.366667	8.8333	2091	948.6

- Where, **A.A, MARF, mm** stands for Addis Ababa, Mean Annual Rainfall, millimeter

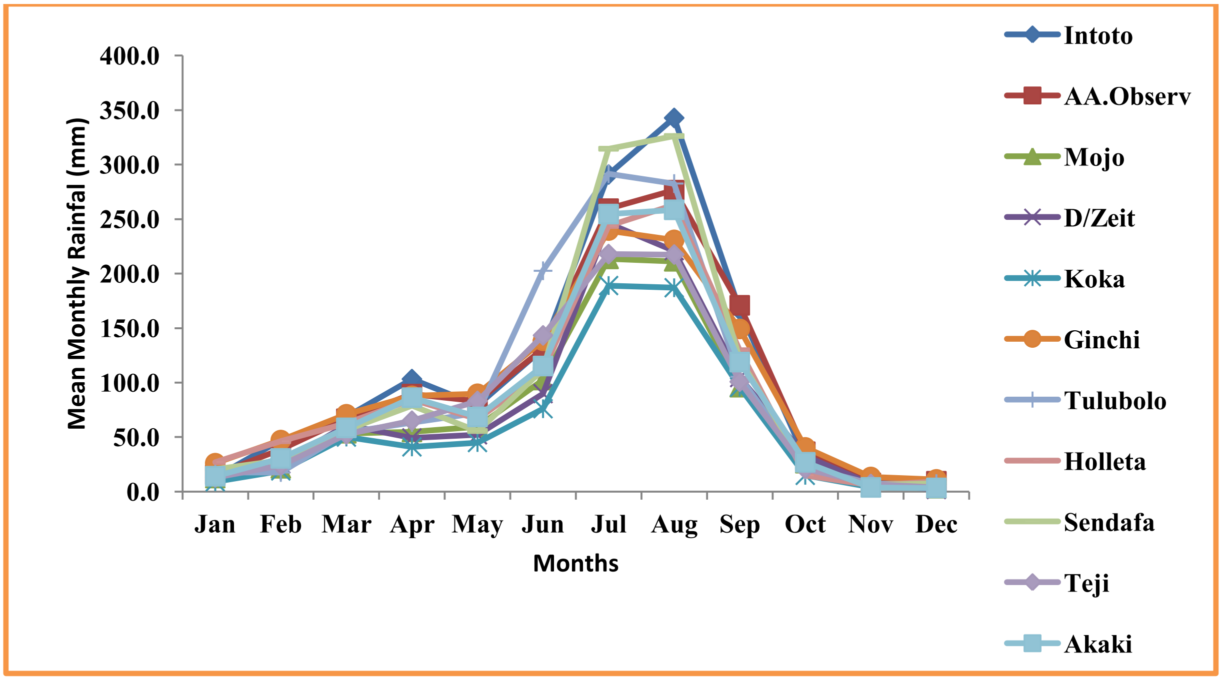


Fig 4.2 Seasonal and spatial distribution of rainfall (National Metrological Agency)

Upper Awash basin addresses part of the basin above Koka dam which was represented by twelve stations. Accordingly, as shown in Figure (4.2) above, the upper awash basin has mono-modal rainfall which has distinguishing quality of peak rainfall taking place in July-August; (See Appendix-6).

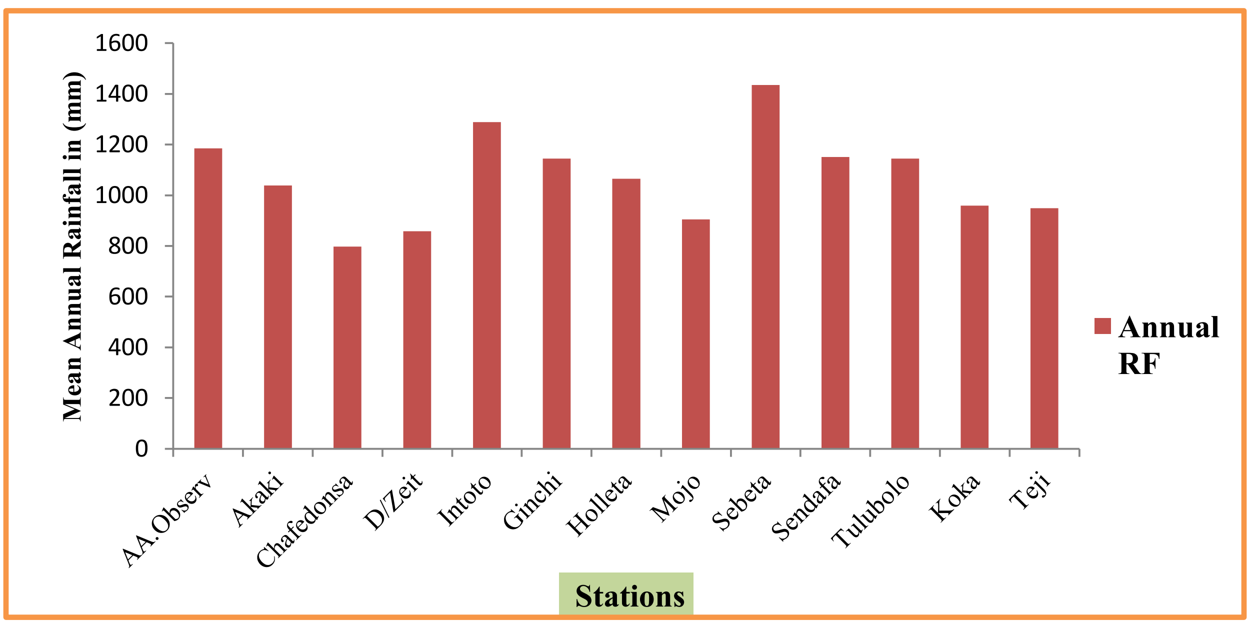


Fig 4.3 Graph of mean monthly rainfall of study area (National Metrological Agency)

In addition to the position of ITCZ, the temporal and spatial slight difference of precipitation of the upper awash is in large proportion give an account of to the physiographic arrangement and seasonal variation in the atmospheric pressure systems that control the more powerful winds. Therefore, because of these circumstances, majority of the highlands experience extensive rainfall meanwhile the central low-lying lands of the rift floor receive little seasonal light fall of rain and in many instances dry.

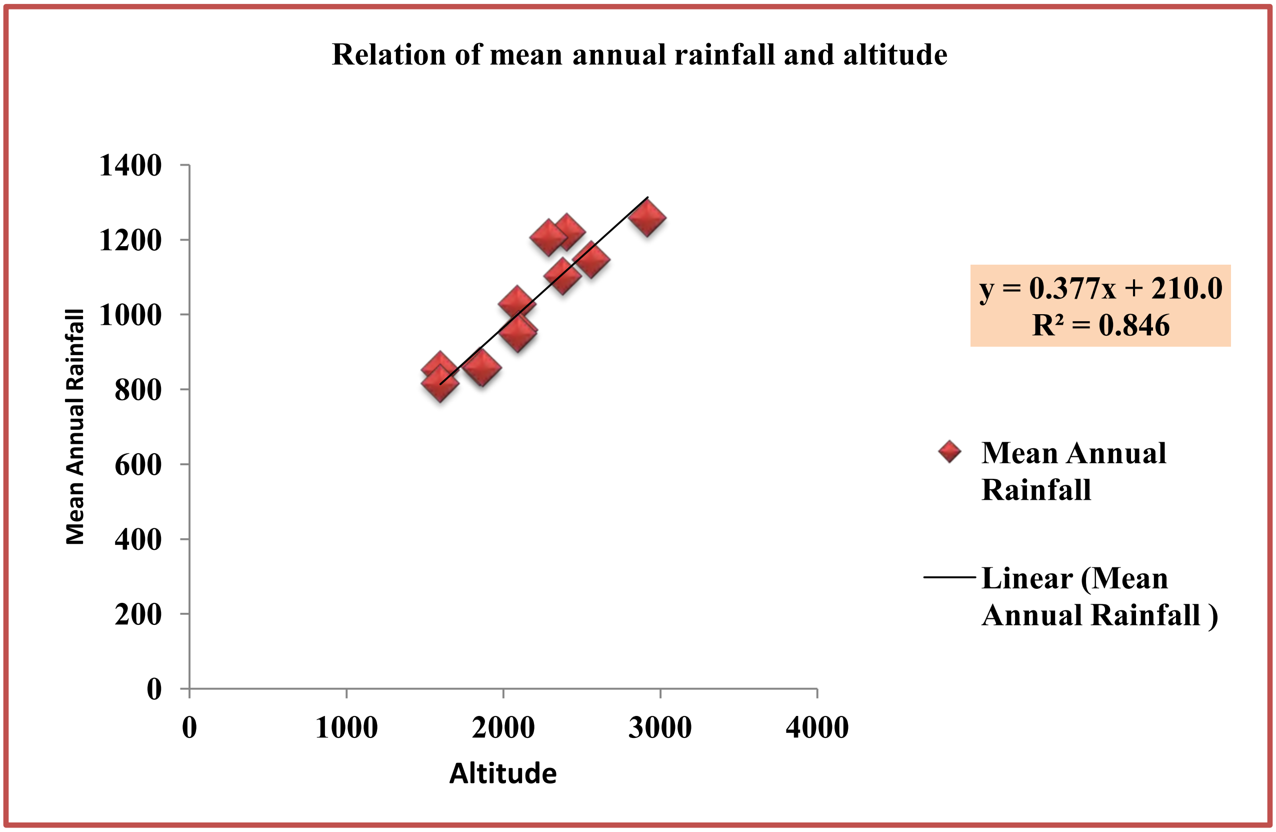


Fig 4.4 Relation between mean annual precipitation and altitude (NMA)

According to (Daniel Gamachu, 1977) the main rainfall is experienced between June to September when moist winds from the Atlantic and Indian Oceans converge over the Ethiopian highlands. Therefore, observation of the amount of rainfall at the meteorological stations from National Metrological Agency take in to account in this study shows that there is a strong correlation **(r^2= 0.846)** between altitude and the amount of rainfall. The mean annual rainfall increases with an increase in altitude. Therefore, precipitation of the upper awash basin is strongly dependent on altitude.

4.1.1.2 Determination of aerial depth of precipitation

Precipitations registered at rain gauges are point data. In whatever way, precipitation exhibits a large spatial variation inside the range of the area affected by physiography. There are lots of ways for computing areal rainfall from point data including arithmetic, isohyets, Thiessen polygon, and normal ratio methods. On other method, isohyets is bringing out intended result in calculating mean aerial precipitation in area featured by high topographic contrast where topographic effect on precipitation is assumed to be very high. Consequently, using different rain fall depth of different stations found in the target study area and the adjoining region, the representative aerial depth of rain fall over the whole area is considered. As a result, Arithmetic mean and isohayetal method is selected, considering the non uniformity of the land and variation of topographic textures of the area and the average of them has been used for explanation purpose. An annual aerial precipitation computed from the average of arithmetic and isohyets is 1018.38 mm.

A. Arithmetic mean method

Arithmetic mean technique is the simplest one for evaluation of mean uniform distribution of rain fall of in the upper awash basin. It is the mean of all the rain gages located within the area of interest (Wilson, 1983). Subsequently, 13 metrological stations are located within Upper Awash basin, the estimated average uniform precipitation (PA) is calculated as follows

$$PA = \sum_{i=1}^{n} Pi \big/ n$$

Where, **PA** = average rain fall the total area

Pi = Measured precipitation at a given station and time

n = Number of rain gauges

Therefore, the annual aerial precipitation computed from arithmetic method is 1020.98mm.

B. Isohyetal method

Bearing in mind, the non uniformity of the land, variation of topographic features of the upper awash basin area (1500-3500 masl) isohyetal method is selected. This technique is evaluated by joining rain fall depth of equal value over the area of interest (Figure 4.5).

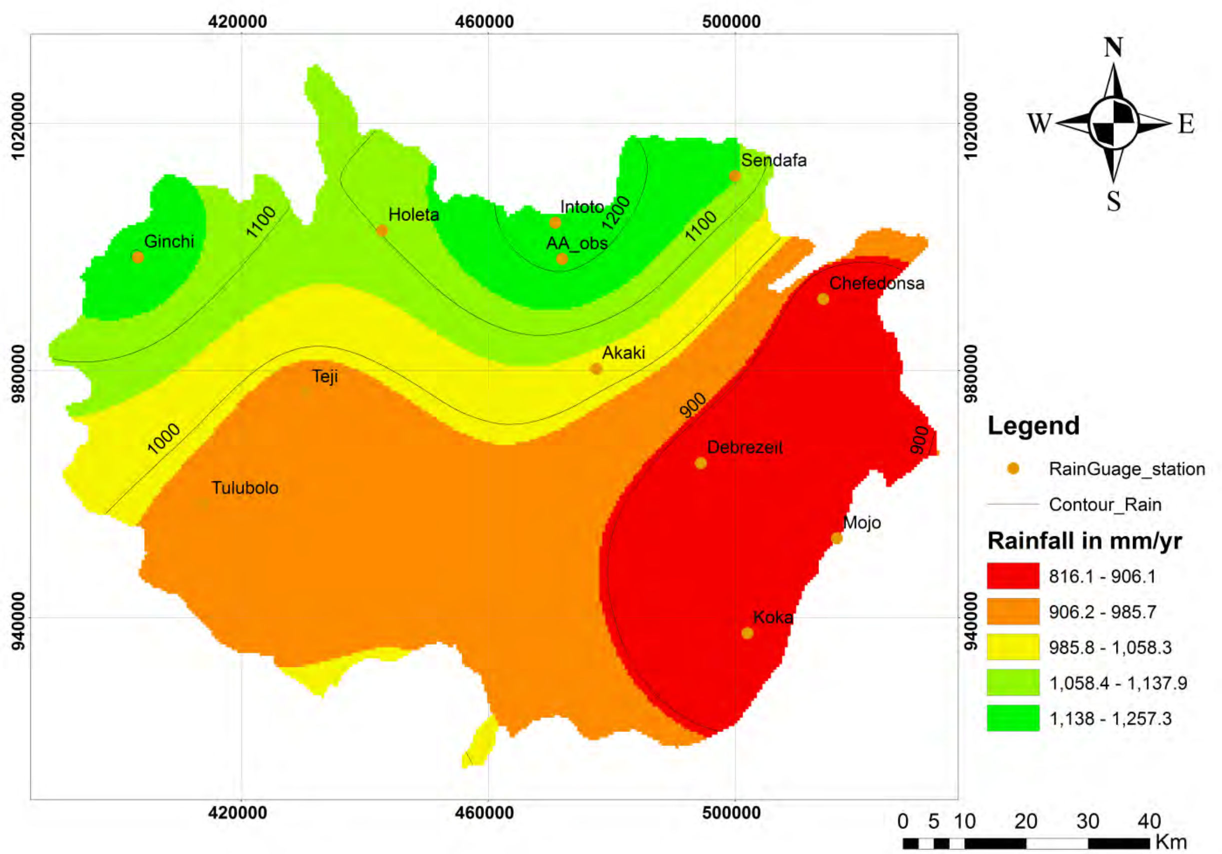


Fig 4.5 Isohytal map of upper awash basin

$$P_a = \frac{P_{12}A_{12} + P_{23}A_{23} + \ldots\ldots + P_{n-1.n}.A_{n-n.n}}{A_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where, **P_{12}**- Rainfall depth between isohyets 1 and 2,

A12- Area enclosed by successive isohyets 1 and 2

A_t- Total area, therefore, the average rainfall depth over the upper awash basin is the mean value of the outcome acquired; i.e. about 1015.77 mm.

4.1.2 Temperature data analysis

Water temperature and air has straightforward effect on evaporation by developing the environment hot and allows the passage of liquid state of water to vapor condition. According to Shaw, 1988 the higher the air temperature, the greater extent of water vapor it can carry, and in the same appearance if the temperature of evaporating water is high, it can more readily vaporized. The mean monthly temperature of years was brought in one from several of stations in the upper awash basin area referring from National Meteorological Services Agency. The mean annual temperature of the upper awash basin is 19.07^{0}C. (See Appendix-5)

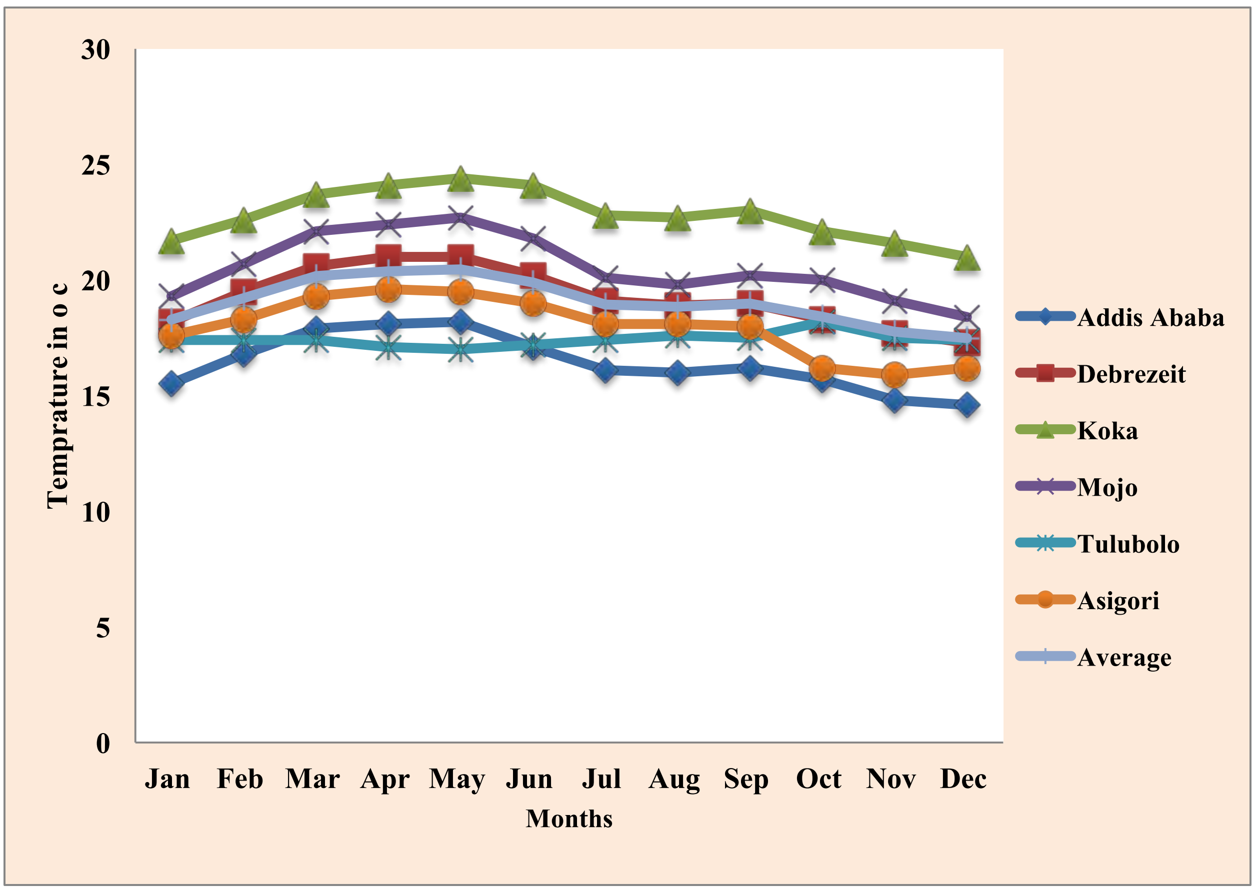


Fig 4.6 Mean Monthly Temperature (°c) of Upper Awash basin from (NMA)

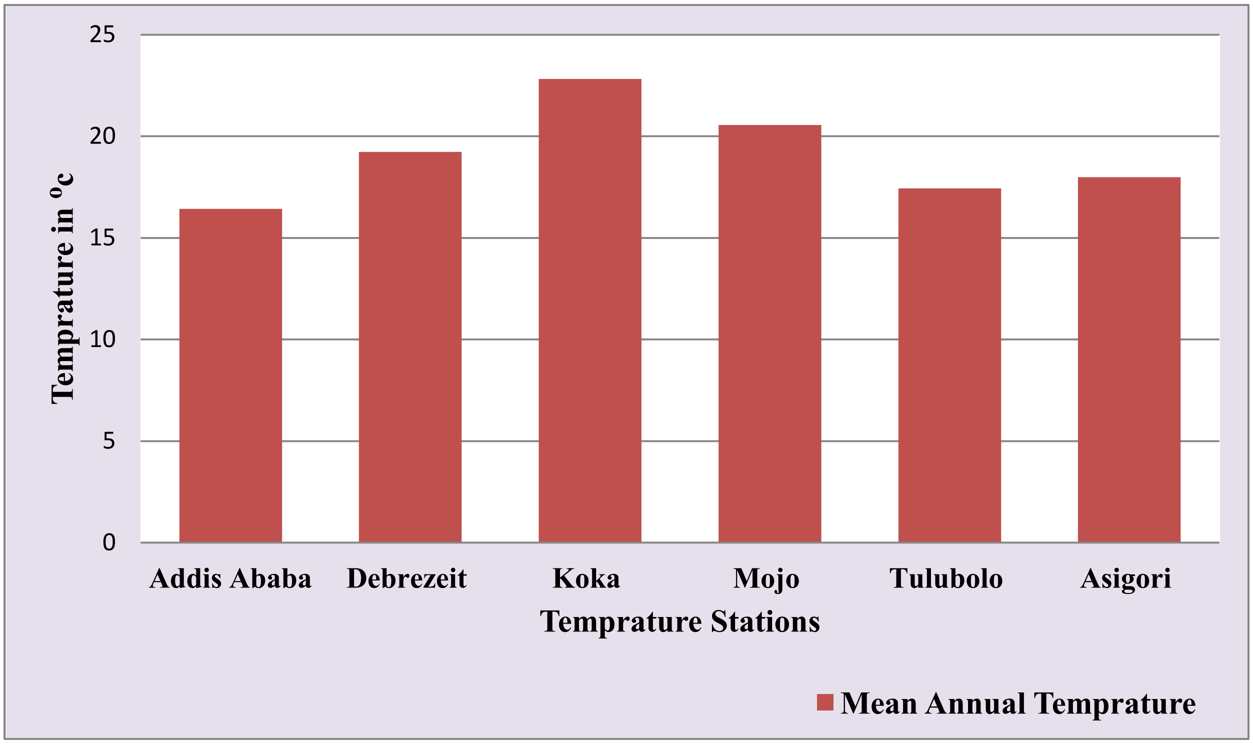


Fig 4.7 Mean Annual Temperature variations in the study area

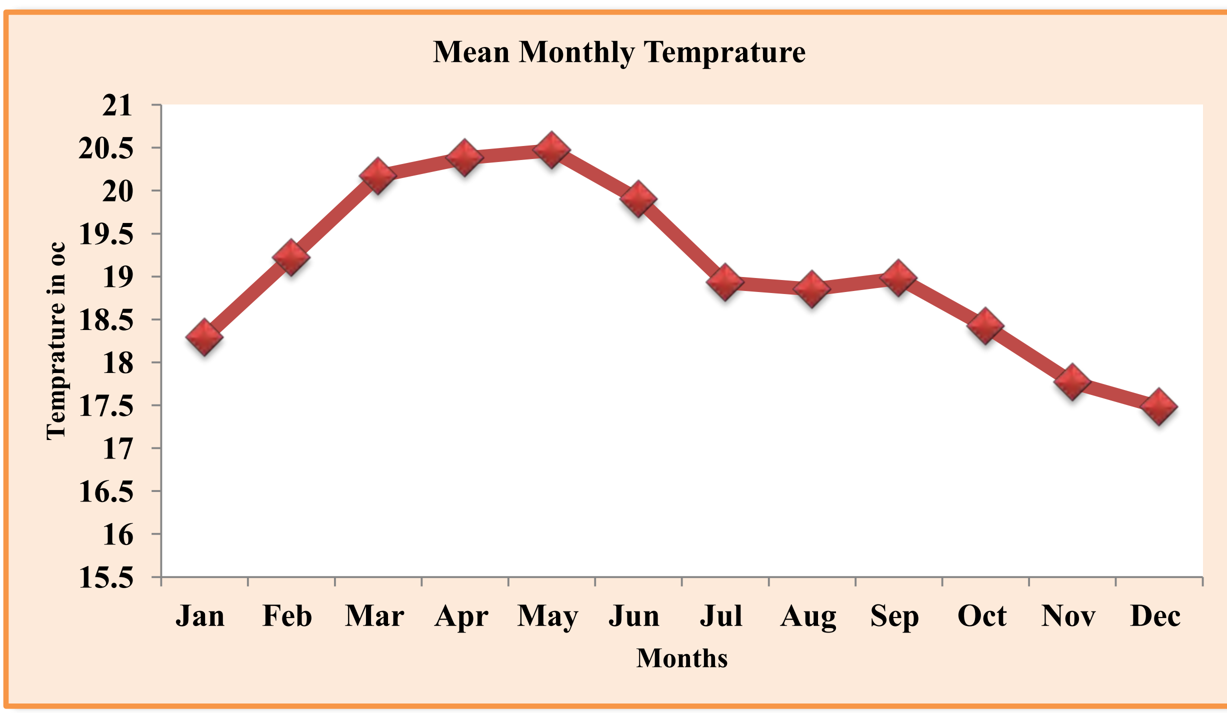


Fig 4.8 Mean Monthly Temperature in (^{0}c)

4.1.3 Sunshine hour data analysis

Sunshine hour of the upper awash basin area is characterized by data brought from Debrezeit station and Addis Ababa station. The maximum sunshine hour is perceived in the months of October, November, December and February and minimum values in the months of July and august.

Table 4.2 Sunshine (hr/d) from gauged Ethiopian Metrological Agency (EMA)

station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	mean
Debrezeit	9.3	9.4	9.1	8.4	8.5	7.2	5.5	5.8	7.3	9.4	9.9	9.7	8.29
Addis Ababa	8.9	8.7	7.9	6.8	7.3	5.5	3.5	3.8	5.4	8.4	9.5	9.1	7.07

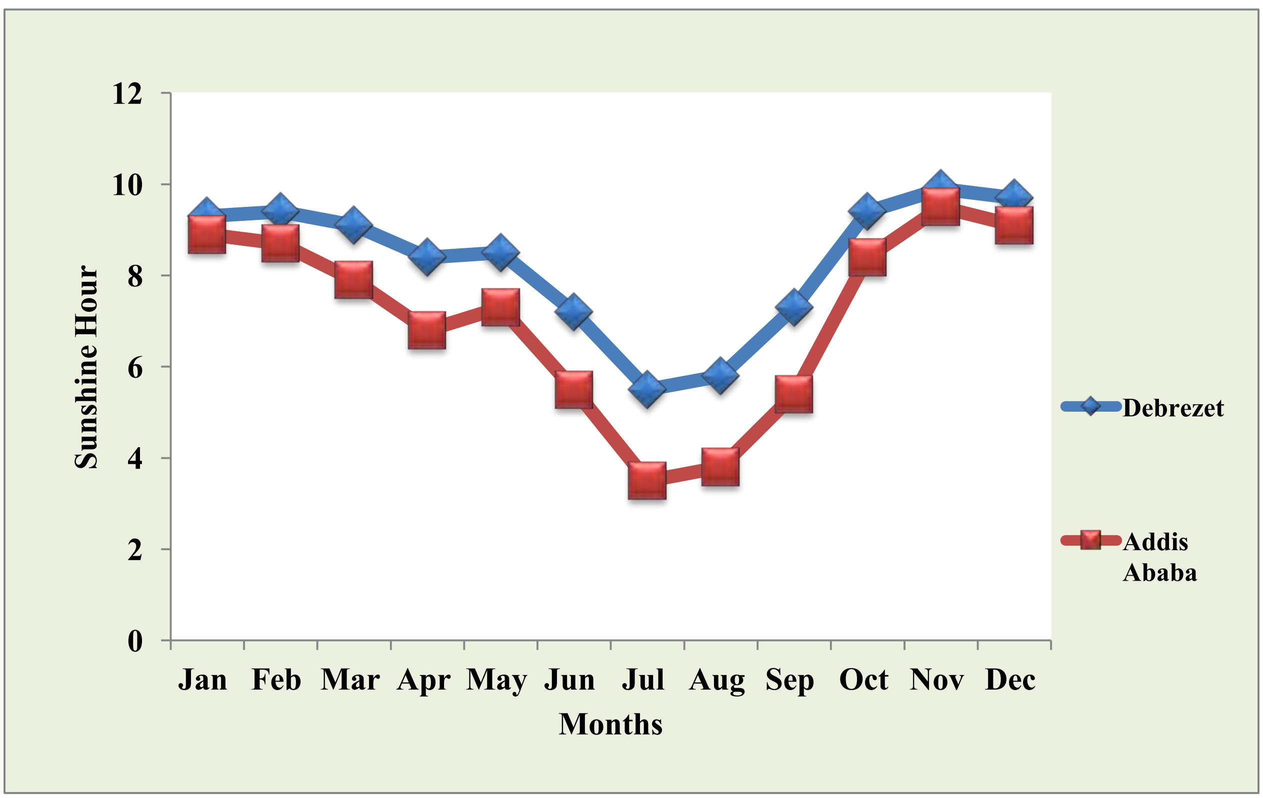


Fig 4.9 Mean Monthly pattern of sunshine duration in (hour) from (NMA)

4.1.4 Wind speed data analysis

One off the major factors of evaporation is wind speed, the action of decreasing of wind speed resulting in non removal of saturated vapor that make a difference to evaporation rate. Wind speed data in the study area is analyzed from the Debrezeit station and from Addis Ababa Meteorological Station.

Table4.3 Monthly Mean wind speed at upper awash two Meteorological Stations m/Sec), measured above 2m

station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
DebreZeit	1.4	1.6	1.6	1.6	1.6	1.3	1.2	1	1	1.4	1.6	1.5	1.4
Addis Ababa	1.6	1.7	1.8	1.8	2	1.8	1.5	1.5	1.5	1.5	1.4	1.6	1.6

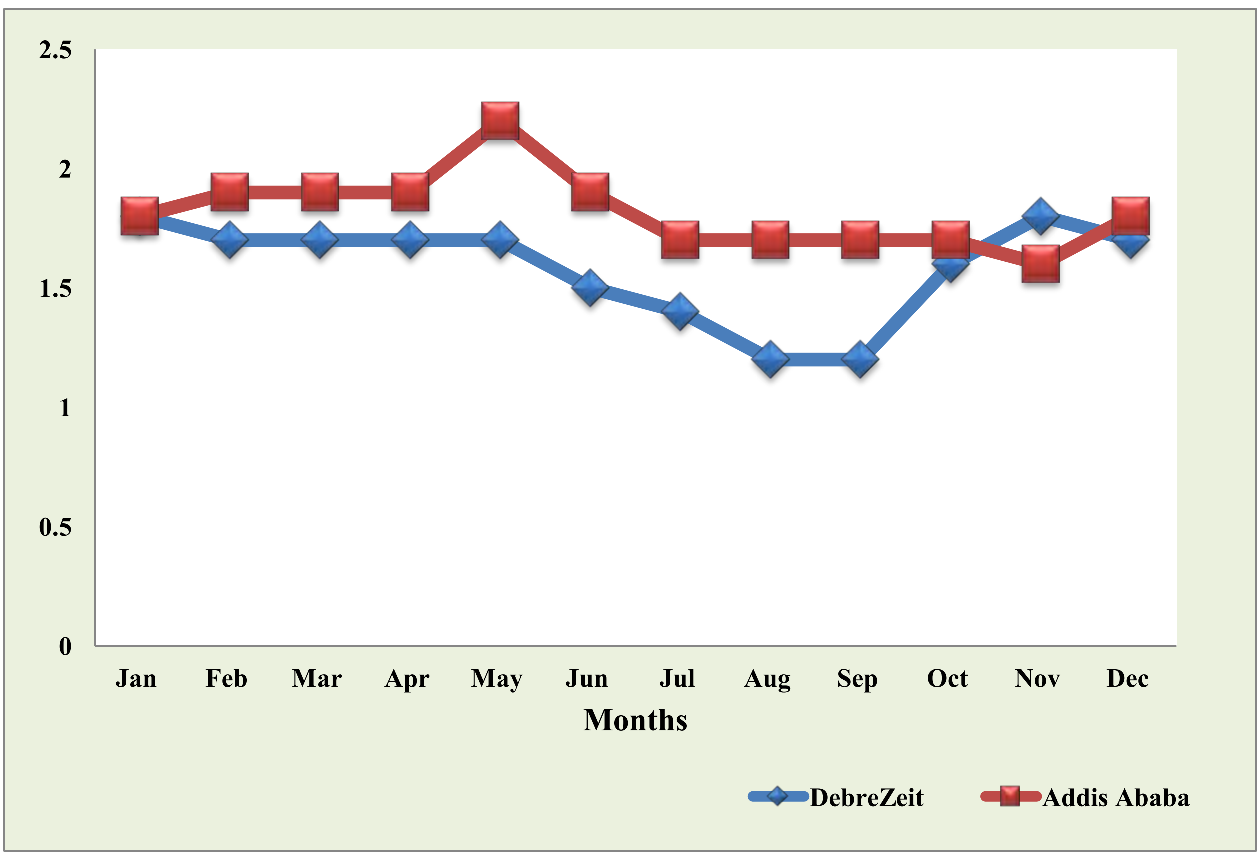


Fig 4.10 Graph of Monthly Mean wind speed in m/Sec, measured above 2m

4.1.6 Relative humidity data analysis

Relative humidity is the relative measure of the extent of moisture in the air to the amount required to saturate the air at the identical temperature. The relative humidity of the air is mostly dependent on temperature and rain fall. According to (Shaw, 1985) relative humidity is the relative measure of the amount of moisture in the air to the amount needed to saturate the air at the same temperature ed/ea represents as a percentage.

$$RH=(e_d/e_a)\ 100$$ where: - **RH** is relative humidity,

e_d is actual vapor pressure at the dew point, Td;

e_a is saturated vapor pressure at air temperature, Ta

As air humidity is in an instance of increasing, its ability to absorb water vapor decreases and evaporation rate slows down. For evaporation to undergo there must be a difference in humidity (Tenalem Ayenew and Tamiru Alemayehu, 2001; Fetter C.W, 1994).

Table 4.4 Relative humidity (%) stations in the study area

stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Debre Zeit	59.7	60	57.2	59.2	60.1	67.5	77.4	79.1	74	59.8	58.4	59	64.3
Addis Ababa	56.1	52.7	53.9	59.2	57.5	65.8	75	76.2	70.8	56.8	55	55.9	61.2

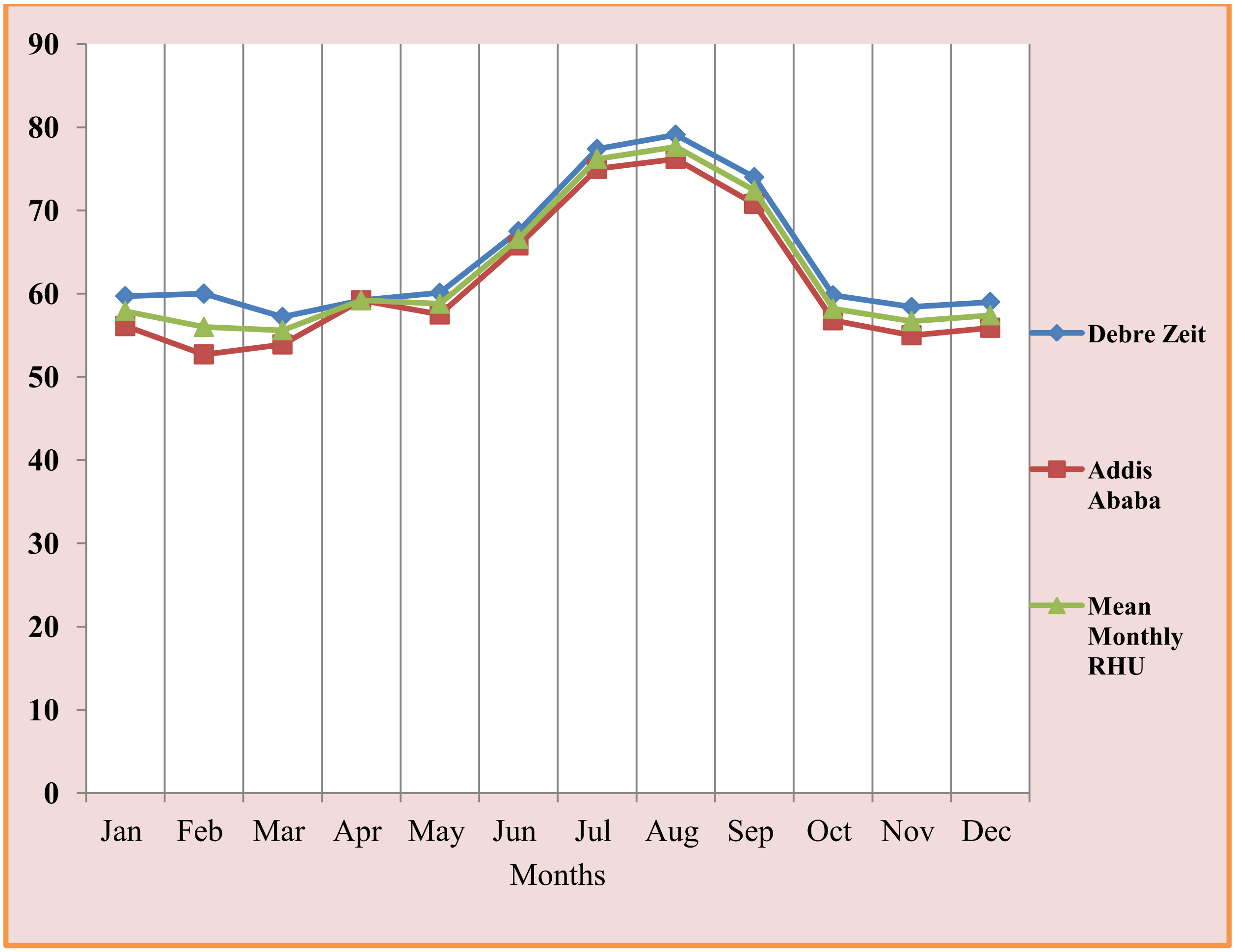


Fig 4.11 Graph of Mean Monthly Relative Humidity (%)

Therefore the above result showed that relative humidity of the air is largely relying on rainfall and temperature. As a result at Debrezeit metrological station has a maximum mean relative humidity value of 79.1 in the month of August and a minimum relative humidity value of 57.2 in the month of March and at Addis Ababa metrological station has a maximum mean relative humidity value of 76.2 in the month of August and a minimum relative humidity value of 52.7 in the month of February.

4.1.7 Evapotranspiration data analysis

Evapotranspiration (ET) gives a detailed account of the discharge of water to the atmosphere from vegetations and land surface.

According to (Bonan, 2002) the frequency of evapotranspiration at any particular place is influenced by different circumstances containing as part of the whole obtained energy are connected to solar radiation and, humidity, air temperature, wind speed above the surface, water serviceability, land cover features such as vegetation, and soil characteristics. Evapotranspiration cannot be measured directly. The Pan Evaporation data can be used to determine lake evaporation, apart from transpiration and evaporation of intercepted rain on vegetation are unknown variables. There are two principal standards to quantify evapotranspiration indirectly. But because of absence of pan evaporation data, empirical formulas that use distinct meteorological data are used to determine mathematically potential evapotranspiration and actual evapotranspiration.

4.1.5.1 Estimation of potential evapotranspiration (PET)

As stated by Brutsaert, (1982) PET is the quantity of water that was evaporated under an optimal set of circumstances, among unlimited supply of water. In other words, it would be the water needed for evaporation and transpiration given the local environmental significant influence. One of the greatest significant factors that establish water requirement is solar radiation as energy supplied increases the pressing requirement for water.

4.1.5.1.1 Thornthwaite method

Potential evapotranspiration is as rule measured indirectly, from other climatic elements, apart from they also rely on the surface characteristics, for example free water like lakes and oceans, the soil variety for bare soil, and the vegetation. In many instances a value for the potential evapotranspiration is calculated at a close by climate station on a reference surface, conventionally short grass.

This value is known as the reference evapotranspiration, and can be changed to a potential evapotranspiration by multiplying with a surface coefficient. In whatever way, this particular procedure is depend on the assumption that PET is affected only by meteorological circumstances, does not take into account the effect of vegetative density and maturity. The Thornthwaite method is known to methodically underestimate PET in more arid regions and seasons. Quantifying of the potential evapotranspiration, calculated on monthly principles, is given by:

$$PET_m = 16N_m\,(10t/I)^{a}$$

m is months

N_m is monthly adjustment factor depending on latitude and season

t is mean monthly temperature

I is annual heat index obtained by adding 12 months heat indices

(i) each of which are defined

$$i = (t/5)^{1.514}$$

$$a = 6.75*10^{-7}I^3 - 7.71*10^{-5}I^2 - + 0.017921I + 0.49239$$

Depending up on this formula potential evapotranspiration of the upper awash basin is found to be 902.33mm/yr. (See Appendix-2).

4.1.5.1.2 Penman method

As stated in Penman, (1948), first merged elements to account for a grant of energy and a process to take off the water vapor from the immediate neighbor of the evaporating surface and produced a formula which provides the circumstances under which evapotranspiration takes place from a vegetated surface. Penman combined the energy balance with the mass transfer methods of evaporation estimates; and derived an equation to calculate the evaporation from an open water surface using standard climatological data of sunshine, temperature, humidity and wind speed. The most important and widely used equation for calculating evapotranspiration is the Penman equation. The Penman-Monteith variation is put forward with approval as being suitable for a purpose by the Food and Agriculture Organization (FAO). The fundamental equation of penman that determines mathematically the Potential Evapotranspiration (PET) is:-

$$PET_m = (\Delta/\gamma)\,H_t + E_{at} / (\Delta/\gamma) + 1$$

H_t is the available heat and it is calculated from the formula given by

$H_t = R_I (1-r) - R_o$, where **r** is the average albedo of the catchments part based on land cover type. In our case **r = 0.24** and R_I and R_o are incoming and outgoing radiation respectively and their empirical formulas take the form: $R_I (1-r) = 0.76 R_a f_a (n/N)$

r- Is the albedo, $f_a (n/N)$ **-** takes several forms $f_a (n/N) = (0.16+0.62n/N)$

and the empirical formula of the outgoing radiation takes the form

$R_O = 6T^4(0.47-0.75ed^{1/2})(0.17+0.83n/N)$

Where T^4 is the theoretical black body radiation at **Ta** which is then modified by functions of the humidity of the air(e_d) and the cloudiness **(n/N)**

-Temperature in ^oK is a converted result of temperature in ^oC

-The parameter e_a (saturated vapor pressure in mm/d) at air temperature t_a (in ^oc) is obtained from standard table of air temperature and saturation as:

$$e_a (T_a) = 6.11\exp(17.3T_a / T_a + 273.3)$$

-Relative humidity **(RH)** in **%** is used to calculate the value of actual vapor pressure **(e_d)** as:

$$e_d = e_a \%RH \text{ (C.D.ARHENS, 1991)}$$

-Wind speed **(U_2)** in m/s was converted to mil/day in column five

-The energy for evaporation **(E_{at})** is given by $E_{at} = 0.35(0.5+U2/100)(ea-ed)$

The value Δ/γ is established from weighing factor Δ/γ versus temperature from (FAO, 1967) result in (E.M. Shaw, 1996) to which Δ is the slope of saturated vapor pressure versus temperature and γ is the hydrometric constant which has a typical value of 0.4859mm**Hg^{o}c** (JAY RAMI, 1996). **PET** was evaluated using this formula and appropriately potential evapotranspiration of upper awash basin is 1012.04mm/yr. (see Appendix- 1)

4.1.5.1.2 Estimation of actual evapotranspiration

In view of the fact that, the study area upper awash basin is located within the rift system, the actual Evapotranspiration which is one of the components that are vital in calculating the water balance of the area is expected to be high. The methods by which AET is calculated is:-

Thornthwaite method (water balance method)

Thornthwaite and Mather method, (1957) has been used to estimate the actual evapotranspiration using precipitation and soil moisture values. From which the water budget for different profiles vegetation distribution or land cover and available water capacity were done.

When the soil reaches a saturation condition with moisture it will hold no more water. In this case actual evapotranspiration equals potential evapotranspiration (Shaw, 1988). Given the fact that the values of soil moisture deficit and actual evapotranspiration vary with soil type and vegetation, during times when there is no rain to replenish the water supply, the soil moisture gradually becomes depleted by the demand of vegetation to produce a soil moisture deficit (SMD). As a result the actual evapotranspiration becomes less than the potential evapotranspiration. Parameters used as inputs for this method are precipitation, potential evapotranspiration and soil moisture values.

Accordingly, the value of soil moisture at the end of the month, if **Pm > PET** is computed as

$$S_m = \min((P_m - PET_m) + Sm\text{-}1)\ S_{max})$$

And if **Pm<PET**, resulting a soil moisture deficit, the soil moisture is given as

$$Sm = S_{m-1} \exp \frac{(- PET\text{-}Pm)}{Smax}$$

Following these procedures and principles, AET for each month is obtained based on the amount of Precipitation and PET calculated from Thornthwaite method as:-

If P>PET…………AET= PET

If P<PET………….AET = P + ΔSm (Sm-1 – Sm)

The soil moisture deficit and surplus are also calculated for each month. Based on these the average AET computed for the entire basin from the soil water balance approach is 640.7mm/yr. (See Appendix-3)

4.1.8 Direct runoff data analysis

Direct runoff is water that is not percolated by soil or that does not soak into the soil but flows into surface waters. The Geology, slope, and topography of the area are the most influencing circumstances of runoff, and in addition the area, actual evapotranspiration, rainfall and vegetation cover least to influence runoff. In general, less than average rainfall, high evapotranspiration, gentle slope, very permeable volcanic falls and disappearing drainage pattern can assure the lowest runoff. Direct runoff is that component of the precipitation, snow melt, or irrigation water that come in existence in uncontrolled surface streams, rivers, drains and sewers. It is composed of precipitation that neither evaporates, transpires nor goes into the surface to become groundwater. It happens whenever the rate of rainfall on a surface go beyond the rate at which water can percolate the ground and any depression storage has already been become full. This is more frequently takes place in arid and semi-arid area, to which rainfall intensities are far above and the soil infiltration ability is become smaller by reason of surface impervious, or in pavement region.

The upper awash river basin is segment of the Awash River basin extend over a total catchment area 10,841of km^2.The river begins on the high plateau located at short distance away Ginch town west of Addis Ababa and flows along the rift valley into the Koka dam and also in preference to come into the artificial reservoir; Koka the upper Awash River basin has two main tributaries in the study area Mojo and Teji Rivers. There are also many intermittent tributary streams. The variation in monthly percentage of rivers flow brought about the distinction in hydrology and hydrogeology of the upper awash basin. In the upper awash basin the main Awash River and its major tributaries were gauged at separate locations. Major tributaries: Mojo River and Teji River are gauged at their outlets before joining Awash River. The main Awash River is gauged at Bello, Melkakunture and Hombole. (See Appendix-7)

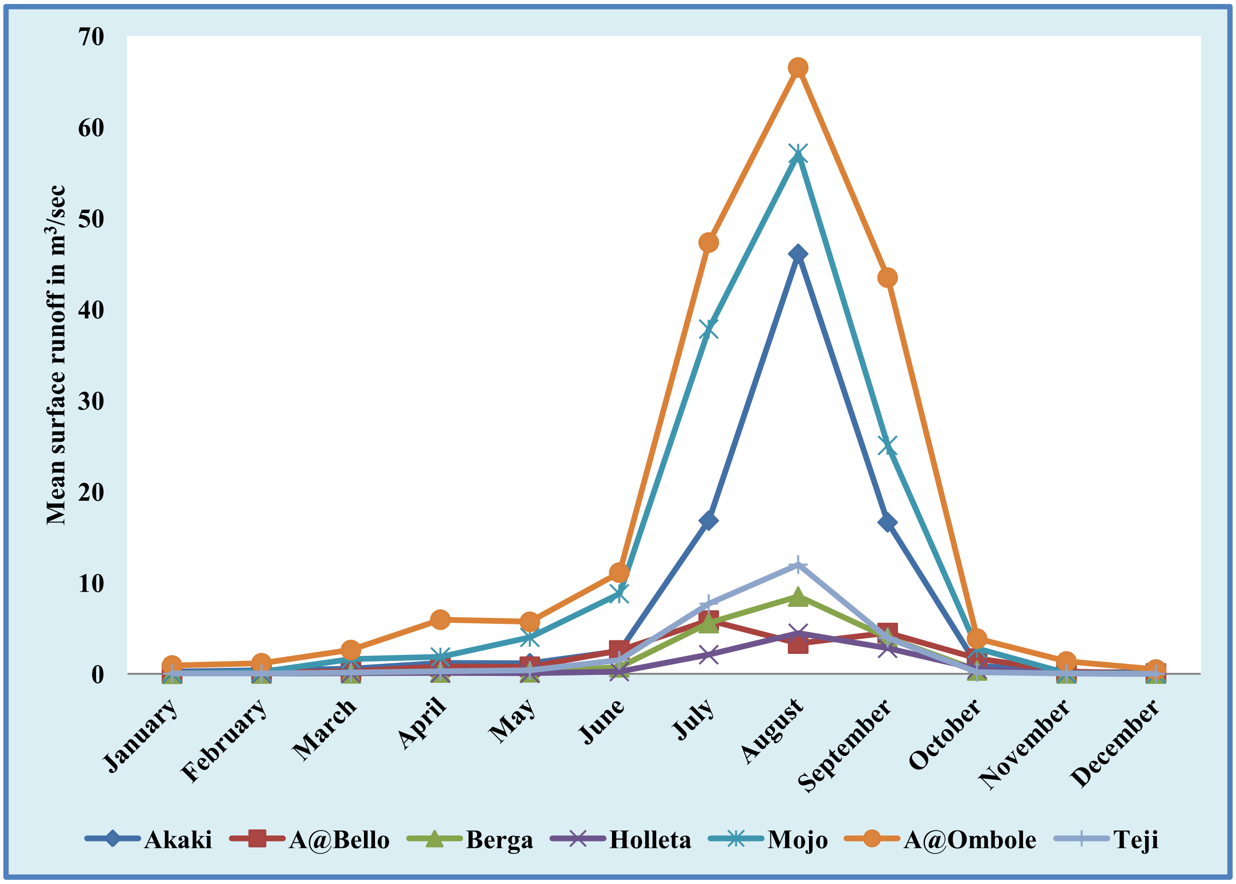


Fig 4.12 Long-term mean monthly Surface Runoff main rivers in the upper awash basin

The discharge records evidenced of the same fashion, the peak flow agree almost exactly with the rainy months of June, July, August and September (Figure 4.13). Occasionally this association, even though there is peak rainfall in June its river discharge is less than average, proving majority amount of the rainfall soaks in to strata below earth's surface to saturate or up to the infiltration ability of soils. The existing real sequence of flow throughout the course of the year is controlled by precipitation, evapotranspiration, soil and geological feature of the upper awash basin. The higher the percolation in the storage amount of a stated catchment, the high flow is validated through the dry period of the year, and the highest flows after time of highest precipitation. According to geology, topography, climate and additional influences each catchment in the upper awash basin the area is characterized by its readily distinguishable by the percentage of monthly flows.

CHAPTER FIVE

RESULTS AND DISCUSSIONS

5.1 Groundwater recharge evaluation

In a broader sense, groundwater recharge is defined by water that reaches an aquifer from any direction, i.e., down, up, or laterally. In the upper awash basin, groundwater recharge by downward flow of water through the unsaturated zone is generally the most important mode of recharge. Consequently, groundwater recharge as used in this research refers to the downward percolation of water reaching the water table from the unsaturated zone (Freeze and Cherry, 1979; Lerner *et al.*, 1990). According to (Scanlon *et al*., 2002) evaluating groundwater recharge in arid and semi-arid- regions can be not easy, in view of the fact that, in such areas the recharge is usually low compared to the average annual rainfall or evapotranspiration, and thus complicated to determine accurately. Recharge processes differ from one place to another, and there is no guarantee that a method developed and used for one locality will give reliable results when used in another. Therefore, it is necessary to identify the probable flow mechanisms and the important features influencing the recharge in a locality before deciding on the recharge method to use (Lerner *et al*., 1990). A wide variety of techniques exists for evaluating groundwater recharge, which have been designed to represent the definite physical processes of the recharge. The recharge evaluation methods that have been included in this study include;

1. **Water balance method**
2. **Baseflow separation method**

On the basis of the differences among the recharge evaluation methods as listed above, and the evaluated groundwater in each technique discussed below.

5.1.1 Water balance of upper awash basin

During water balance evaluation both natural and artificial gains and losses in water supply must be take in to account when developing judgment. The principal natural gains to surface bodies are those which outcome from runoff circumstances by precipitation and effluent seepage of groundwater. Evapotranspiration and not able to recovered infiltration are the thoughtful natural losses. Water balance put forward including many detail account of the hydrologic regime in the basin.

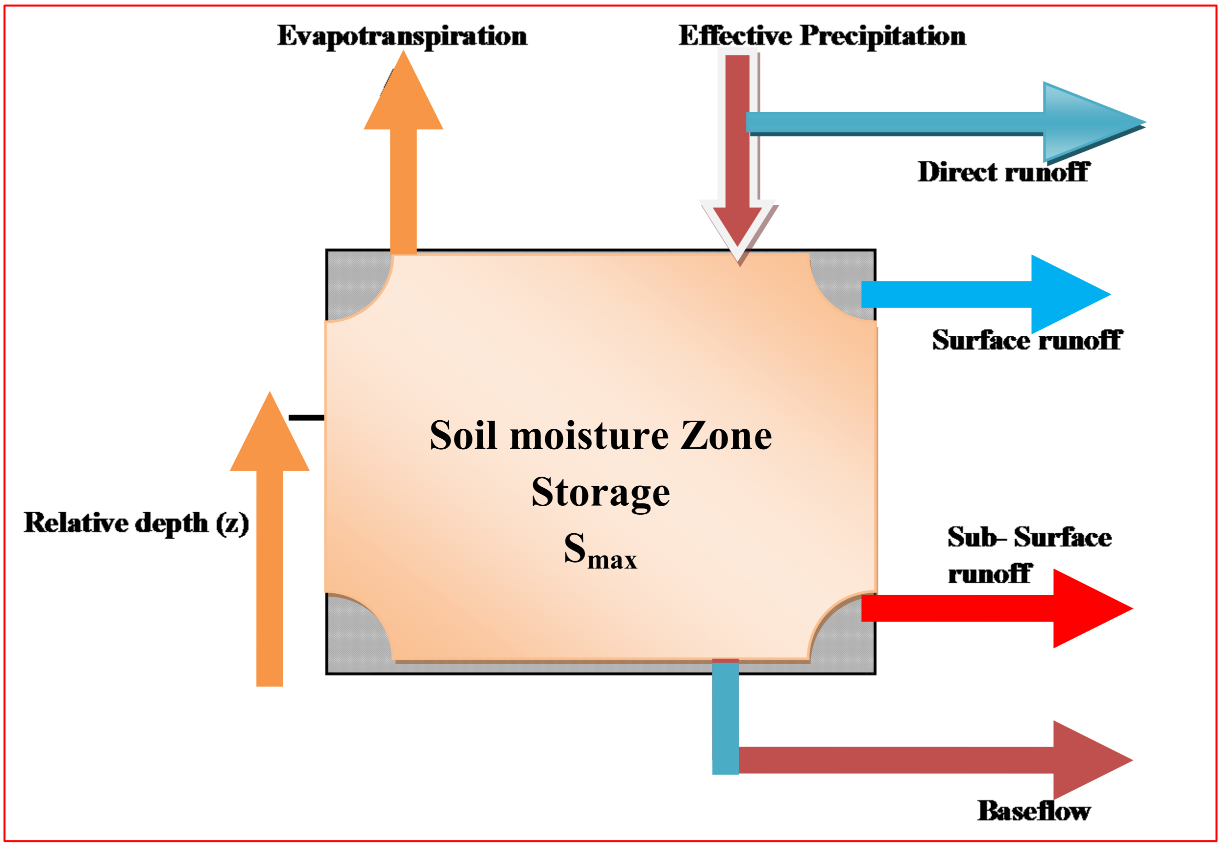


Fig 5.1 Simple schematic diagram of the water balance model

It is a model that simulates variation in soil moisture and runoff. The model constitutes two components. The first is a water balance elements that reports water movement into and out of a conceptualized catchment figure (5.1) above and the second is the computation of potential evapotranspiration, for which there are three capable choices, depending on data accessibility.

In most cases, water balance is estimated by:-

Inflow=Outflow+ Change in storage……………….. ………. (5.1)

Where, inflow make up precipitation and groundwater flow Out flow includes evapotranspiration, runoff, groundwater out flow and infiltration for that justification, the connection of these water balance basic parts are appear as follows:-

P+Gi=AET+Ro+Go+I±ΔS………………………………………. (5.2)

Where **P** is precipitation,

Gi and **Go** are groundwater in flow and out flow respectively

AET, is actual evapotranspiration

Ro is runoff

I is infiltrated water to soil, affected by **AET** & it affects **Ro** and groundwater recharge (**R) ±ΔS** change in Recharge

But water balance techniques go after certain assumptions such as; surface water divide corresponds with groundwater divide, no inflow from out and no out flow from basin and abstraction by human is insignificant. Based on the assumption above, the basin is water hard to move and no subsurface movement of water towards the defined watershed, to carry out the water balance on long term averaged data equation can be reduced in to:-

P= AET+ Ro± ΔS……………………………………. (5.3)

R=P-AET-SRO

Where, P=1018.4 mm, AET= 640.7mm, SRO= 139.68 mm

R= 1015.77 mm -640.7mm-139.68mm

R= 238.02 mm/year

Using the above formula, the recharge of the upper awash basin is 238.02 mm/year which is 23.4% of annual precipitation is recharged. Groundwater recharge evaluated in the upper awash basin takes place in three months (June to August). In contrast in the other month's groundwater bring about to AET and total runoff, and also this circumstances is caused to be visible by negative value of recharge.

5.1.2 Baseflow recharge estimation method

According to Balek, (1988) recharge was defined as the process of downward movement of water through the saturated zone under the force of gravity or in the direction determined by hydraulic conditions. In some instances baseflow has been second-hand as to estimate fairly accurately of recharge with an assumption that it is almost certainly less than the amount of recharging the groundwater system (Chen and Lee, 2003). Drainage systems are influenced by climate, topography, land cover, and geology considering the tectonic structures of the area. The climatic and hydrologic characteristics of the upper awash basin generally produce a discontinuous stream flow regime in most of the watersheds. The drainage systems in these regions more advanced over the steep mountains and follow topographic slopes. According to Erickson and Stefan, (2008) baseflow is the long-term discharge into a stream from natural storage, such as groundwater, generally maintaining flow between rainfall events. The Rivers that flow unceasingly all around the year experience high baseflow component. Therefore, many techniques, of which afford subjective results have been established to evaluate baseflow as a record of groundwater discharge under the stream flow hydrograph. Consequently, analysis of long term daily stream discharge data records of the streams cause to be visible that the majority of the streams have flashing characteristics that exists only throughout the course of the short duration of rainy seasons. Thus, in the period of summer rainfall occasion, the rivers exhibit progressive flow to the Awash River from residual watershed but flows are completely dry during the duration of dry seasons.

Awash River is the main river in the study area that flow in direction of northeast in same direction the as main rifting axis. Its discharge is measured at several places such as Akaki, Awash Bello, Mojo, Teji, Holleta, Berga and Ombolle). Therefore, detailed examination of the relationship between magnitude and occurrence of stream flow component and its connection with the stream peak (rainfall occasion) is absolutely necessary to identify the intended meaning of the dynamics and occurrence of groundwater discharge to streams. The daily time-series record of stream flow was having already been used to derive the hydrograph components of the seven rivers. In this hydrograph detailed examination, periods which have all the necessary daily discharge record were most suitable for hydrograph separation and evaluation of Groundwater recharge in the upper awash basin.

As stated in Andarge Yitbarek, (2009) the major statement that assumed to be true when using baseflow for evaluating recharge is that baseflow equals groundwater discharge from the aquifer storage and that groundwater discharge is more or less equal to recharge, assuming that losses from gauged watersheds caused by underflow, groundwater evapotranspiration and abstraction are minimal.

In this methodology of indirect groundwater recharge or baseflow for the upper awash basin is evaluated by applying the baseflow separation excel spreadsheet program using daily river flow records of Mojo, Teji, Holleta, Ombole, Berga, Akaki and Awash Bello. The total recharge or baseflow of the study area by using excel spread sheet program is shown in the table including with % mean annual areal precipitation of the study area.

Table 5.1 Baseflow recharge from excel sheet

Stations	Awash @Bello	Awash @Hombole	Holleta	Mojo	Berga	Teji	Akaki
Area	2568.8	7656.0	119.0	1264.4	248.0	662.5	884.4
Baseflow in mm/yr	98.07	111.8	251.75	98.7	148.7	65.8	138.7
P in mm	955	886.7	1064.5	857.5	1050	948.6	1038.6
%ARF	10.3	12.6	23.65	11.5	14.1	6.9	15.7
BFI	0.83	0.69	0.48	0.38	0.51	0.37	0.5

Where, **BFI, %ARF, P** stands for Baseflow Index, Percent of Annual Rainfall, and Precipitation respectively.

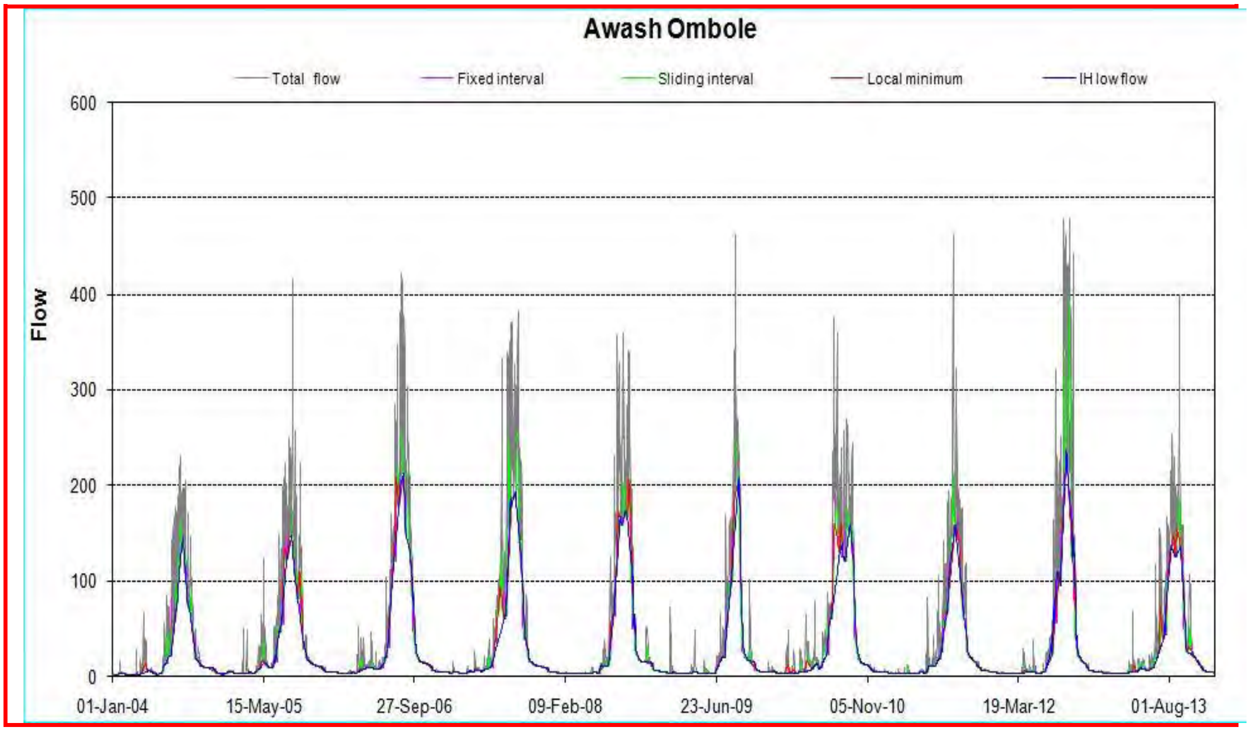


Fig 5.2 Baseflow Separation of Awash River at Hombole

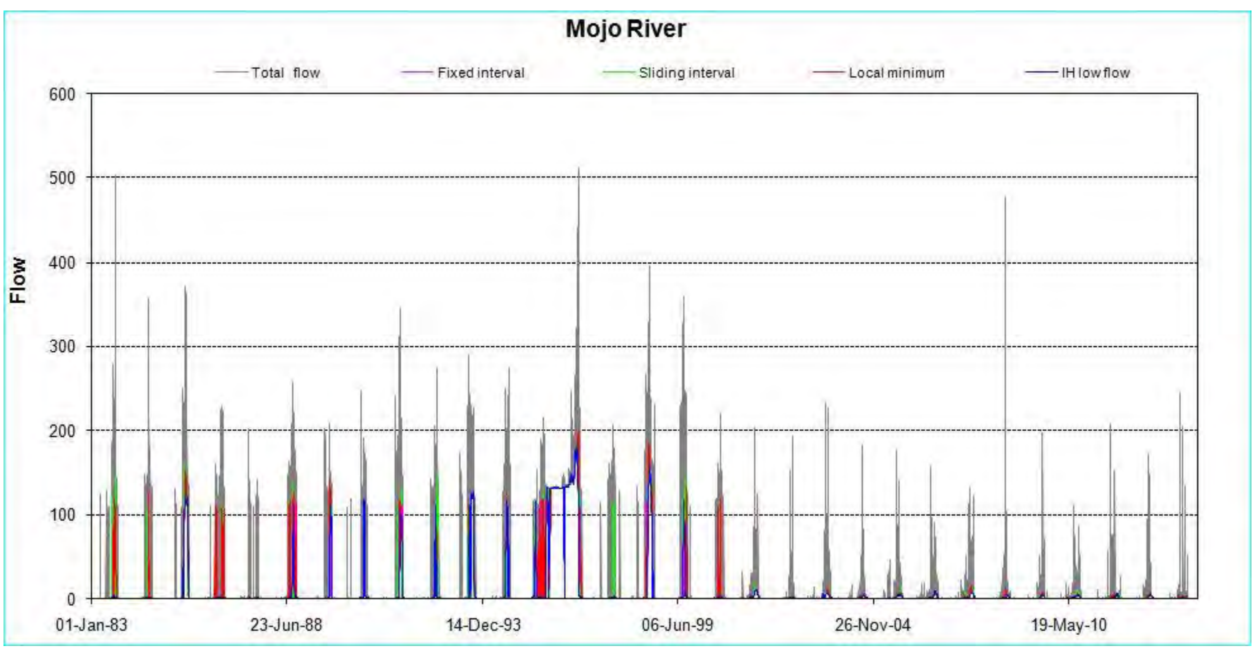


Fig 5.3 Baseflow separation of Mojo River

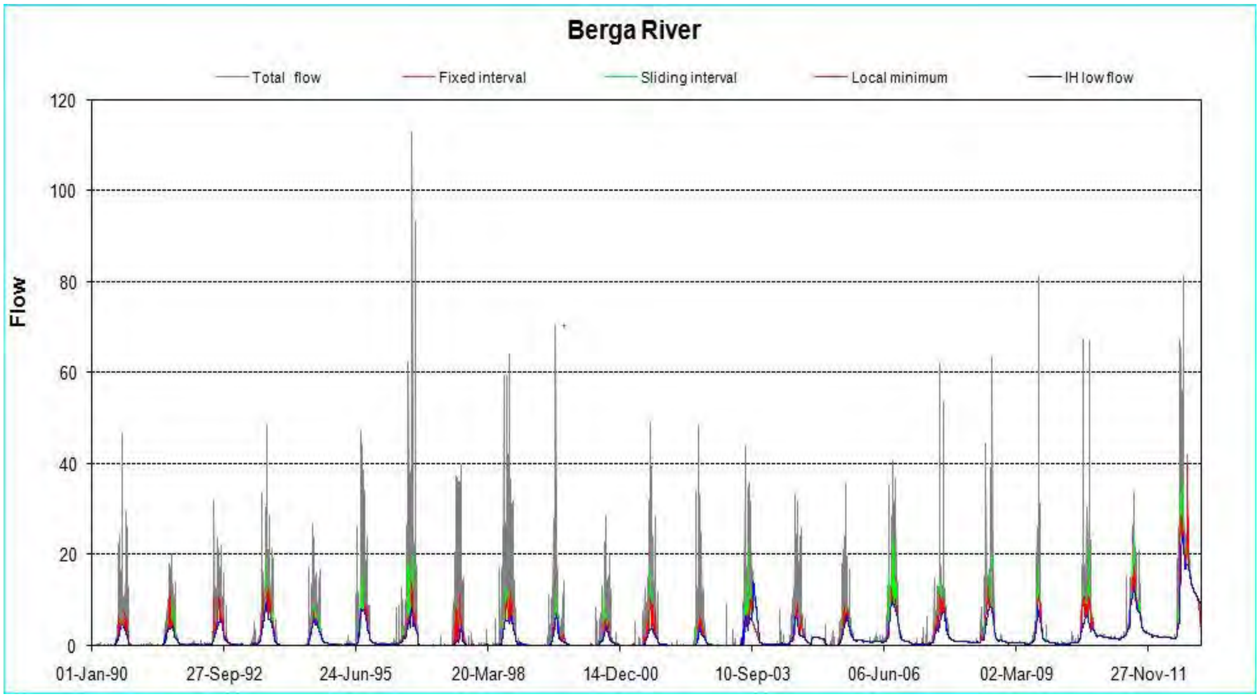


Fig 5.4 Baseflow Separation of Berga River

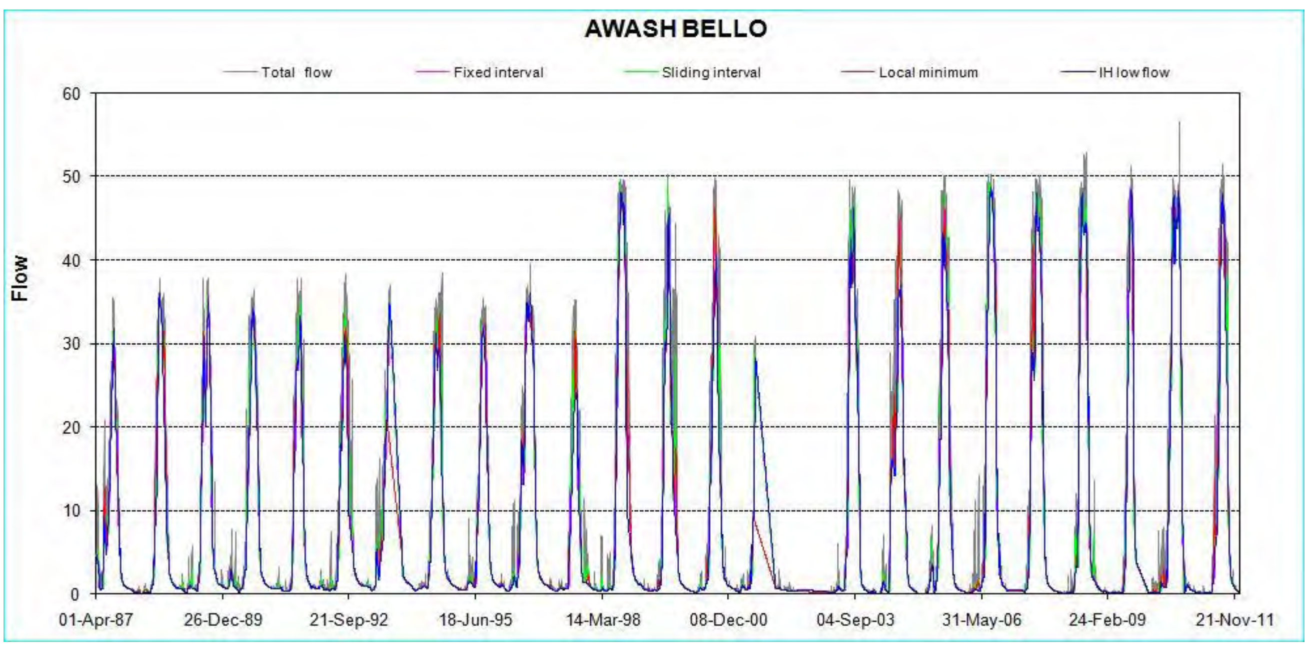


Fig 5.5 Baseflow Separation of Awash River at Bello

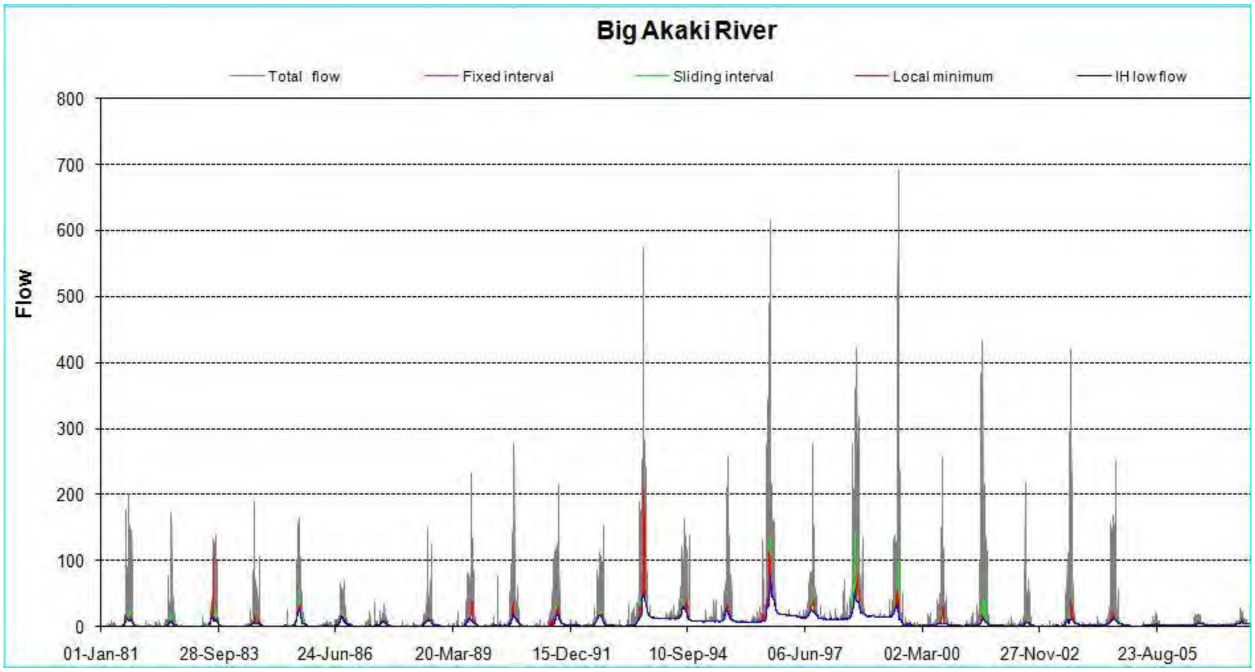


Fig 5.6 Baseflow Separation of Akaki River

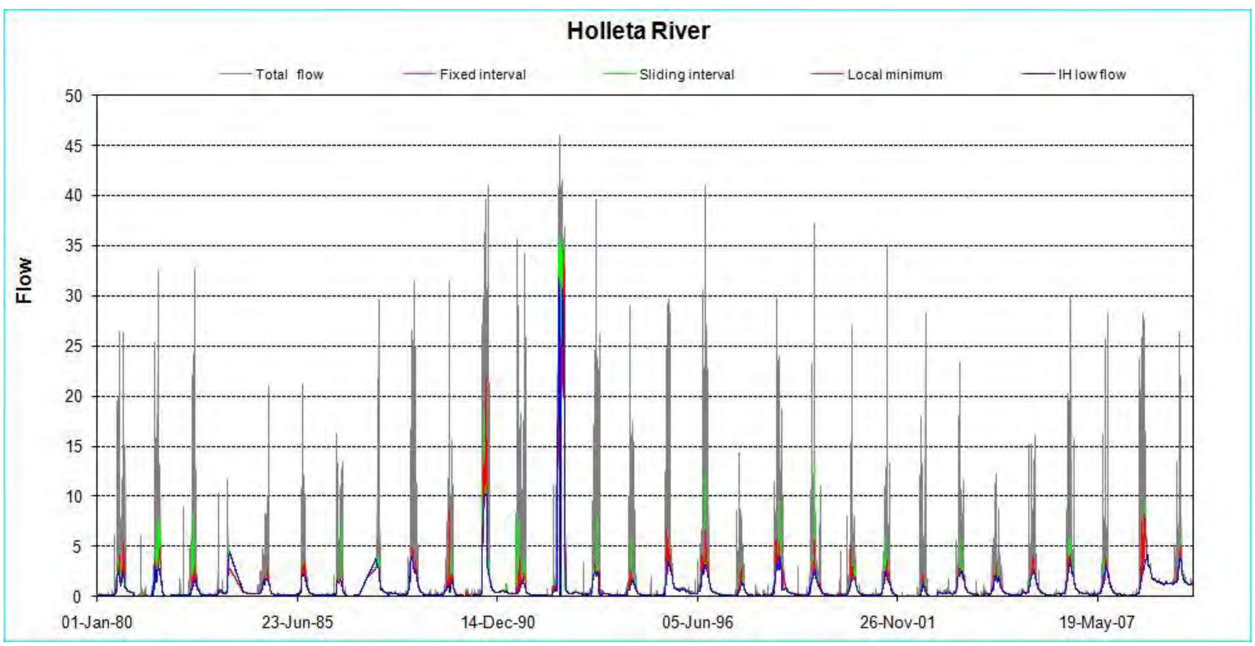


Fig 5.7 Baseflow Separation of Holleta River

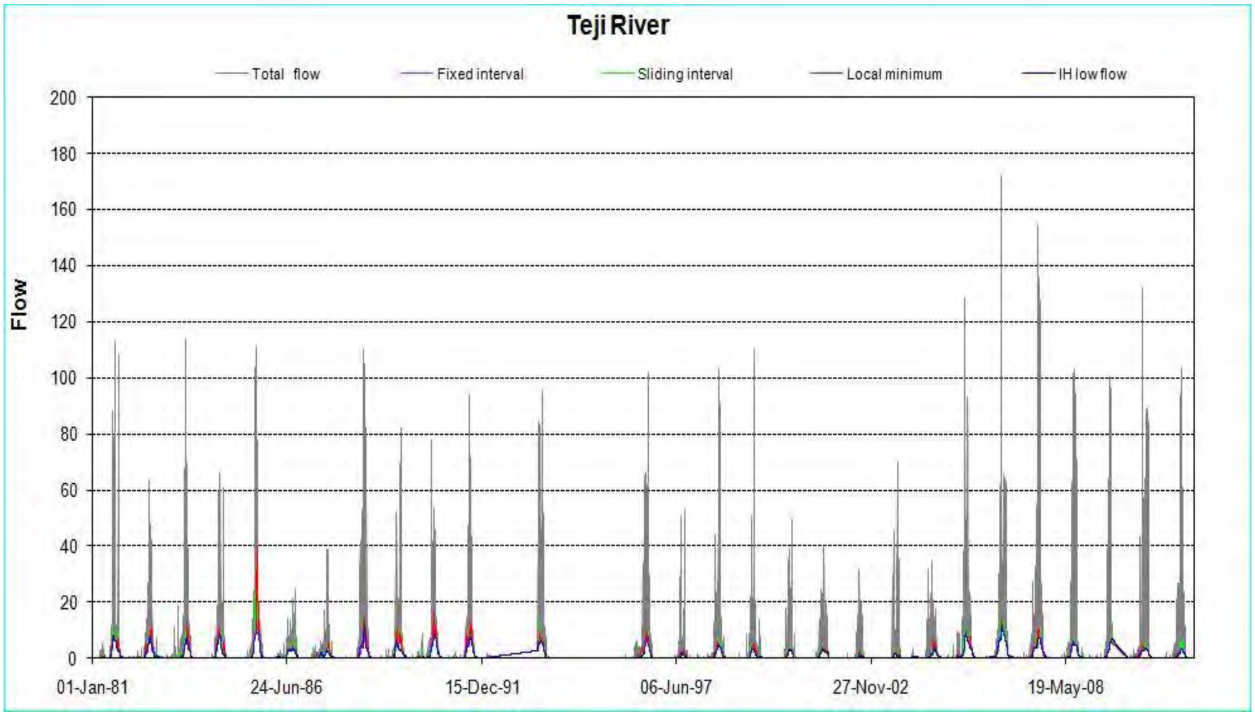


Fig 5.8 Baseflow Separation of Teji River

Similarly, based on the baseflow found by using Excel Baseflow sheet above demonstrates that, the average annual groundwater recharge of upper awash basin (mean annual baseflow divided by the area of the upstream catchment). While, measured at Hombole commanding a catchment area of 7656km^2 was estimated to be 111.8mm, which amounts to only 12.6 % of the mean annual areal precipitation of the area, Mojo River catchment have an area of 1264.4km^2 was estimated to be 98.7mm, which accounts to be 11.5% of the mean annual areal precipitation, Teji River which have an area of 662.5km^2 was estimated to be 65.8mm, which accounts to be 6.9% of the mean annual areal precipitation, Akaki River which have area of 884.4km^2 was estimated to be 138.7mm, which accounts to be 15.7% of the mean annual areal precipitation, Berga River have an area of 248km^2 is estimated to be 148.7mm, which accounts to be 14.2% of the mean annual areal precipitation, Awash River at Bello have an area of 2568.8km^2 was estimated to be 98.0mm, which accounts to be 10.3% of the mean annual areal precipitation and Holleta River catchment which have an area of 119km^2 was estimated to be 251.75mm, which accounts to be 23.65% of the mean annual areal precipitation of the study area.

The amount of annual groundwater recharge in the upper awash basin using baseflow separation of seven rivers found in upper awash basin was 130.5mm/year which accounts 12.8% of annual rainfall was percolated to the aquifer.

5.1.2.1 Rainfall-river discharge relationship

The highest peak in the river discharge corresponds to the highest rainfall in the months of July and August. In the figures below Rivers selected from the Upper Awash basin for rainfall-discharge relationship shows that the months of June have relatively high rainfall amount than the months of September having equal amount of river discharge. At the beginning of the rainfall (June), rainfall is being interrupted by vegetation or soaked into the ground and making up soil moisture deficit. At the months of September the soil is at its field capacity most of the rainfall amount contribute to the river flow in addition to base flow from groundwater stored in the previous months. Runoff takes place when the amount of rainfall on a surface go above the rate at which water can infiltrate the ground and any depression storage has already been filled. This more frequently, occurs in arid and semi-arid regions, where rainfall intensities are high and the soil infiltration capacity is reduced because of surface sealing, or in paved areas.

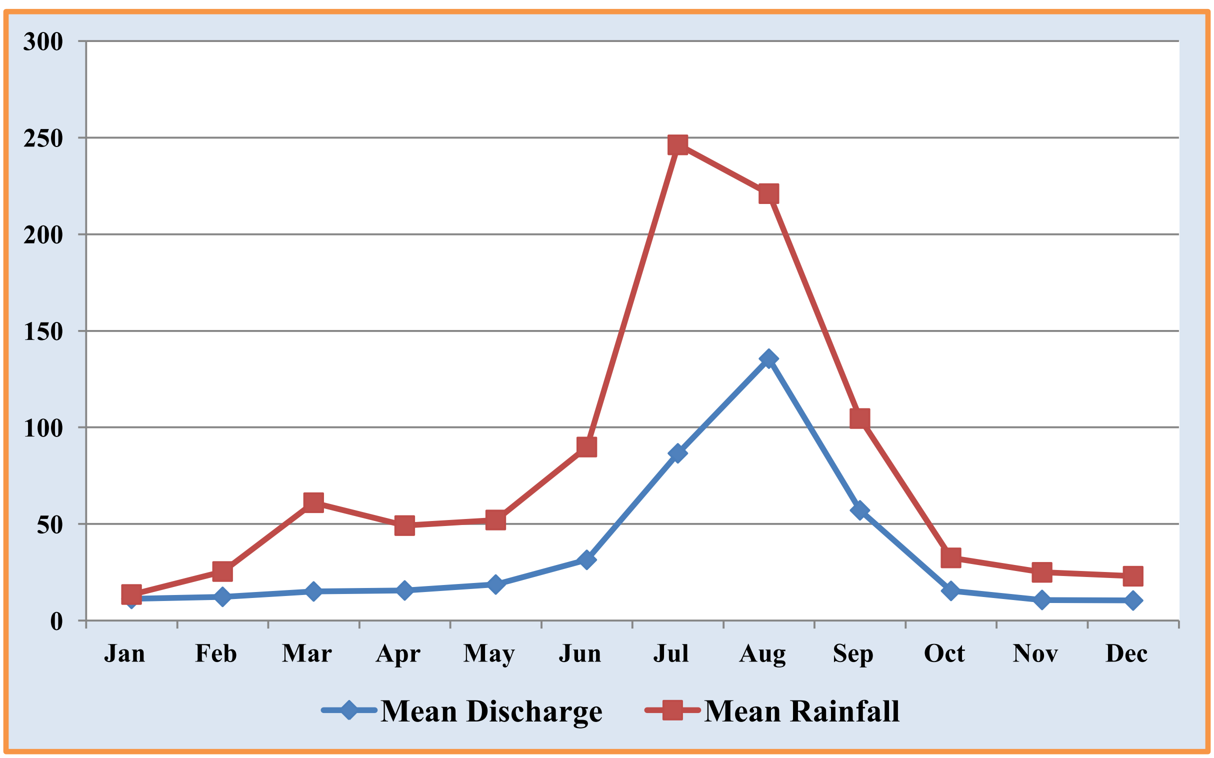


Fig 5.9 Rainfall -River discharge relationship at Mojo River

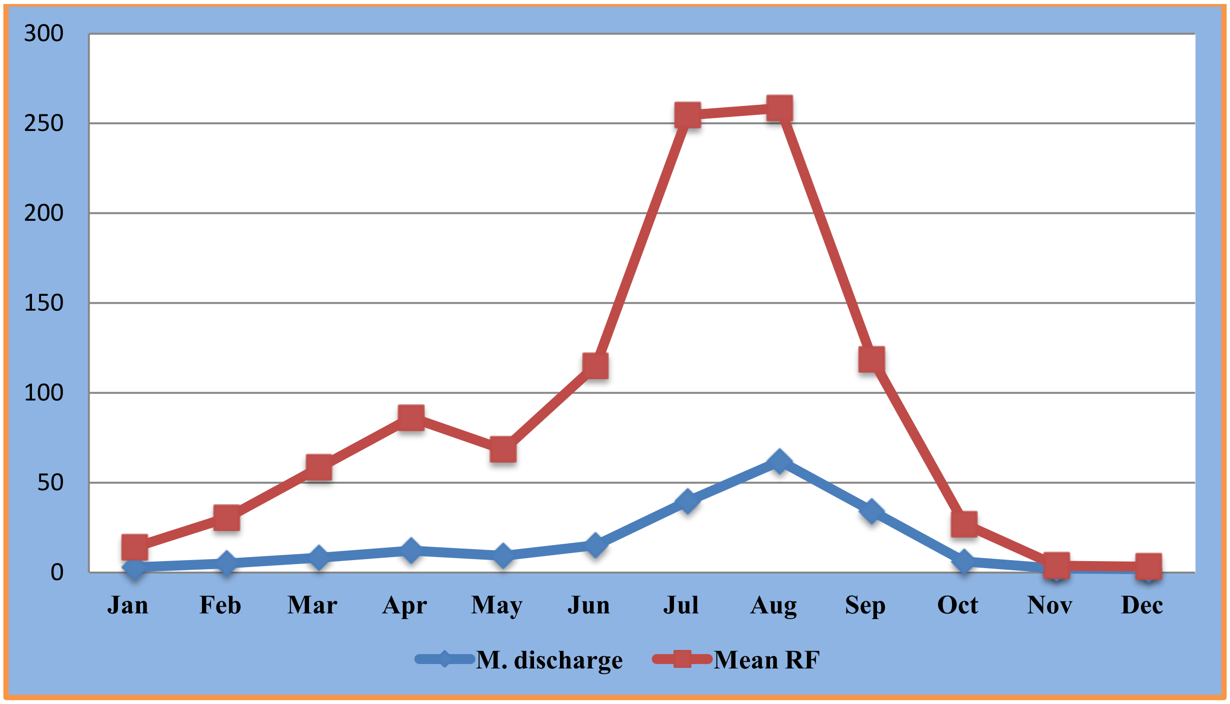


Fig 5.10 Rainfall -River discharge relationship at Akaki River

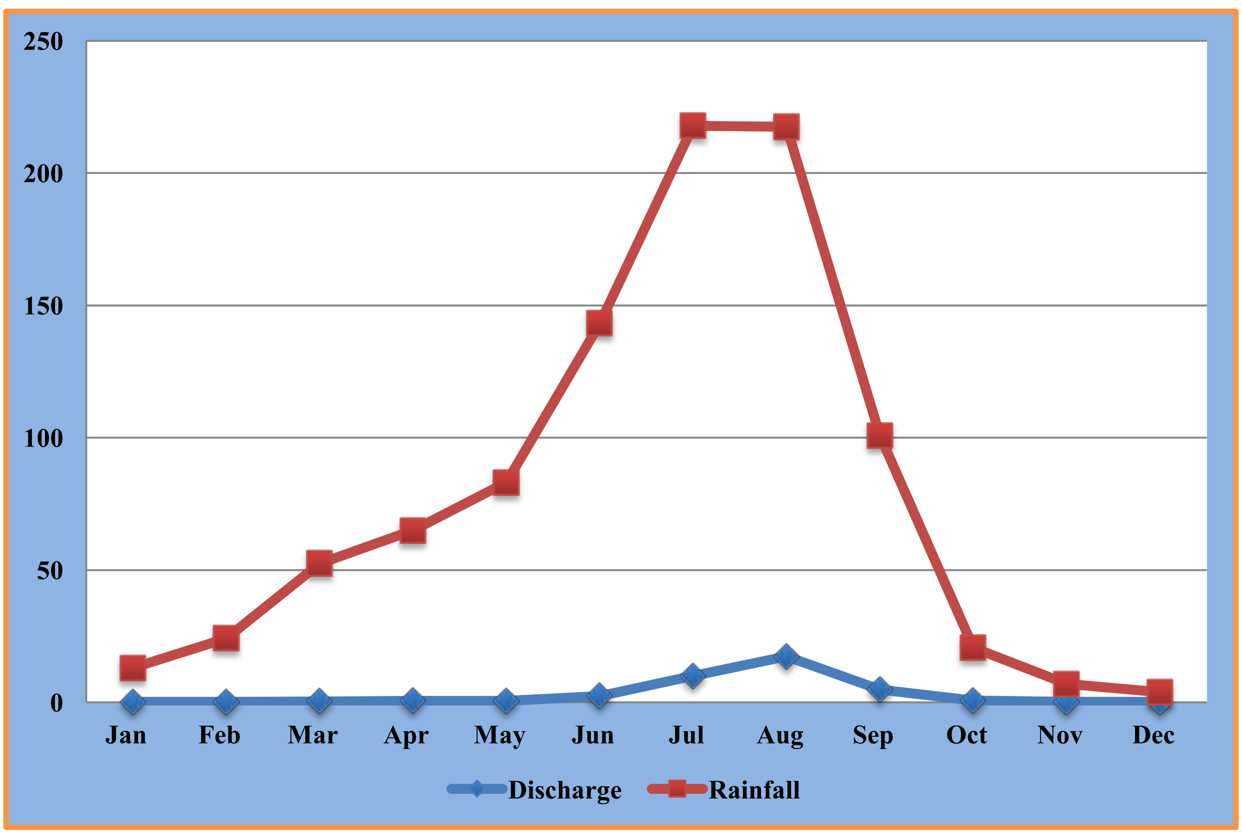


Fig 5.11 Rainfall -River discharge relationship at Teji River

Rainfall intensity and infiltration capacity of the soil was one of the factors that influence runoff process. If the rainfall intensity is lower than the infiltration equilibrium capacity, but less than the initial infiltration capacity, at the beginning all the water will infiltrate, but when the infiltration capacity drops below the rainfall intensity, some of the water remains on the land surface. Surface runoff or overland flow is the water that doesn't infiltrate and forms flow as a thin sheet across the land surface. The highest peak in the river discharge matches up to the highest rainfall in the months of July and August. In the hydrograph (figure 5.11) the months of June have relatively high rainfall amount than the months of September having equal amount of river discharge.

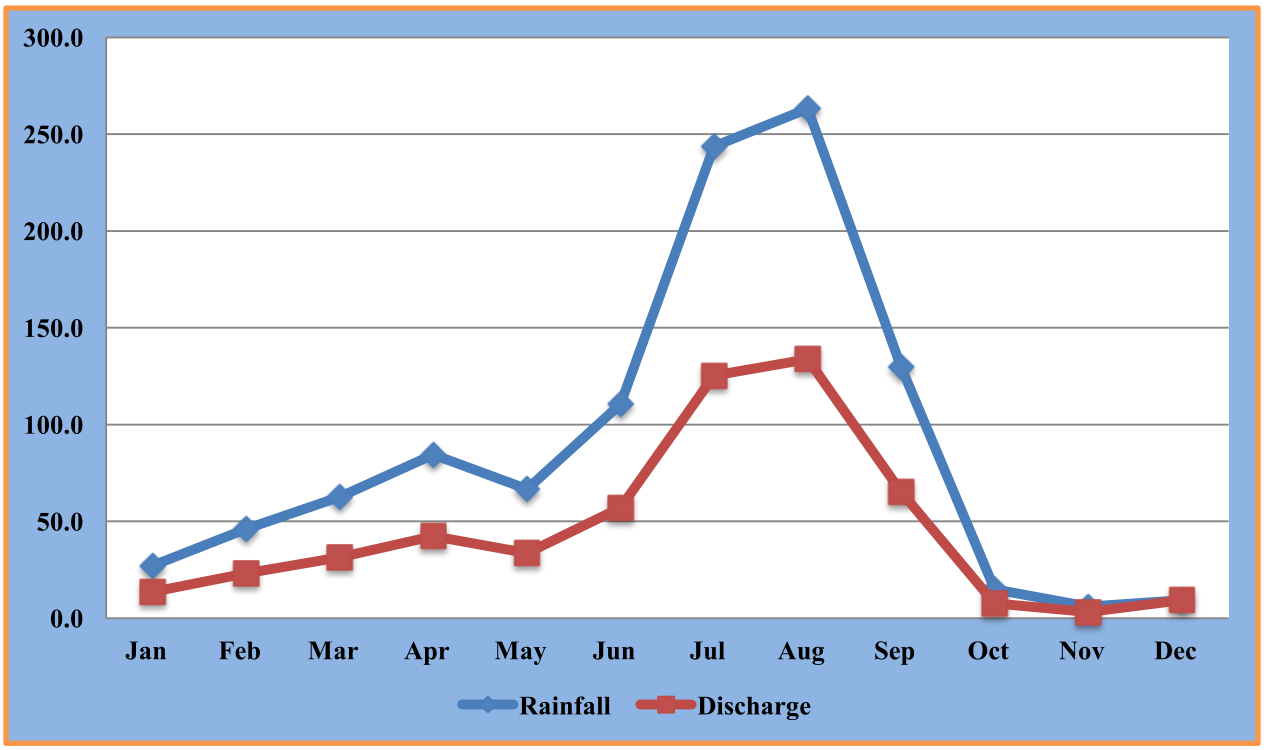


Fig 5.12 Rainfall -River discharge relationship at Holleta River

In all Rivers the hydrogeological point of view shows that, the catchment do not show fast response to rainfall at the starting of the wet seasons however, as rainfall increases the response turn out to be faster. This means, there is a time delay between high rainfall and run off. September has nearly equal rainfall and river discharge to June and July, having higher river discharge and lower rainfall than June and July correspondingly. This elucidates that there is a relatively higher residence time and storage of groundwater.

5.1.2.2 Seasonal dynamics of baseflow index

The Baseflow Index (BFI) is used as a measure of the baseflow characteristics of basin. It endows with a systematic way of evaluating the proportion of baseflow in the total runoff of a basin. As a result, it indicates the influence of soil and geology on river flows. The average intra-annual monthly baseflow index matches up to the variation (seasonality) of the baseflow due to the seasonality of precipitation. In this study, the one year discharge data was used to identify the seasonal dynamics of baseflow index in the upper awash basin. As cited in Andarge, (2009) based on rainfall coefficient values the following precipitation category can be made for the Upper Awash basin. Whereas, dry months like October, November, December, January and February have rainfall coefficient of less than 0.6. However, rainy months have Rainfall Coefficients of above 0.6 such as March, April, May, June, July and August have moderate to high rainfall concentrations. Using this result the areal rainfall pattern was classified in two season's rainy and dry season. The groundwater component of a river was derived from continuous and intermittent flows from aquifers that drain to the river under varying degrees of hydraulic connection.

Table 5.2 Monthly Baseflow components of selected Rivers in the upper awash basin

Name of Rivers	Awash Bello	Awash Hombole	Awash Melkakunture	Akaki	Teji	Holleta
BFI in Dry (mm/yr)	66.3	2.5	4.9	31	34	75.9
BFI in Rainy (mm/yr)	49.1	1.1	1.34	6.38	9.4	57
% of BFI in Dry	57	69	79	83	78	57
%BFI in Rainy	43	31	21	17	22	43

Whereas, BFI, , mm/yr, m^3/sec stands for Baseflow Index, Mean Daily Baseflow index, millimeter per second and meter cube per second

In the figure (5.13) below the pie chart shows that the increase in percentage of baseflow index at the time of dry season and shows astonishing decrease in summer time. Groundwater flow contribution to total stream flow comes from shallow aquifer storage (Arnold and Allen 1996).

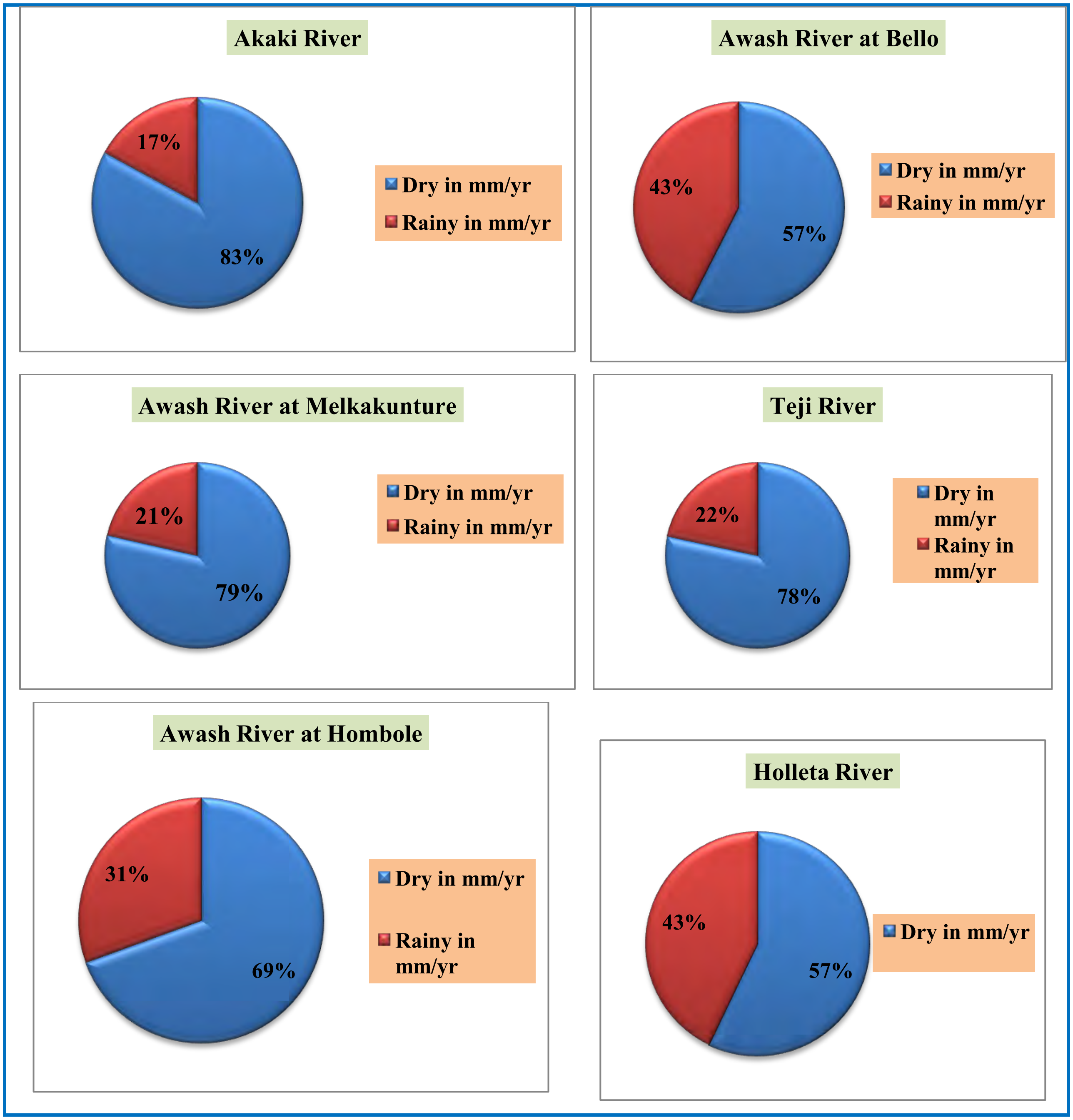


Fig 5.13 Baseflow index dynamics seasonally dry and summer season (%)

In the maps below shows that there is variation of baseflow index (the contribution of groundwater to rivers) seasonally due to precipitation and evapotranspiration. Groundwater contribution was shown to vary according to the nature of the aquifer lithology, the mechanism of groundwater-surface water interaction and the scale at which one examine this interaction.

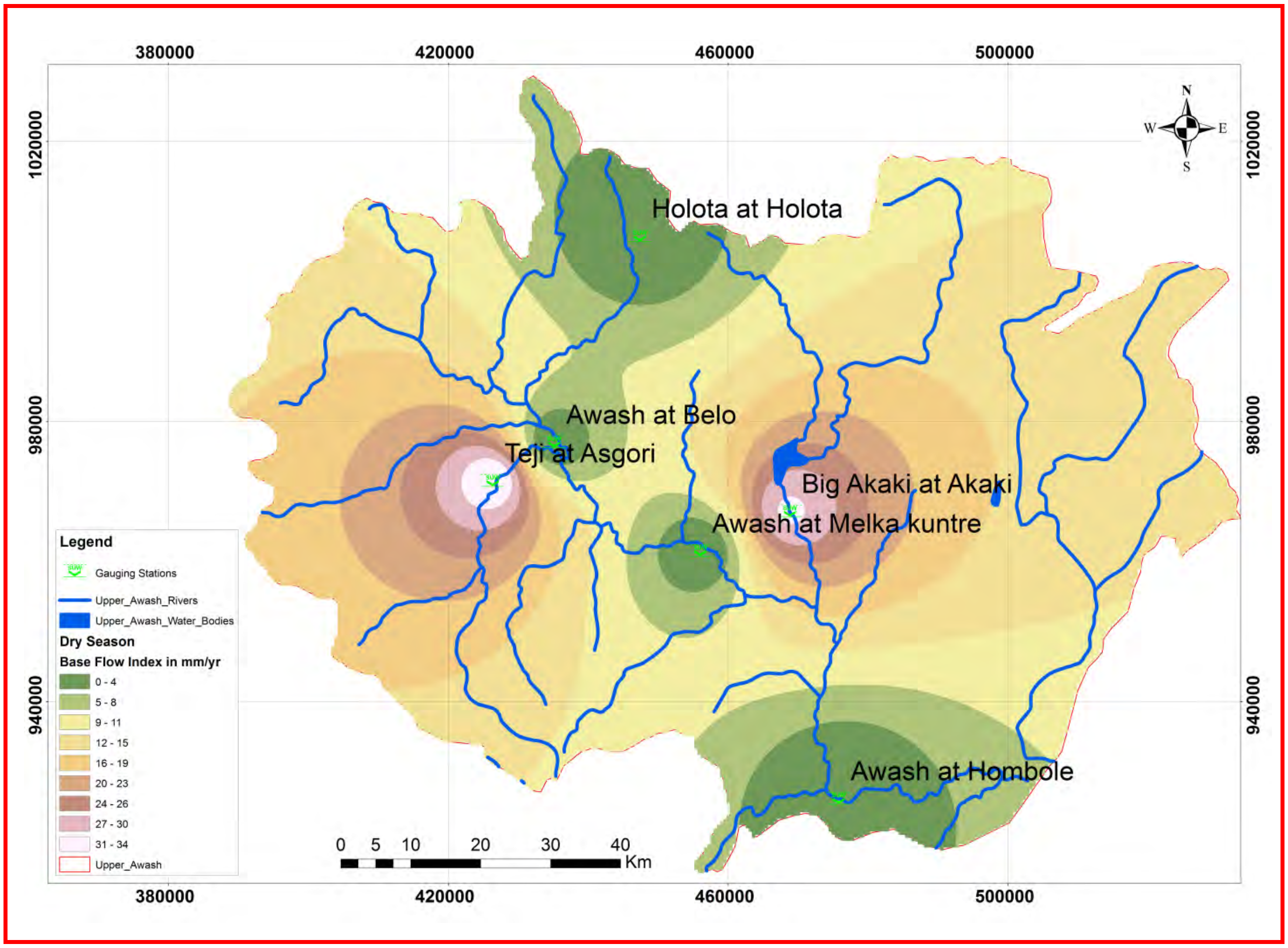


Fig5.14 Baseflow index spatial map in dry season

The map above shows that baseflow index (contribution of groundwater to rivers) is highest at the dry season and lowest at the time of rainy season. The BFI was directly related to the dynamics of the water storage in the basin, controlled by subsurface storage and transmissivity, which are a function of lithology and weathering. An increase in stream density or drainage density is matched by an increase in baseflow index. Therefore, BFI has a strong relationship with climate and geology and catchments with high rainfall or low evapotranspiration tend to give high baseflow in the case of Akaki and Holleta catchments. For example, catchments with high rainfall and shallow soils, there is little storage so that catchments with high rainfall still can have a lower BFI.

Therefore, all river gagging stations like Awash Bello, Holleta, Teji, Awash at Melkakunture, Akaki and Awash Hombole shows remarkable increase in groundwater contribution to rivers in dry season.

In figure (5.14) results in the map indicates that the most notable pattern to emerge is an increase in BFI values in dry months like October, November, December, January, and February which appears to be robust. Continued aquifer discharge to river systems depends on significant aquifer storability and transmissivity, maintenance of high water tables and a hydraulic gradient towards the discharge point or zone, and hydraulic connectivity with the rivers in the study area. Groundwater dominance is mostly represented by stability of the flow region. This can be characterized by high amount of Baseflow Index (BFI). The values of BFI are strongly influenced by lithology and geology as well as by land cover, in particular the occurrence of major urban surfaces in the basin.

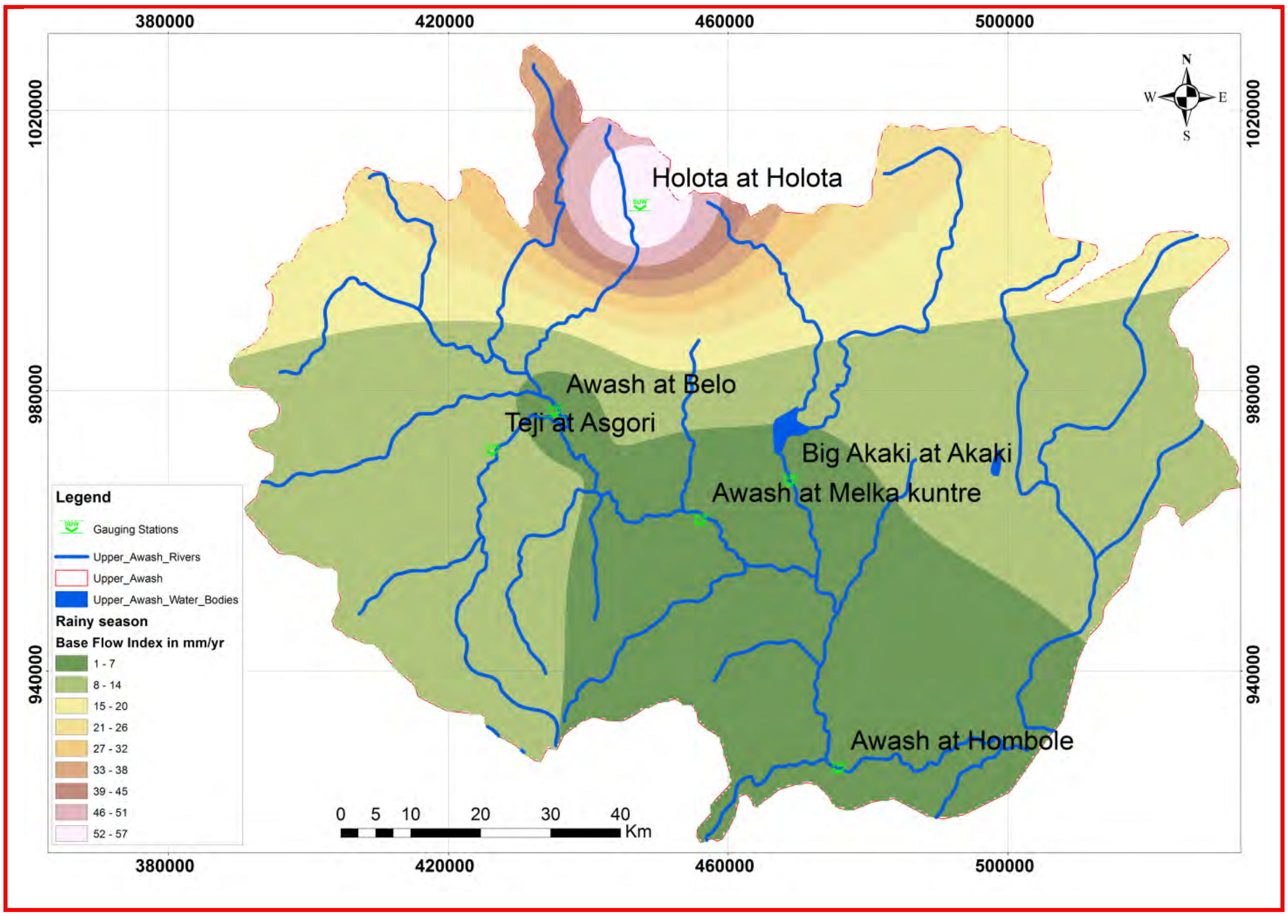


Fig 5.15 Baseflow index spatial plot of rainy season

The seasonal variability of the BFI during wet and shown in Figure (5.15) results in the map indicates that the most notable pattern to emerge is decrease in BFI values in rainy or wet months like, March, April, May, June, July, August and September the baseflow index shows that decrease in groundwater contribution to rivers. This shows that the BFI variability is generally of much lower magnitude and weaker during summer.

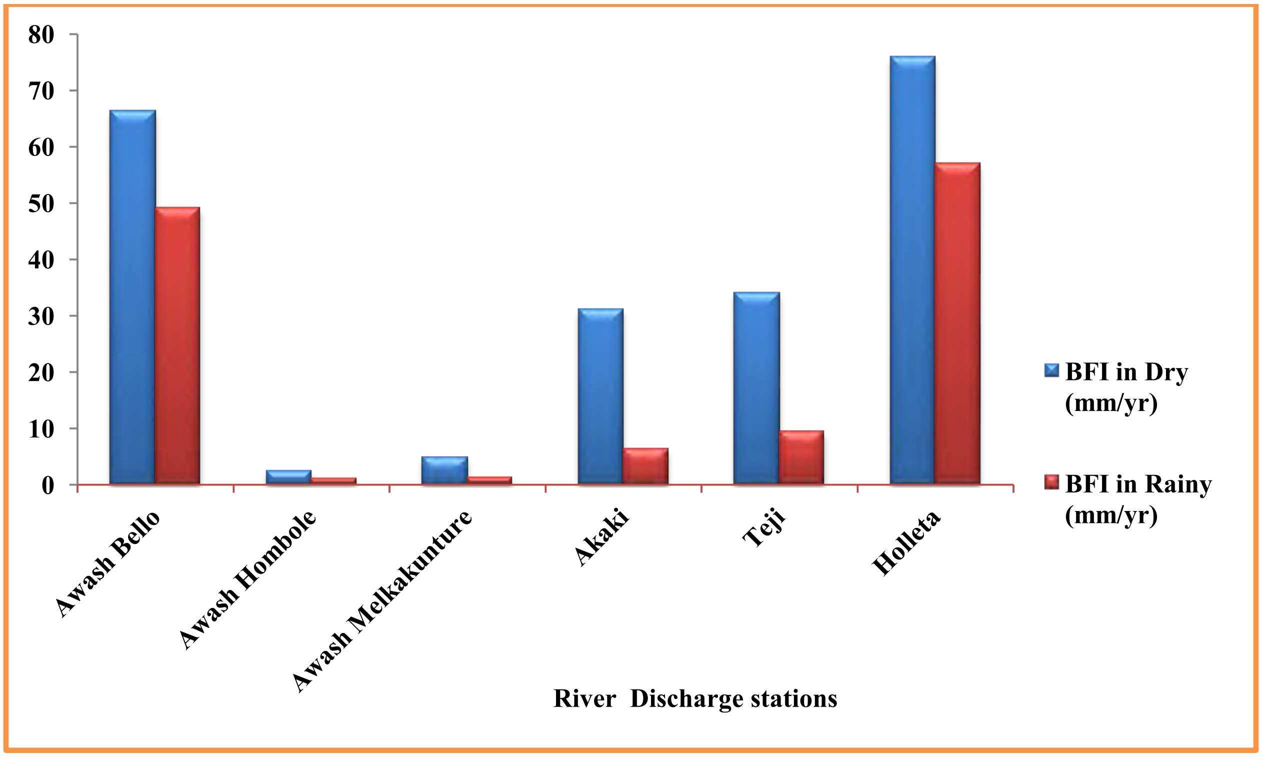


Fig 5.16 Seasonal dynamics of baseflow index

Findings also indicate that the potential of the upper awash basin to release water from the groundwater storage and other delayed sources increases significantly at the October, November, and December and gradually drops until the end of September.

5.1.2.3 Seasonal dynamics of baseflow

Baseflow in the upper awash basin is influenced by natural factors such as climate, geology, relief, soils, and vegetation. Human impacts on the landscape possibly will modify some or all of these factors, in turn affecting baseflow timing and quantity. Therefore, separation of stream flow hydrographs into rapid storm flow and baseflow can vastly improve our understanding of stream flow. Because surface runoff moves rapidly into the stream while baseflow moves more slowly through the soil, separating and understanding these two processes is fundamental to understanding the hydrologic watershed processes. In the upper awash basin many landscapes surface runoff can be intercepted by topographic depressions that can store water preventing transport to the stream and enhancing infiltration. Despite these complications, characterizing this baseflow of stream flow seasonally can greatly improve watershed hydrologic budgets. Therefore, to show this variation of baseflow seasonally six rivers were selected from the upper awash basin in the table (5.3) illustrated below. The separation of the baseflow component from the river flow hydrograph was done by taking the filter parameter of 0.995.

Table 5.3 Mean Daily Baseflow of selected Rivers in the upper awash basin

Name of Rivers	Awash Bello	Awash Hombole	Awash Melkakunture	Akaki	Teji	Holleta
MDBF in Dry (mm/yr)	6.7	16.17	0.88	38.5	12.8	47.4
MDBF in Rainy (mm/yr)	94.8	61.7	6.0	96.5	67.5	132
MDBF in Dry (m3/sec)	1.42	3.93	1.23	1.08		0.18
MDBF in Rainy (m3/sec)	7.72	14.99	7.75	2.07		0.55
% of MDBF in Dry	7	21	13	29	16	26
% of MDBF in Rainy	93	79	87	71	84	74

Whereas, MDBF, mm/yr, m^3/sec stands for, Mean Daily, millimeter per second and meter cube per second

As expressed in the table (5.3) above and in the figures baseflow separation graphs of all rivers, baseflow is expected to vary seasonally, a function of varying levels of evapotranspiration and aquifer storage. Greater precipitation and smaller evapotranspiration rates during the summer months create greater soil-moisture and greater aquifer recharge, increasing surface runoff response and groundwater contribution to stream flow. Therefore, Baseflow was the greatest during the months from March, April, June, July, August and September which have baseflow from (6–132mm/yr) and the least during the months from October, December, January and February which have (0.88-47.4mm/yr).

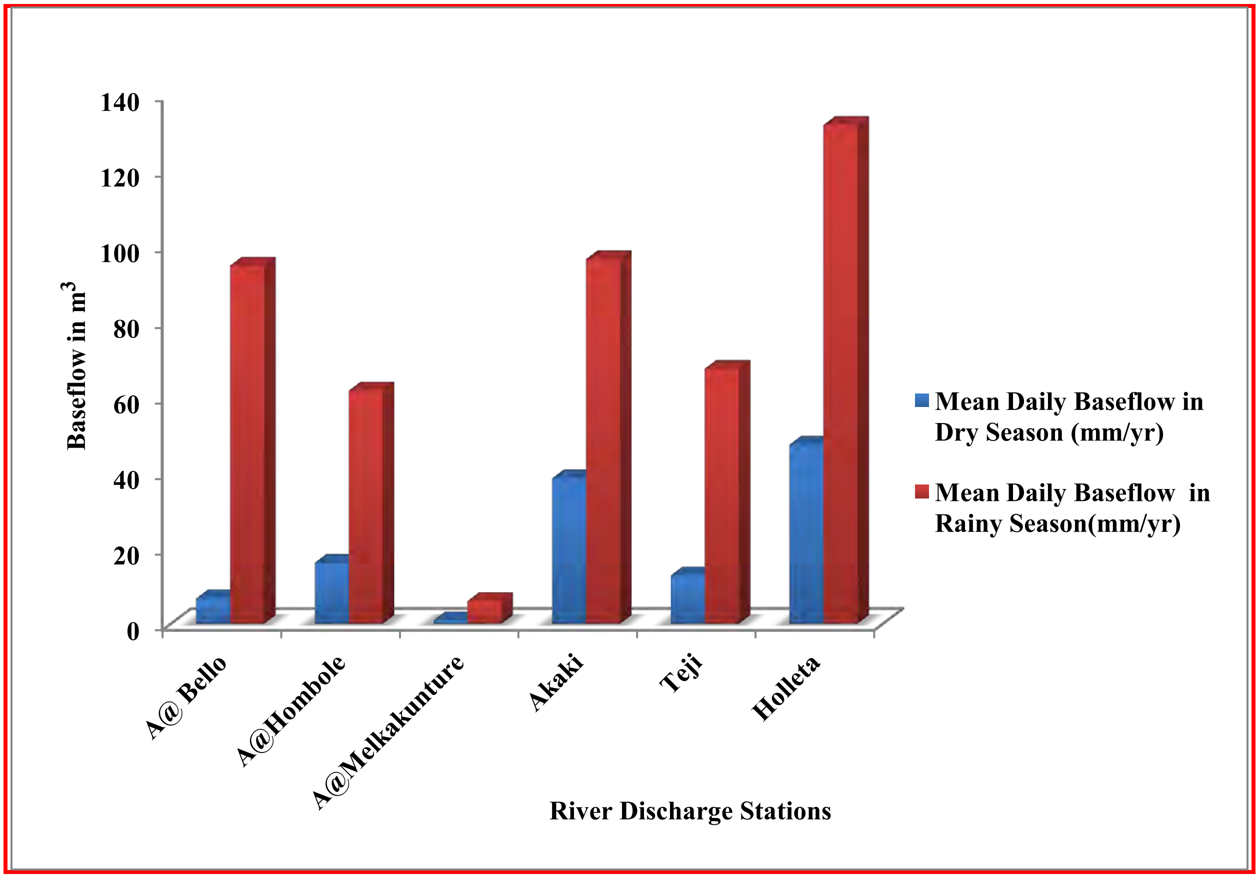


Fig 5.17 Seasonal dynamics of baseflow

In the upper awash basin both stream flow and baseflow increase with increasing precipitation. Therefore, the rate of increase in stream flow with increasing precipitation exceeds the rate of increase in baseflow with increasing precipitation. This is further indication that conditions of high precipitation lead to increases in saturation excess flow in this watershed, increasing the surface runoff component of stream flow at a more rapid rate than the baseflow component. The baseflow separation graphs of the following rivers shows that the response of baseflow to rainfall based on the basin characteristics, such as topography, land use, land cover, geology, aquifer characteristics and soil texture.

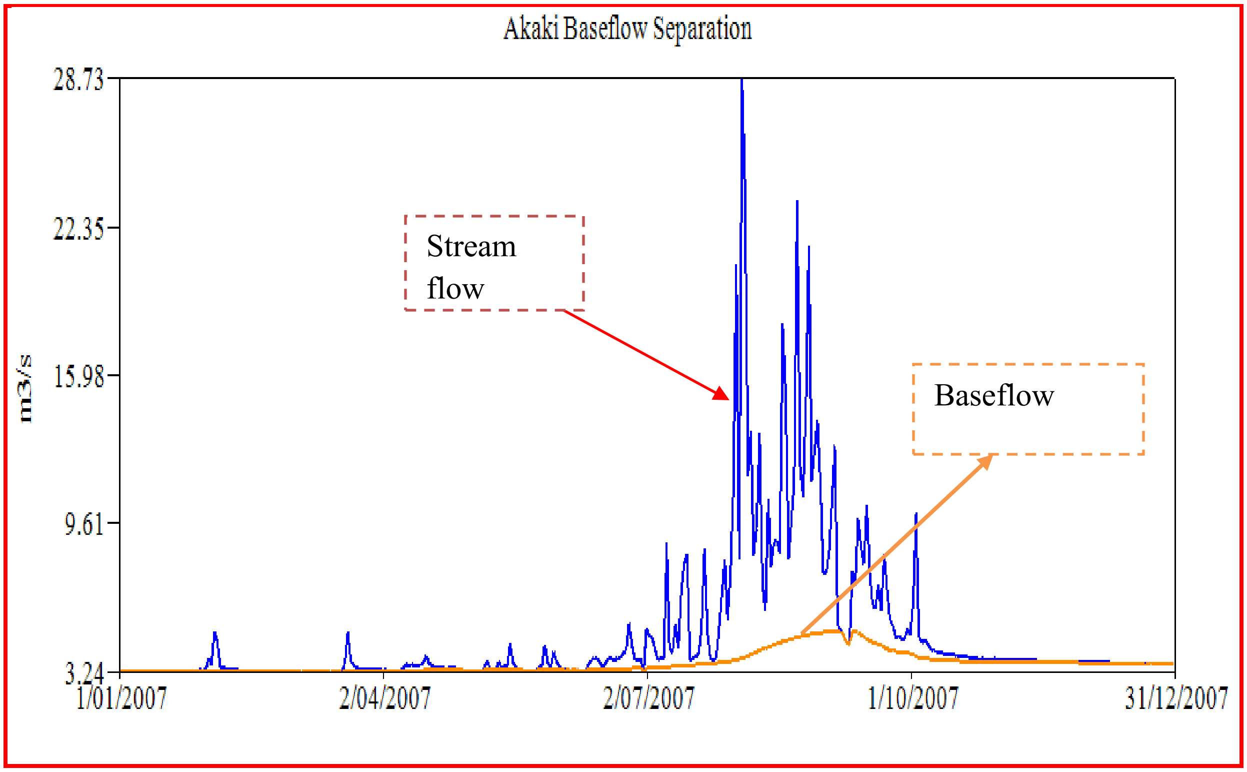


Fig 5.18 Baseflow Separation of Akaki River

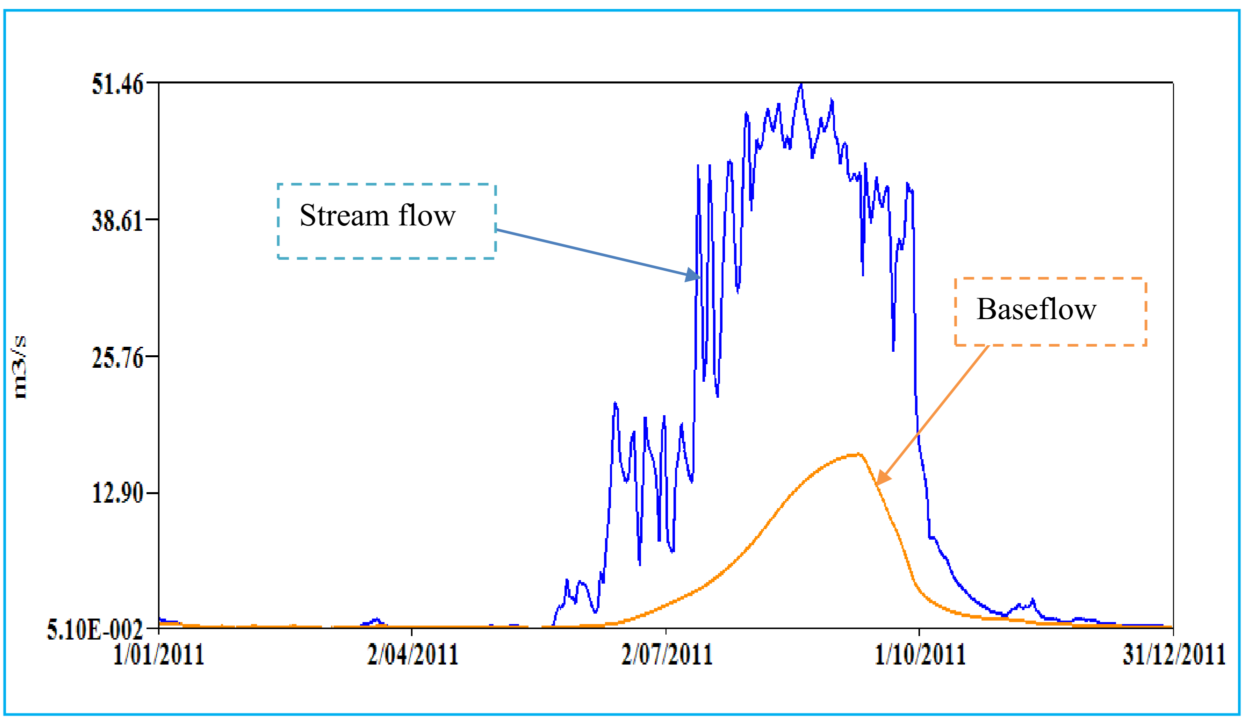


Fig 5.19 Baseflow Separation of Awash at Bello

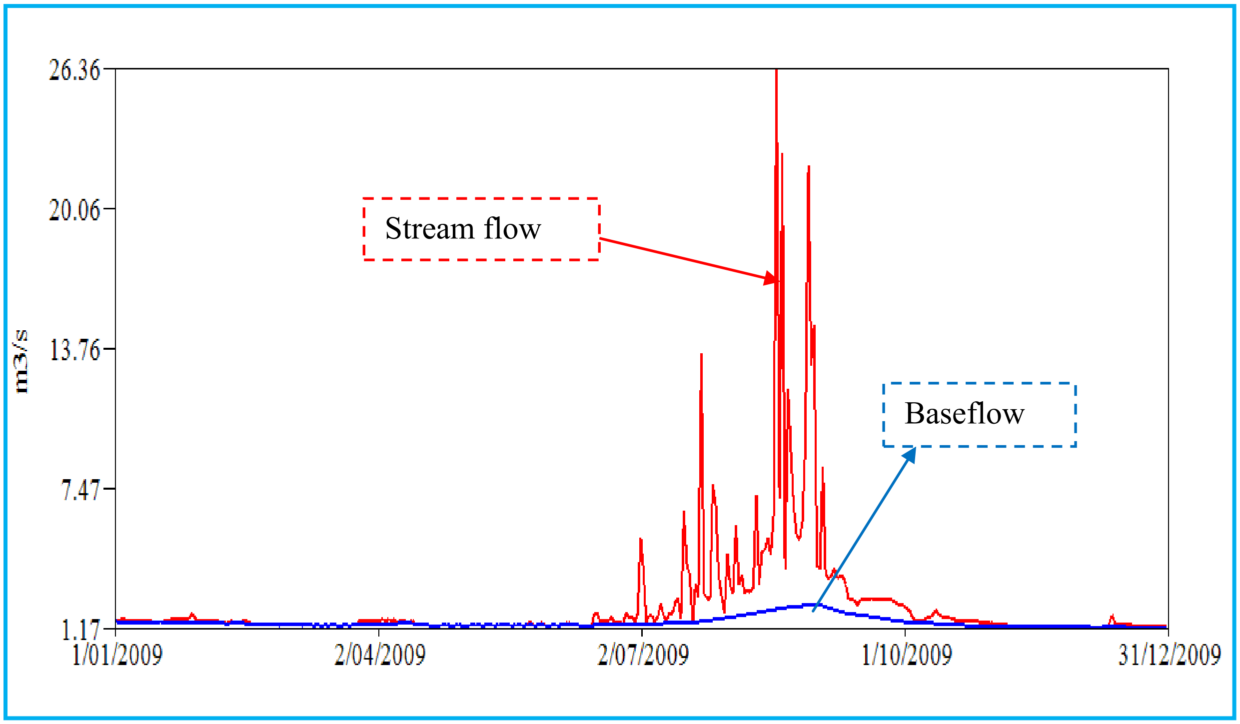


Fig 5.20 Baseflow Separation of Holleta River

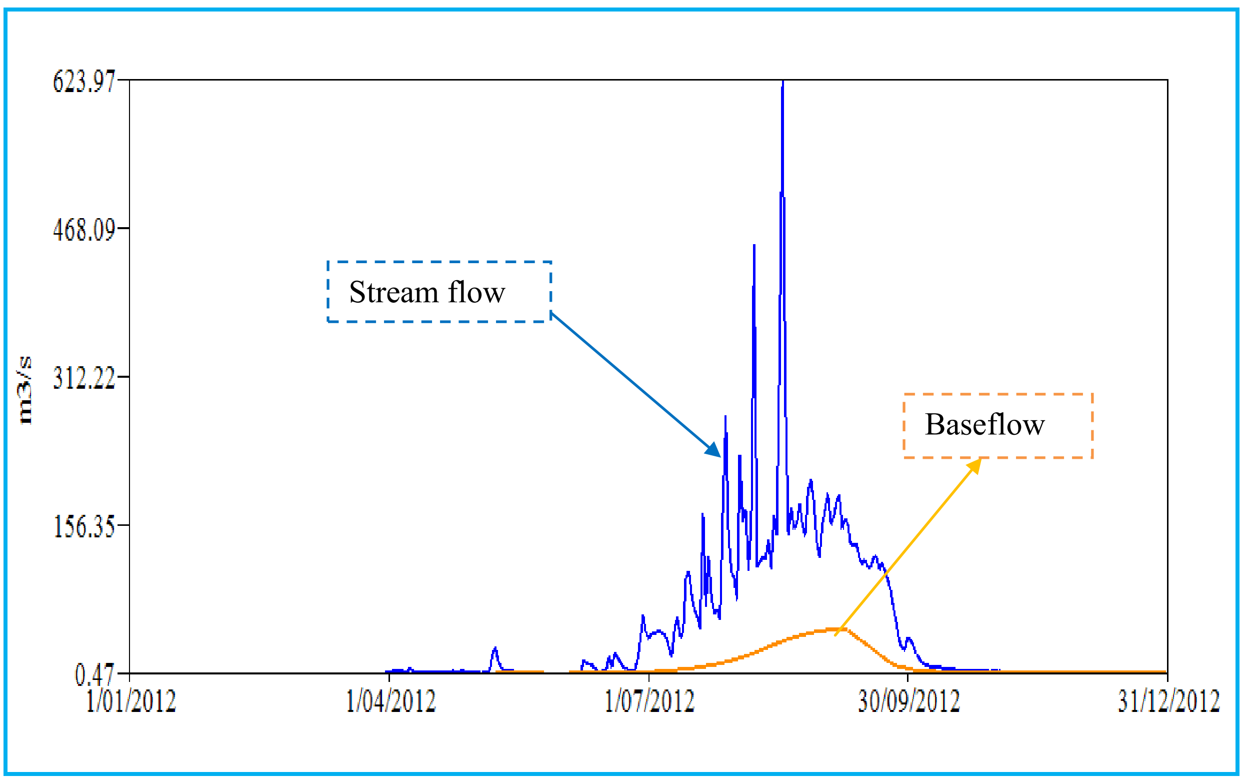


Fig 5.21 Baseflow Separation of Awash at Melkakunture

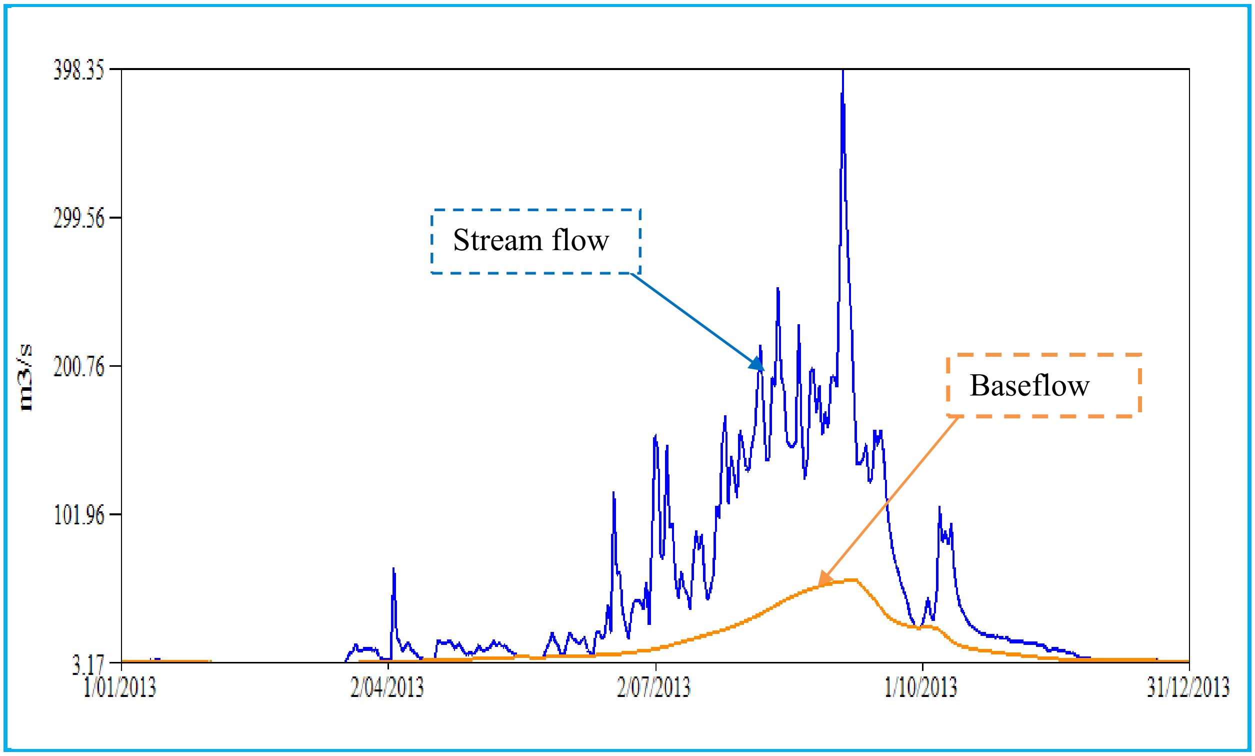


Fig 5.22 Baseflow Separation of Awash at Hombole

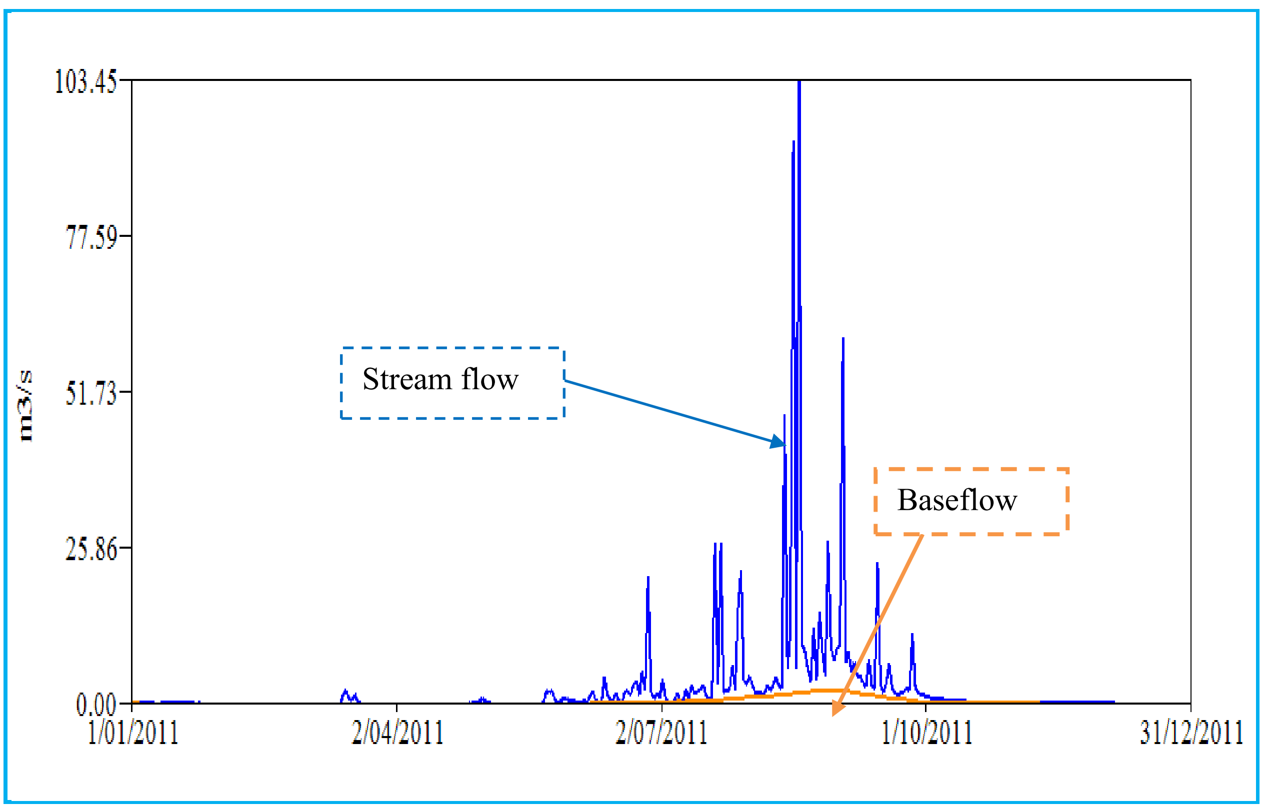


Fig 5.23 Baseflow Separation of Teji River

In the upper awash basin baseflow is naturally influenced by a wide range of factors; basin physiographic characteristics; Distribution of storage in river channels and groundwater aquifers; Evapotranspiration from stream banks and throughout the basin; Geomorphology of the landscape and stream network; Configuration and nature of the aquifers and near-surface soils. Therefore, it is evidenced that from hydrogeological point of view; areas which are upper and lower fractured basaltic aquifer have greater proportion of baseflow in the basin i.e. the Akaki catchment/ upper fractured basaltic aquifer and the Holleta catchment/ lower fractured basaltic aquifer have high baseflow of 23% and 31% respectively, when compared to other catchments both of this aquifers have contributed baseflow of 54% in the upper awash basin. However, the rest of the catchments have lower percentage of baseflow i.e. Teji River, Awash at Hombole, Awash at Melkakunture, Awash Bello and Hombole have 14%, 13%, 1% and18% correspondingly.

Regions such as Hombole, Awash Bello and Teji have limited infiltration, promote considerable runoff, and have at least moderately erodible surface materials. For example, everything else being equal, highly erodible and impermeable rocks tends to have higher drainage density than areas dominated by resistant or permeable rocks. Within a context of consistent bedrock type, topography may exert substantial influence on baseflow processes, particularly in areas of pronounced relief. Spatial variability in ET and precipitation may result from differences in topographic characteristics such as feature and elevation among watersheds. Furthermore, topographic slope and channel network development influence transmission rates of water. A uniformly steep watershed would favor rapid transfer of water out of the watershed, while a uniformly flat watershed may not contain sufficient subsurface storage volume to sustain high baseflow. Furthermore, low slope areas favor runoff and increase the likelihood of surface runoff movement of water next to the stream network itself. High topographic variability reflects the intermediate condition, in which watersheds contain a range of slopes. Impervious surface additions associated with non-forest land use override the evapotranspirative losses. These results also suggest that as development continues in this region, further land use change will be associated with reductions in low flow.

Additionally, farmland and urban land have second-order negative effects on the baseflow dynamics. Baseflow increases whilst forest is replaced by farmland because the evapotranspiration (ET), associated with baseflow decline, is weaker and shorter in duration in the farmland than in the forest. The conversion of forest to urban land increases baseflow owing to the presence of non-contributing impervious surfaces in urban areas, which prevents the urban land from intercepting the baseflow discharge. These results indicate that the baseflow dynamics are closely associated with varying land use types within the upper awash basin.

5.3 Shallow groundwater dynamics

All the porous and fissured rocks below a certain stage of earth surface are saturated with water. The upper surface of this groundwater is called the water table and the depth of the water level is also identified as the static water level, below ground surface as observed from the field measurement during borehole is called the water table (see Appendix-8). The proper utilization of groundwater greatly precedes the detailed examination of static water levels in various degree of this inexhaustible resource. In this activity, quantitative analysis of groundwater resources of upper awash basin under central Ethiopia has been made. Static water level data provides a great deal of information about groundwater dynamics either it is shallow or deep.

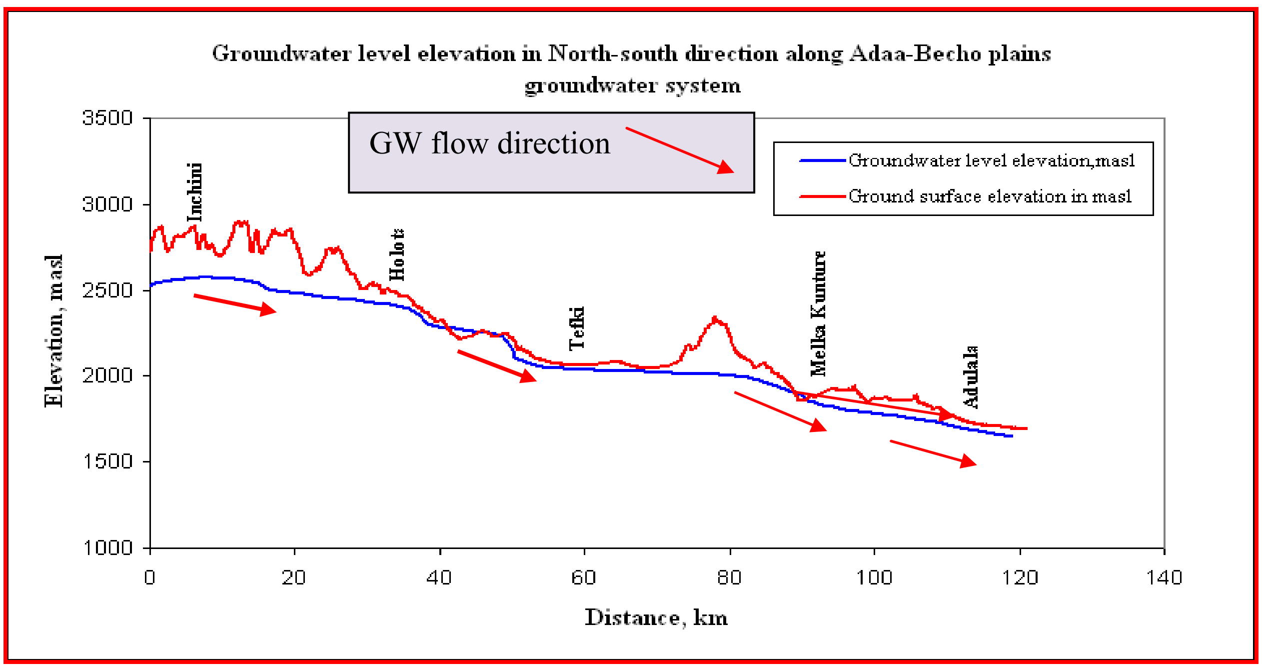


Fig5.24 Simple schematic groundwater level elevation along North-South direction of Ada'a-Becho groundwater system (Modified from WWDSE)

Information about the depth of groundwater table is needed to demonstrate accurately the character of groundwater flow directions and determination of appropriate well-site locations. It is capable to distinguish the high permeable zone from the groundwater contour map of upper awash basin. Therefore, groundwater table contour map categorizes important information to set exact position of new water-wells as the best potential sources of groundwater supply. According to (Andarge Yitbarek, 2008) head observations of water wells having depth greater than 150m are considered deep and less than 150m are shallow. Groundwater head positions establish the potentiality of any place of the detailed investigated area.

The water head position map indicates groundwater flow direction. The water table is higher in areas of heavy rainfall or in places situated near lakes (Koka), crater lakes in Debrezeit and rivers. On the other reference, it is low in mountainous area and on steep slopes. The water table fluctuates from time to time therefore; it is higher in the rainy season and lower in dry season. In regions where the water table or potentiometric surface has a shallow gradient, the groundwater contours spaced well apart. When the gradient is large, the groundwater contours spaced well away from each other and when the gradient is small, the groundwater contours nearer collectively. Groundwater is flow in the general direction that the water table or potentiometric surface is sloping. The contour lines of a water table map or a potentiometric surface map are in fact equipotential lines; therefore the direction of the groundwater flow, being perpendicular to the equipotential lines, can be directly figured out from these maps.

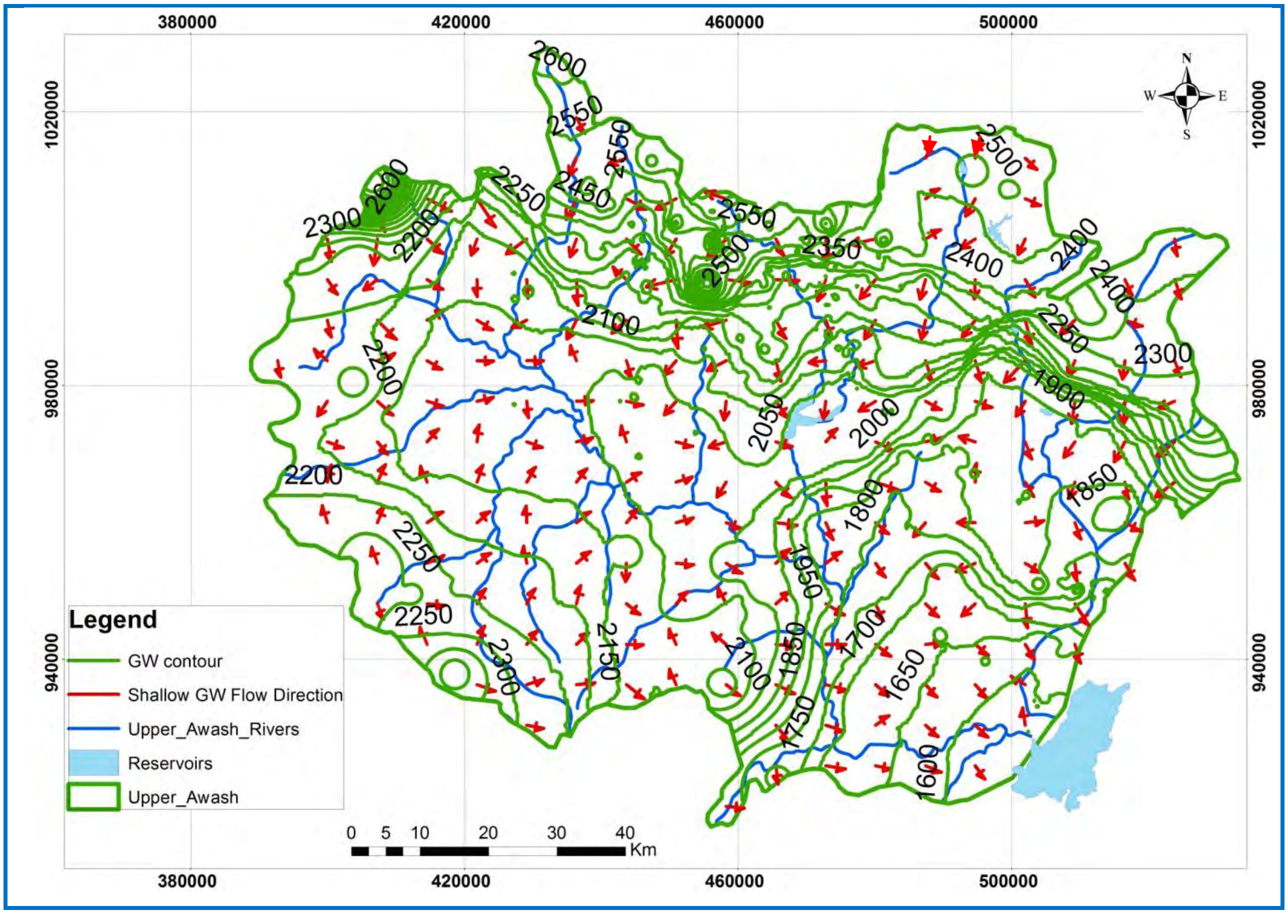


Fig5.25 Shallow groundwater table contour map

According to the shallow aquifer system, in the (figure 5.24) above, several parameters observed like local ground water flows, divergent and convergent zone, local ground water divide.

- **Divergent and convergent zone in shallow groundwater movement**

Groundwater table contour map with the appropriate perpendicular vector map can determine divergent and convergent zones. According to the displayed map above, the groundwater contour map formed circular lines; it was either divergent or convergent zone. Divergent zone is a specific area where the water starts to flow to any other area of different direction and consider as recharging zone, in the map, there are many divergent zones in the north-west and south-east part of the upper awash basin, on the basis of shallow aquifer system, which most probably because of recharging of water from the highlands.

According to the shallow groundwater table contour map areas which converge in discharge zone were located north-eastern part, in Becho plain and southern part of Adaa plain areas i.e. at this convergent zone, water comes from almost all direction of the study area and areas which are divergent zones were specific area where the water starts to flow to any other area of different direction and consider as recharging zone, in the map, there are many divergent zones in the north-west and south-east part of the study area.

As shown in the figure (5.25) above in the near Bishoftu-crater-lake there is divergence of shallow groundwater flow in response to ridges that are locked the lake i.e. the shallow groundwater around the lake flow away from crater lake towards Chelekleka lake.

Plate 5.1 Bishoftu Crater Lake locked by ridges

Convergent zone is specific region somewhere the water flows on the way to specific region that comes from adjoining of any other direction and considers as discharging zone. From the figure (5.24) above, there are three large convergent zones in the upper awash basin which is located north-eastern part, in Becho plain, Akaki well field area and southern part of Adaa plain areas. At this convergent zone, water comes from almost all direction of the study area. The existence of convergent zone possibly depends on several factors among which structure is the main one.

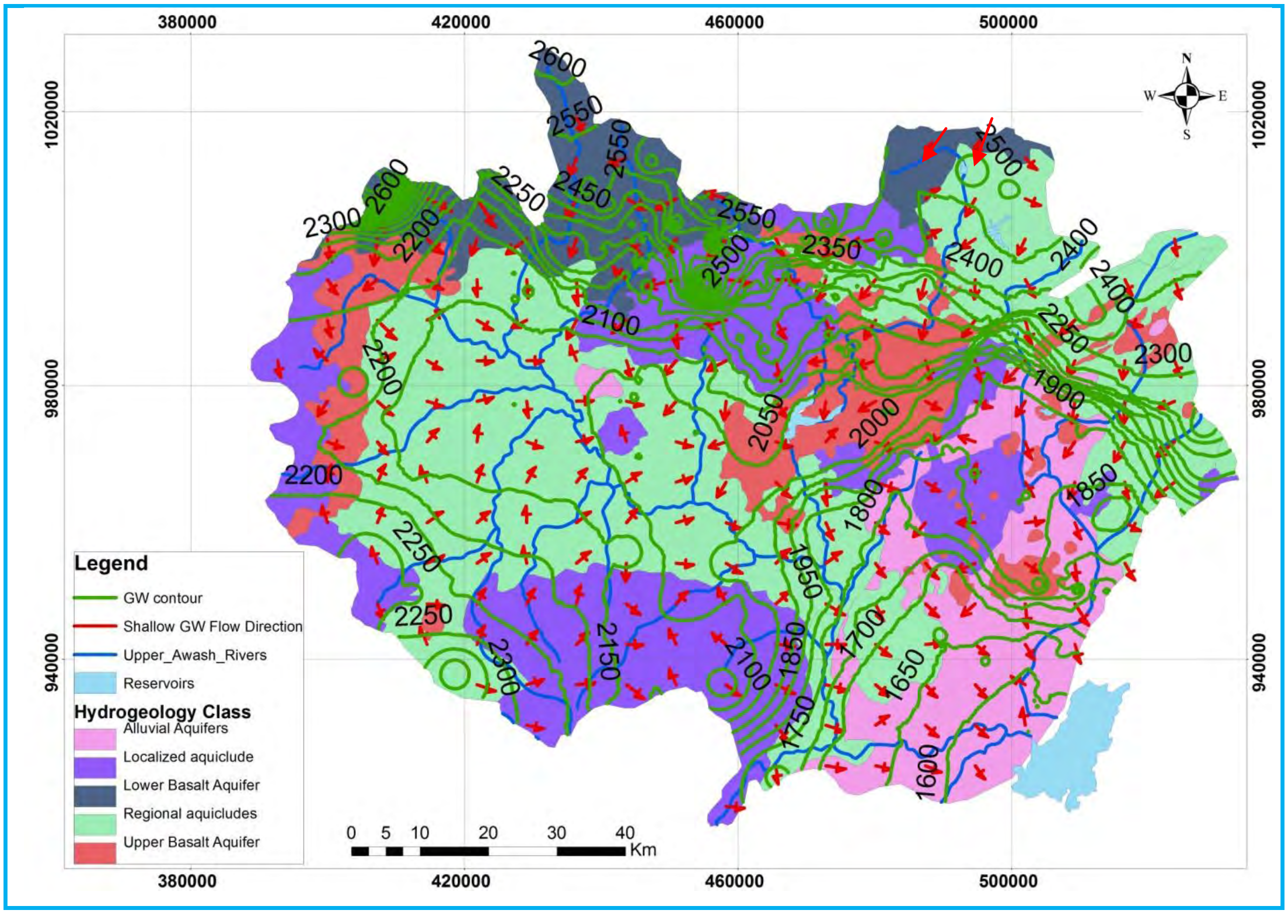


Fig 5.26 Shallow Groundwater table contour map with hydrogeologic classes

The aquifer properties in the upper awash basin are controlled by the litho-stratigraphy of the volcanic rocks and the structures that affect them. For that reason the complex character of the lava flow, the volcanic rocks have highly changeable primary porosity. After they are subjected to weathering these volcanic aquifers can be considered as a double porosity medium due to the fact that both the matrix and the fracture porosity provides to the circulation and storage of groundwater. The alluvial and lacustrine aquifers which composed of coarse sediments are exposed majorly in the southeast around Debrezeit and Modjo areas, and nearby in the northwestern segment of the Becho plain and next to the main perennial river courses allow water to move freely through this formation.

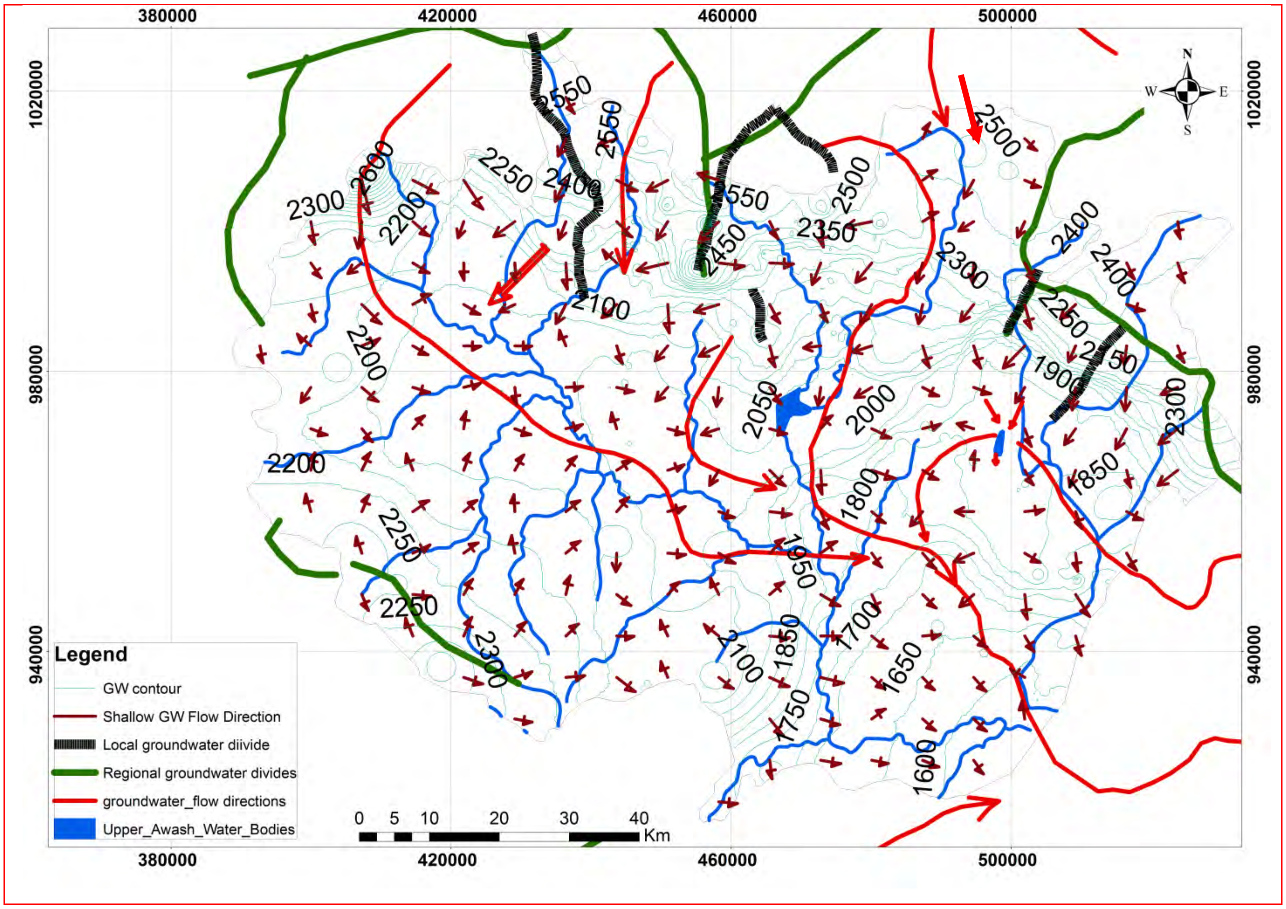


Fig 5.27 Shallow groundwater contour in relation deep groundwater flow

In the fig (5.31) shallow groundwater and deep groundwater in some areas flows the same but in many conditions shallow groundwater follows to direction of rivers and cut perpendicularly the regional groundwater flow line. The volcanic rocks of the upper awash basin have undergone extensive faulting often having a general trend of NE – SW, E-W and at places NW-SE. The majority of the lineaments follow the trend of the rift. The density of faults and lineaments increases to the southeast towards the rift valley. Groundwater flows into different soil and rock arrangements by means of infiltration and percolation throughout interconnected void spaces, along micro cracks between grain boundaries and in large-scale fractures in response to differences in fluid pressure and elevation after the water comes from recharging area. These movements are regulated by well-known Hydrogeologic consideration like lineament, faults, hydraulic conductivity and hydraulic principles of Darcy's Law. First, majority of faults and lineaments are conduits to groundwater flow, in places these open faults allow significant amount of preferential shallow groundwater flow parallel and sub-parallel to the rift axis.

In the rift valley the direction the shallow groundwater was governed by the orientation of local groundwater divide and lineaments. The resulting groundwater table map (Fig 5.26) indicates steep hydraulic gradient in the northern and northeastern part of the basin and gentle in the western and southern part. Although the regional groundwater flow direction (Fig 5.26.) is from north to south following the regional topographic gradient, local barriers, lithology and structures are responsible for the complex flow pattern.

- **Local groundwater divide**

As cited in Freeze and Cherry, (1979) Groundwater divides are imaginary and vertical impermeable boundaries across which there is no flow or the flow is in the opposite direction of these ideal lines. This imaginary line possibly will be locally or regionally continues from one direction to the other direction, in the study area, for shallow aquifer system there are five local ground water divide which exists in the extended form and diverges the flow of shallow groundwater to different directions. The local Groundwater divides which diverges the shallow groundwater flow are found in the Sabeta, Chafedonsa and Dukem areas.

Therefore, groundwater recharge areas in upper awash basin are generally in topographically high places and discharge areas are to be found in topographic lows places like Koka, Hombole, Becho plain and Akaki. In the recharge zones, like Intoto, Sabeta, Wechacha and Furi there is frequently somewhat deep unsaturated zone among the water table and the land surface. On the other hand, the water table is towards either close or at the land surface in discharge zones (Fetter, 1994). For that reason, a water table contour map can frequently be used to place groundwater recharge and discharge zones. The water table vector lines (Figure 5.24, 5.26) tends to diverge from recharge zones and converge in the direction of discharge areas. As a consequence, this convergence does not happen when the discharge zone is large.

5.3.1 Groundwater recharge and discharge areas

Recharge is the series of action by which aquifers are restoring to former condition be with water from the surface. This recharging process takes place in natural manner as component of the hydrologic cycle even though infiltration although rainfall percolates the land surface and like percolation of water into underlying aquifers.

Many of factors influence the rate of recharge in upper awash basin comprising physical feature of the soil, land cover, slope, water content of surface materials, rainfall amount, and also the presence and depth of aquifers and confining layers. Sometimes Surface water bodies can also recharge ground water i.e. this conditions takes place to the greatest extent in arid areas. During heavy rainfall times lakes and dry creek beds may become full up with water, when the water table is low in underlying aquifers, water may leak from the sides of these water bodies and spread through pores into the ground water. Topographically high elevated regions can in most cases take into as recharge regions and topographically low-lying regions can be considered as discharge areas. The direction of horizontal groundwater movement can be inferred from maps of water-level altitude contours. Groundwater flow commonly was from regions of recharge to regions of discharge, in the direction of decreasing water-level altitudes and perpendicular to the water-level altitude contours.

When it is depicted from groundwater table contour map, it shows divergence of flow direction, as a result the upper awash catchment of the Awash River above the Becho plain are assumed to contribute recharge into the upper aquifer of Becho and Koka area Groundwater basins. Direct recharge takes place from the rainfall and recharge areas are generally in topographical high places, while much of this rainfall is lost through evapotranspiration in the Koka, Debrezeit and Mojo area. As it is observed in the (figure 5.32) areas of groundwater discharge is identified from groundwater table contour map. The red circles in figure below are discharge or convergent zone for the upper awash basin.

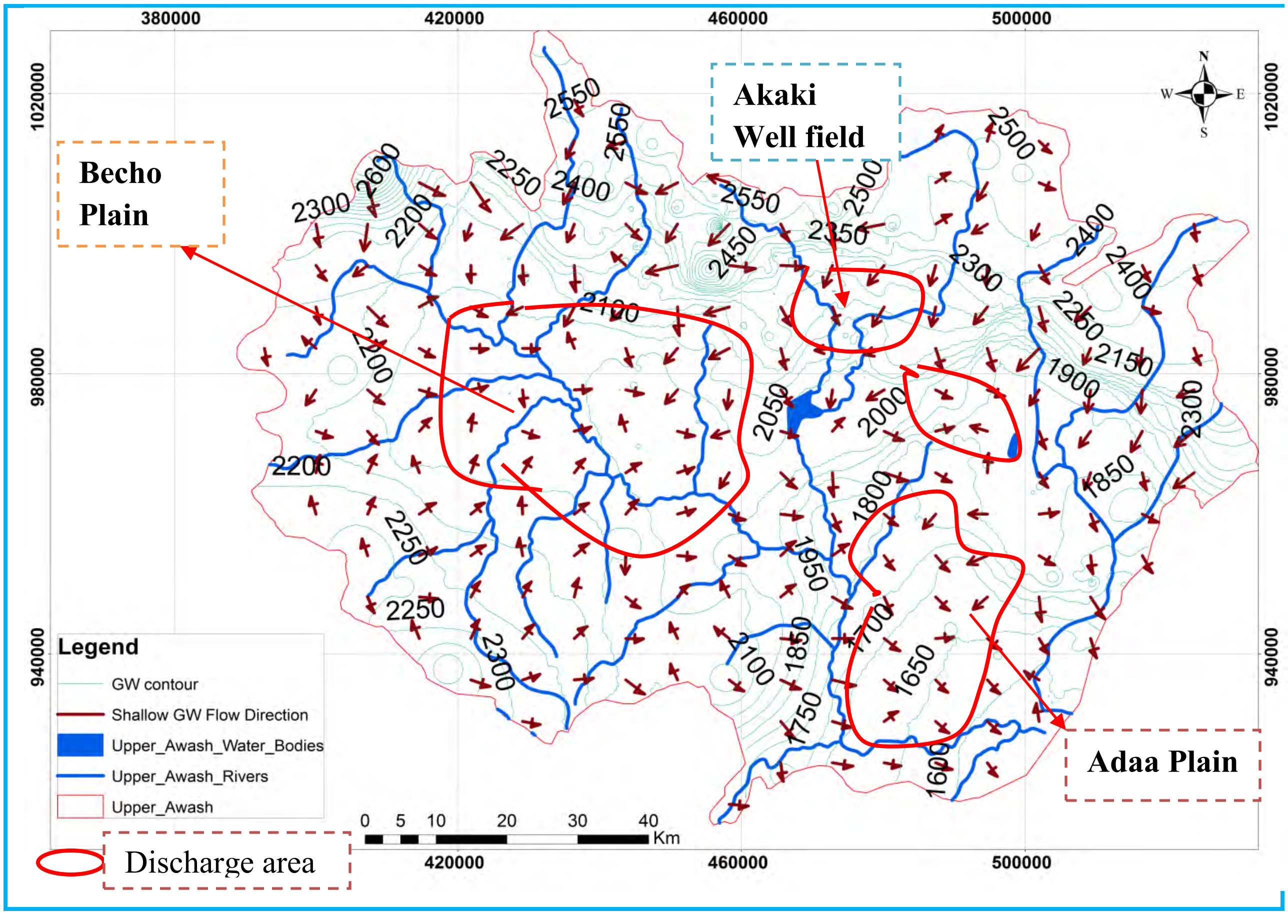


Fig 5.28 Discharge area map from groundwater table contour map

Groundwater discharge can be determined as the removal of water from the saturated zones cross ways the water-table surface, in proximity with the associated flow toward the water-table within the saturated zone (freeze & cherry, 1979). Therefore, discharge areas are to be found in topographic lows. In the recharge zones, there is frequently somewhat deep unsaturated zone among the water table and the land surface. On the other hand, the water table is towards either close or at the land surface in discharge zones (Fetter, 1994). For that reason, a water table contour map can frequently be used to place groundwater recharge and discharge zones.

5.4 Groundwater well inventory

Groundwater is the major source of water supply for rural livestock, domestic, and used as a means of industry in the upper awash catchment. The grounds for which this groundwater well inventory is in order to present officially an inventory and assessment of existing wells in the upper awash basin region that was made duration of January through March, 2017. The techniques used contain physical and electronic records searches and field reconnaissance to physically validate well real place, access, depth, and measurement of depth to water. According to Lapham et al, (1995), this information was assessed to conclude appropriateness of each well for use in a monitor network. During the course the well-records try to find with consciousness, information for each well was arranged in a worksheet. The techniques used include physical and electronic records searches from water related offices and field reconnaissance to physically verify some of the well location, access, depth and measurement of depth to water. Therefore large quantity of the information established at the duration of the field visit is strongly implied on the well and site inventory outline and is self-explanatory. Supplementary information and approach are available for use below on four actions connected to the field inventory visit and the final well selection, description of well position and site features, determination of well elevation, measurement of water levels, and well maintenance.

5.4.1 Description of well location and site features

A description of the well location and site characteristic is provided that at the duration of the location visit. The latitude, longitude and elevation should be recognized for every well. Consequently, well location and the field site features are provided by location maps, and possibly photographs, and by documenting land use and land cover. As a result the best distinctive proof of number is by latitude, longitude and elevation is necessary for every site. Therefore, information on the location map particularly contains roads and water bodies. Photographs of well sites and nearby aspects show the important features and unwanted pollutant sources near the well. Furthermore, record of events of photographs of each well site is accessible for use visual record for well reorganization, well location, and water-level measuring points. The written descriptions of the site and the well complement site and wellhead sketches and make available for use supplementary important information that can be critical to smooth field operations and to personnel safety. For Example like;

- Directions for gaining access to the site, such as if owner notification is required before sampling, the well is locked,
- Difficulties that might be encountered that related to well location, water-level measurement,
- Conditions that might affect the safety of field personnel such as, dangerous domestic or wild animals.

Plate 5.2 Water flowing through coupling in Asgori

Plate 5.3 Opened annular space in Asgori production well

In the plate above (5.2) and (5.3) the space between the cathodic shield well casing and the wall of the well boring, frequently referred to as the "annular space," shall be efficiently preserved to avoid it from being a preferential pathway for the movement of poor-quality water, pollutants, or contaminants. In some cases, secondary reasons of the annular close are to stabilize the borehole wall, guard casing from degradation or corrosion, and guarantee the structural reliability of the casing. In particular the plate (5.2) the water is flow out through coupling this shows that inadequacy of existing groundwater management arrangements for a particular level of resource development (both in terms of technical apparatus and institutional necessities). By working down the levels of development of every groundwater management tool or instrument, an investigative profile is produced which can be compared to the authentic stage of resource development to point out main concern features for vital concentration.

Plate 5.4 Hand pump well and Borehole in Asgori

Plate 5.5 well drilling in Teji which affects nearby shallow wells dry

The cases of well hydraulics considered so far have implicated only one well pumping from an aquifer system. However, in plate (5.4) there is often two wells tapping the similar aquifer in Asgori and located within the radii of influence of the wells, which result in intersecting cones of depression. When the cones of depression of two or more close by pumping wells overlap, the well is said probably to interfere with another well. Well interference enhances drawdown, and thus pumping lift is increased.

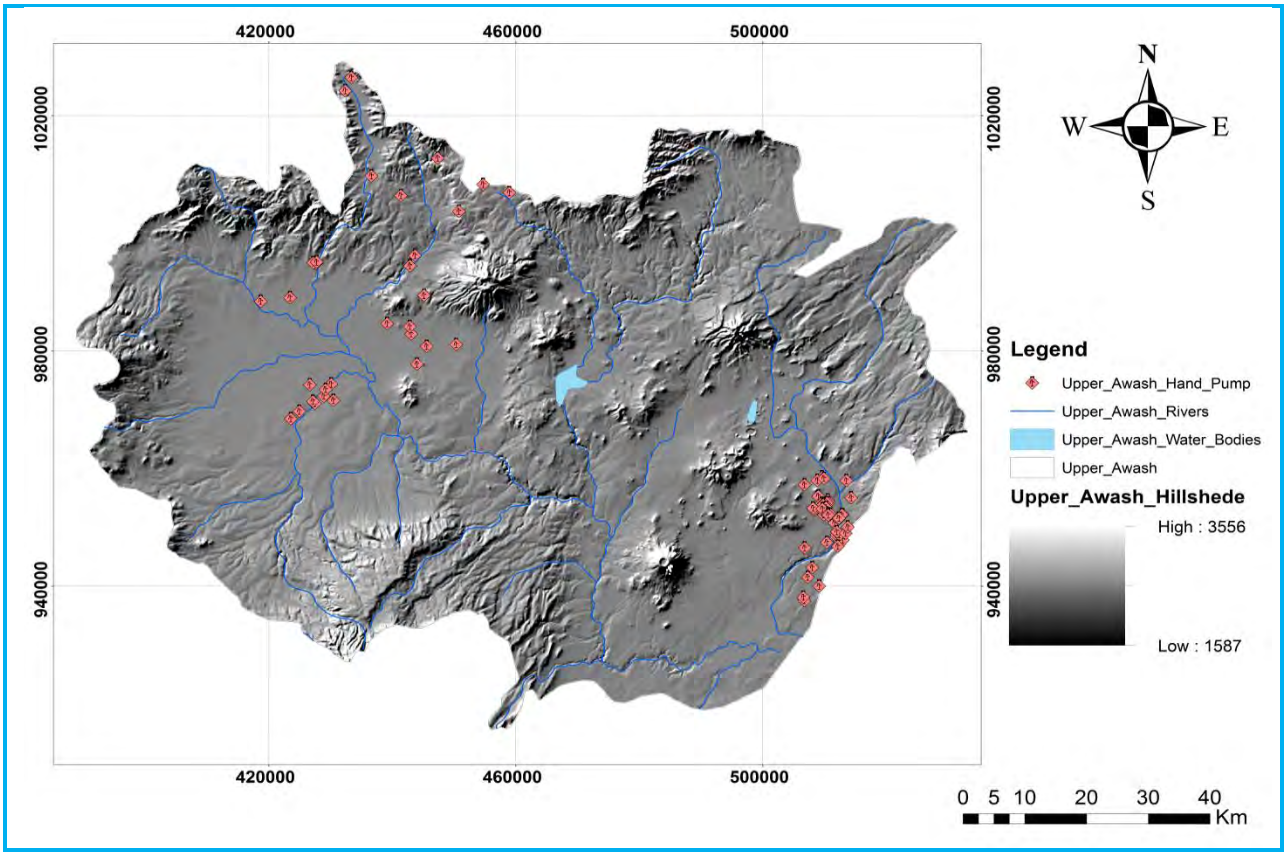


Fig 5.29 Location map of Hand Pump Wells

This Hand pump wells that were located in the (figure 5.28) above were found in the upper awash basin and collected directly from the area during the field crew. They have no observation well in order to measure their static water level.

Plate 5.6 Hand pump wells in Tefki and Holleta area

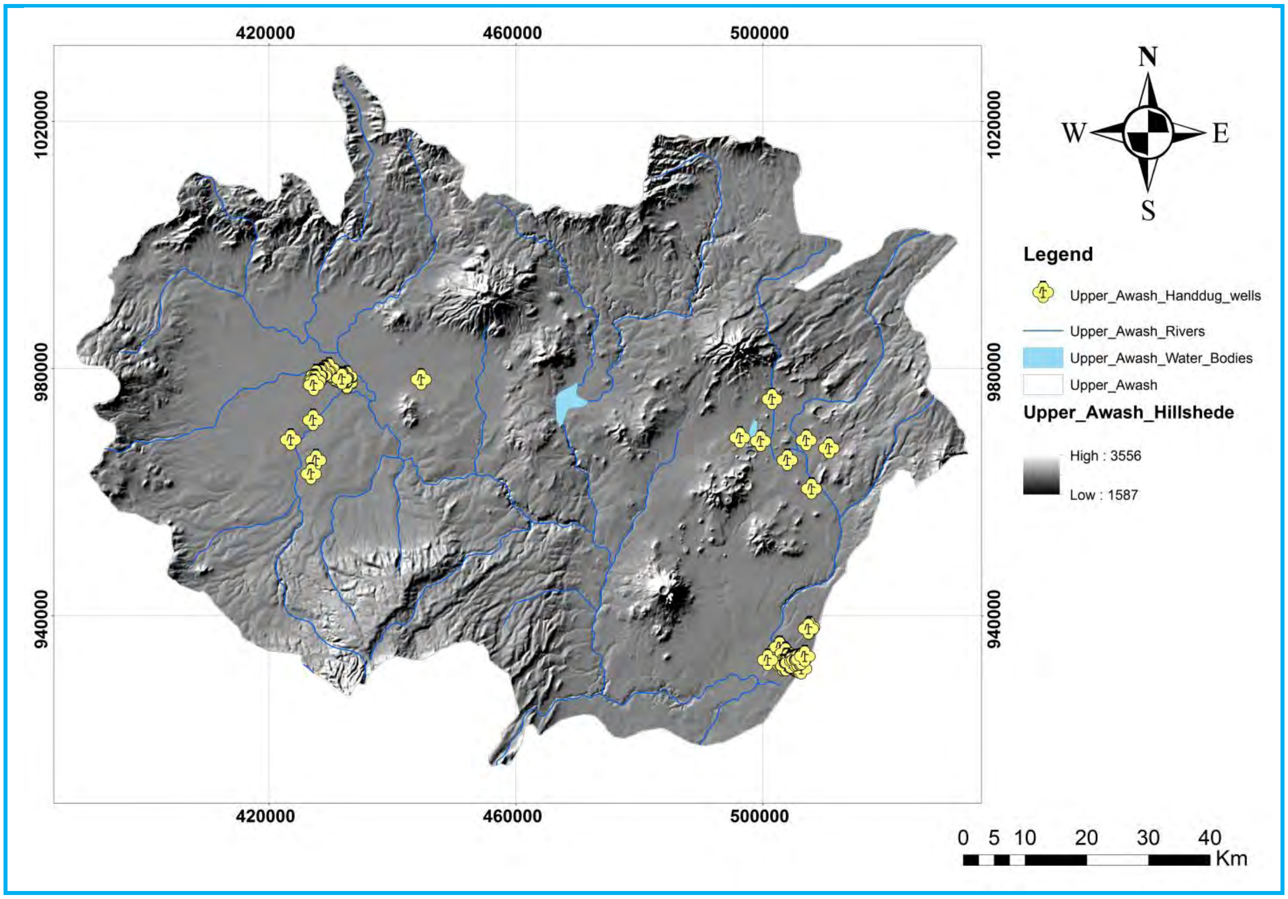


Fig 5.30 Location map of hand dug wells

Both deep and shallow boreholes are drilled in the upper awash basin by Governmental, non Governmental and private Drilling Company. Most of the deeper boreholes are fitted with submersible electrical pumps and the others boreholes are equipped with Indian mark I, II, and Afrideve hand pumps and Windmill pumps. However, in the maps above the wells were accessible for static water level measurement because they were open to irrigation and domestic use. This hand dug shallow wells are found in Adaa, Holleta, Berga and Becho areas this shows that they have depth of maximum 12m.

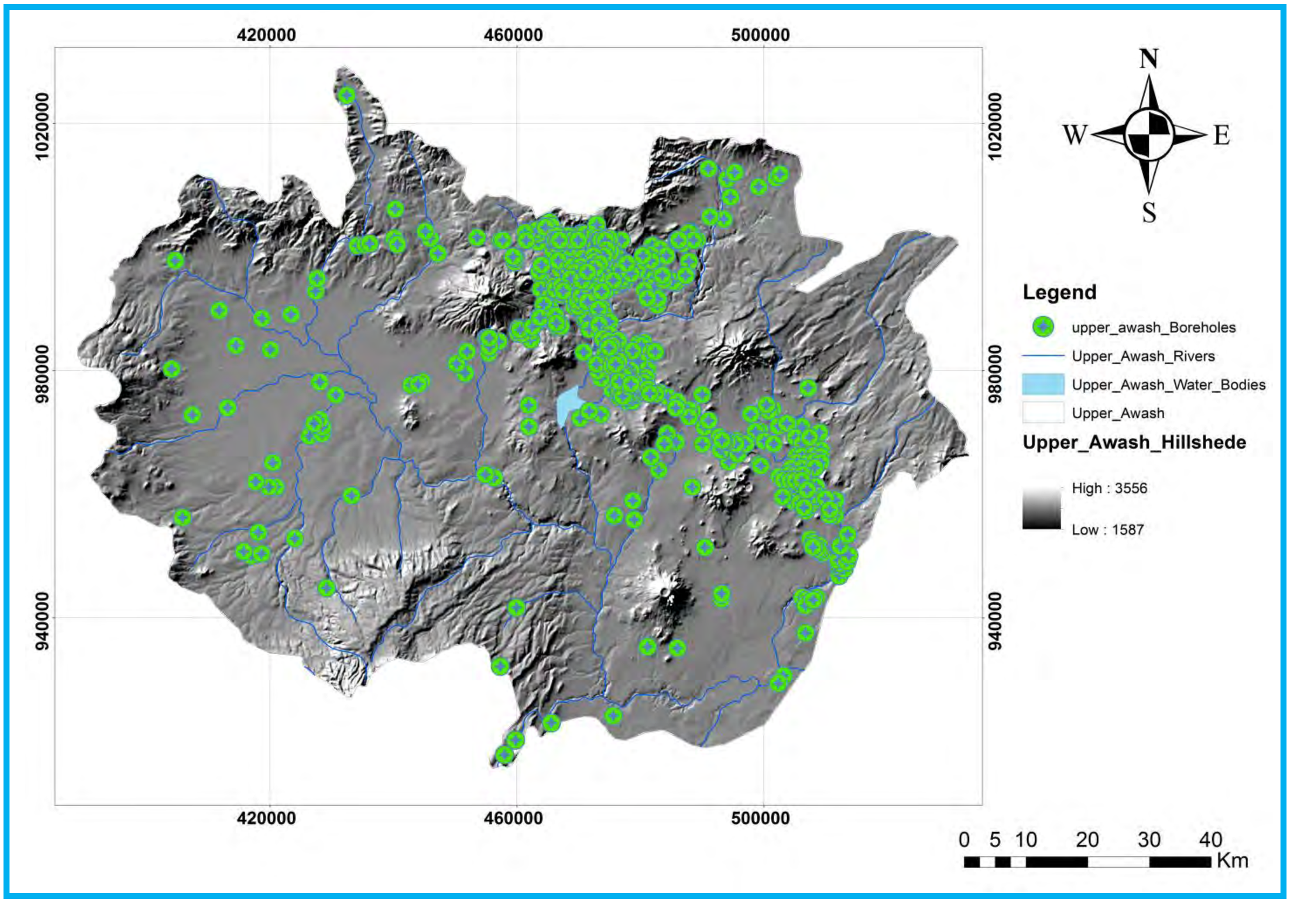


Fig 5.31 Location maps of boreholes

The majority of the boreholes were found in Addis Ababa, Debrezeit area, Becho plain and to small extent in Koka and its vicinity. This is shows that the other sparsely distributed areas shows that poor handling of well compilation data and have no scientific consideration about the groundwater well inventory. In some areas like Becho, Mojo, Koka, Hollota, Bui, Teji, Berga and Sendafa have the well inventory data but the major problem during well data interpretation was this areas have no measured values of GPS and static water level during construction and after construction.

5.4.2 Measurement of static water levels

Measuring water levels is a repeatedly followed category of a well inventory excluding when a well construction cause to be measurement impractical. The water level is mandatory to ascertain the depth of sample collection in connection to the screened or open interval of the well, as a result Water-level measurements also support in well selection and in the analysis of groundwater quality characters.

Water levels are required to help launch hydraulic gradients and, as a outcome of that, directions of groundwater flow, rates of groundwater flow, and locations of groundwater recharge and discharge the amount of water in storage in aquifer, the change in storage over time, and aquifer hydraulic characteristics. For that reason, repeated measurements of water levels over time permit a chronology of water-level fluctuations that can help explanation and analysis of water quality data. For example, seasonal variations in recharge or changes in recharge give rise to by nearby pumping can give rise to changes in hydraulic gradients that can have close similarity to changes in water quality.

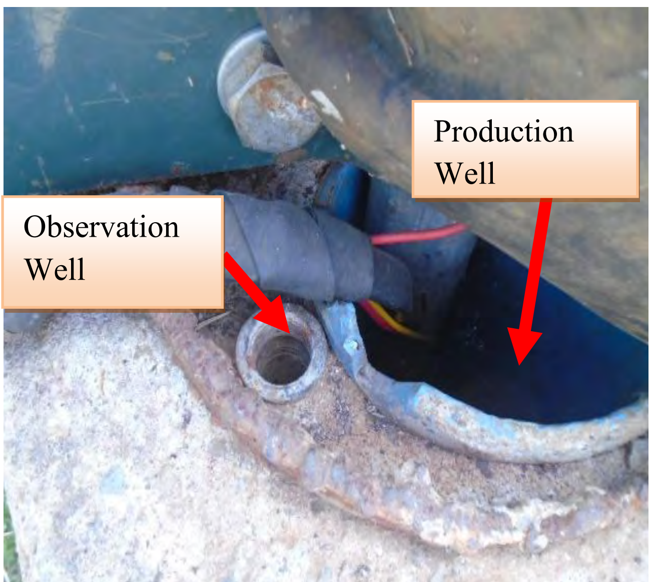


Plate 5.7 Sand filled Observation and Production Well in Holleta Research Center which is 146m deep

Plate 5.8 Well head protection that is not caped in Bui which is 350m deep

The wells in the plate (5.7 and 5.8) were found in Holleta research center and Bui Guraghe Zone, have an observation well near production well but, the main problem was the observation wells are not working properly. The Holleta research center observation well was filled with sands and soils due to improper well head protection. Like Holleta research center well, Bui observation well was not functioning due to a problem happened at drilling time.

Plate 5.9 Cable tool well drilling near Mojo River

Plate 5.10 Hand pump well with no observation well in Becho area

Plate 5.11 well drilled but have no Observation well near production well in Dukem area

Plate 5.12 Dip meter which measures up to depth of 300m

In the plate (5.11), the caption shows that wells drilled in Dukem area that have no observation well with production well, i.e. it was difficult to monitor the well in quality study or water level measurement.

Plate 5.13 Hand dug well extraction for irrigation in Koka area (shallow Groundwater use trends)

Plate 5.14 Mojo River downstream side of tannery factory pollution source for Groundwater

- ✓ There are plenty of moveable capacity pumps are abstracting fresh water from the rivers and shallow groundwater by investors and private commercial farms throughout the year.

- ✓ A groundwater pollutant is at all a substance that, when it gets to an aquifer, makes the water impure or otherwise unsuitable for a particular purpose. In plate (5.14) sometimes the substance is a manufactured chemical, but just as often it might be groundwater contamination.

Contamination moreover can happen from naturally occurring mineral and metallic deposit in rock, chemicals thrown from factory, industrial plant and soil. For many years, people thought that the soil and sediment layers deposited on top of an aquifer acted as a natural filter that set aside many unnatural pollutants from the surface from percolating down to groundwater. Water pollution is a contamination of water by dirt, toxic chemicals, metals, oils or extra substances that thrown in to rivers. This also has effect on surface waters as rivers, lakes, reservoirs and oceans, as well as the water beneath the earth's surface and groundwater. Water pollution is able to damage many species of plants and animals.

Plate 5.15 Dried Hand dug well in dry season around Holleta area

Plate 5.5.16 Mojo River upstream side of tannery factory

In the plate (5.15) above many of hand dug wells that were shallow in Holleta and its vicinity were drier during the dry season i.e. it shows that the areas which were shallow groundwater was dependent on rainfall and wells full up to the surface at the time of rainy season. In the figure below (5.31) the shallow well distribution map indicates wells are highly populated in Addis Ababa area, Adaa plain and Becho plain areas. As it is evidenced from the existing and field data the area contains 1546 wells and 74 springs. Out of these wells 473 collected in field well inventory and 1073 wells and 74 springs collected from water related offices/sectors. Therefore, all wells that were drilled in this catchment extracting groundwater resource from upper awash catchment, but the majority of data collected from water related offices did not have any completion data that tells each and every detail about the boreholes. The wells used for static water level measurement were hand dug wells, Hand pump and boreholes that have observation wells and less than 150m deeper.

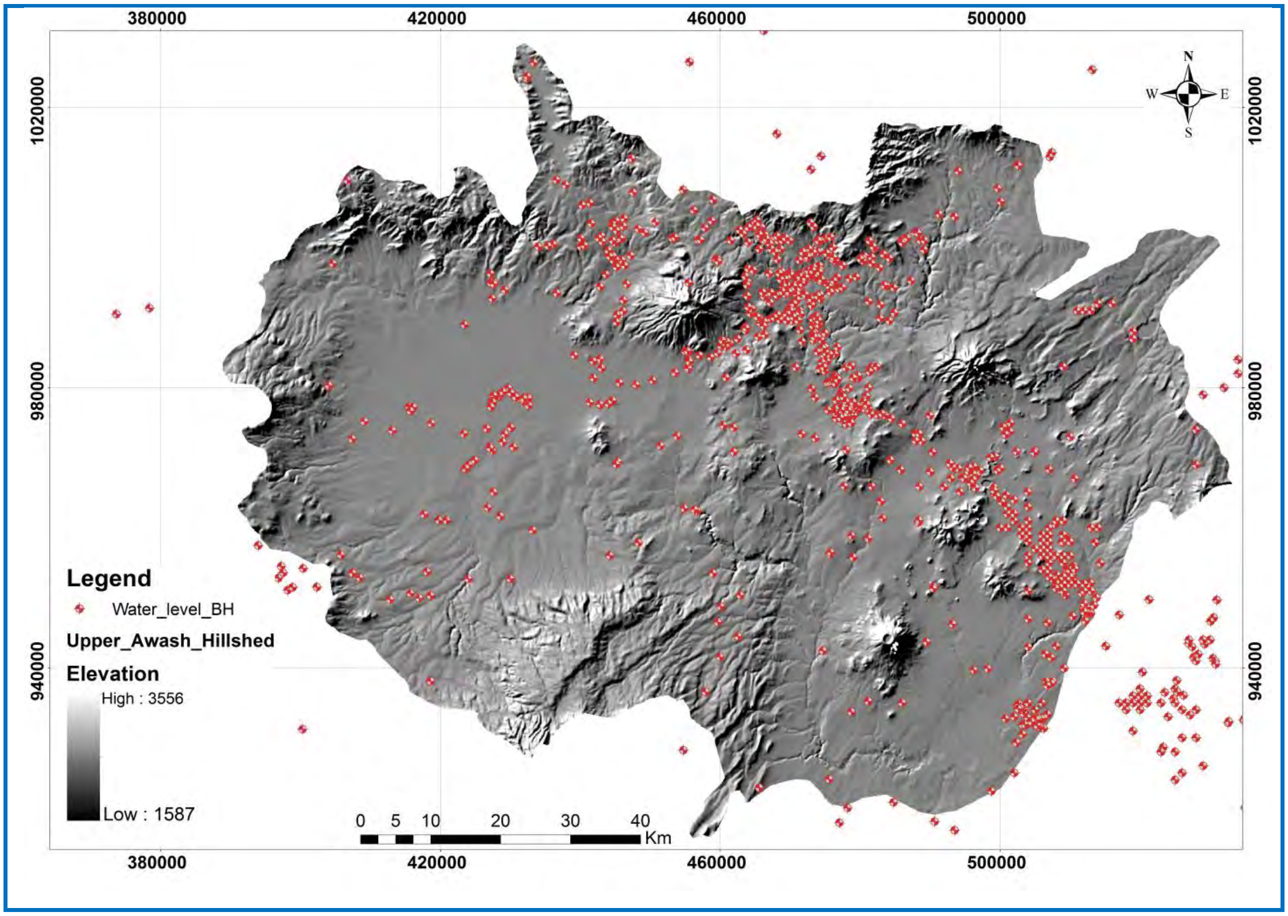
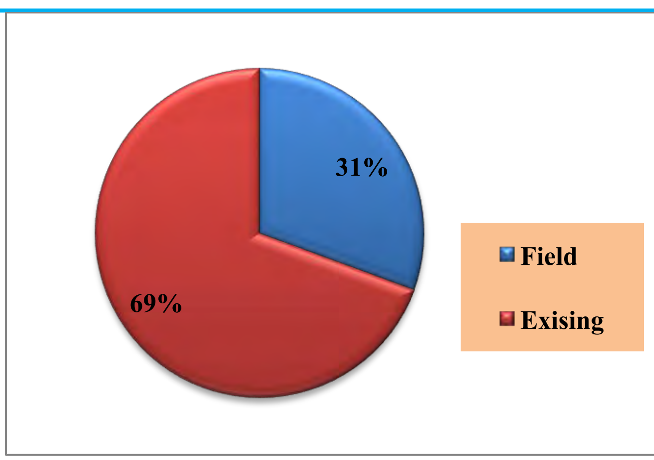


Fig 5.32 Map of wells that used for groundwater table contour map

As it is shown in the map of well distribution in the upper awash catchment the wells collected through filed excursion and water related offices. Over 1546 wells were drilled in the upper awash basin, but the major problem is there is no standard of groundwater data collection protocols in zonal and district.



In the figure (5.37) the pie chart shows that 31% of data is collected from field excursion and 69% of data is collected from water sectors like Woreda, Zone and water construction enterprises.

(See Appendix-8, 9 and 10)

Fig 5.33 Extent of data originality

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The Awash River rises on the high plateau near Ginchi town west of Addis Ababa in Ethiopia and flows along the rift valley into the Afar triangle. The upper awash basin is located in central Ethiopia at the western border of the Main Ethiopian Rift (MER). The main objective of this study was to evaluate the groundwater recharge and recognize the dynamics of shallow groundwater for sustainable management and utilization of the groundwater resource.

The principal rock formations in the upper awash basin are; Lacustrine cover and alluvial deposits, Ignimbrite, Quaternary Trachyte, Quaternary Rhyolite, Tulu Rie Basalt and Tarmaber basalts. These rock units are affected by different faults and geodynamic forces. There is also large number of regional faults in the basin. The lacustrine sediments are compact and fairly welded tuff, ashes, silts, and clay. The alluvial deposits are composed of sandy clay and silty clay with gravel at the lower bed with brown, red or black color and showing slight difference in thickness from place to place. The basalts range from fresh, dense and massive type to highly fractured, jointed or vesicular type. Ignimbrite ranges from massive, dense, and fresh to highly weathered and fractured. Quaternary Trachyte is grayish pink in color, course grained poorly fractured. Quaternary Rhyolite light brownish grey to white soft material and poorly fractured and weathered. The main aquifer categories in the in upper awash basin are Quaternary alluvial and lacustrine deposits; Upper Basaltic and Lower Basaltic. There are also Localized and regional aquicludes. As part of the determined attempt in estimating recharge, identifying the shallow groundwater dynamics, groundwater well inventory and the recharge distribution has been assessed.

The annual mean annual precipitation was analyzed by arithmetic mean and isohytal method; and the average annual rainfall over upper awash basin was calculated to be 1020.98mm and 1015.77mm. Before evaluation of recharge in the upper awash basin, values for AET, PET and SRO were quantified by using distinct approaches and empirical formulae.Evaluation of potential evapotranspiration and actual evapotranspiration has been carried out by a means of Thornthwaite and Penman techniques. Therefore, according to these formulas the potential evapotranspiration calculated by Thornwaite and Penman was 902.33mm/yr and 1012mm/yr. additionally the average actual evapotranspiration calculated for the entire basin from the soil water balance approach is 640.7mm/yr. These results were integrated and analyzed using different approaches and empirical formulae to arrive at annual groundwater recharge amounts to the aquifer systems of upper awash basin.

Based on these evidences groundwater recharge was evaluated using the water balance and baseflow separation techniques. Therefore, the water balance method give recharge of the upper awash basin was 238.02mm/yr, which is 23.4% of annual precipitation was recharged to groundwater. The groundwater recharge evaluated in the upper awash basin takes place in three months (June to August). In contrast in the other month's groundwater bring about to AET and total runoff, and also this circumstances is caused to be visible by negative value of recharge in the study area. To achieve the stated goals, an effort has been made to collect original data sets and apply multi-disciplinary approaches in order to increase the reliability of the study representing the most likely situations. The amount and distribution in time of river flow rely on precipitation, evapotranspiration, soil and geological characteristics of the basin.

Detailed assessment of baseflow separation was carried out from long terms daily time-series record of stream flow of seven rivers that drains from separate physiographic areas of upper awash basin to perceive the hydrological response of the basin comprising baseflow (recharge) dynamics. The annual groundwater recharge of the Mojo River, Teji River, Holleta River, Berga River, Akaki River and Awash River at Hombole and Awash River at Bello were found to be 98.7mm, 65.8mm, 251.75mm, 148.7mm, 138.7mm, 111.8mm and 98.07mm respectively. The average aerial annual recharge of the upper awash basin is estimated to be 130.5mm/yr, which accounts about 12.8% of the mean annual aerial precipitation of the upper awash basin. As it evidenced from the two methods, the results doesn't equivalent; therefore, the difference might be due to the various assumptions employed in both methods. In the case of baseflow, the recharge is low compared to water balance method due to; some of the rivers are losing in the upstream to deep aquifer, water use trends for agriculture, no constant known baseflow filter parameter for each geologic formation and hydrogeological formation variation in upstream direction. However, the water balance uses meteorological measurements such as precipitation, temperature, relative humidity and sunshine hour.

The evidence obtained from one year river discharge of selected rivers shows that there is significant variation of baseflow index dynamics and baseflow in the upper awash basin. The variation of baseflow index (contribution of groundwater to rivers) seasonally is due to precipitation, evapotranspiration and nature of the aquifer lithology which is directly related to the dynamics of the water storage in the basin, controlled by subsurface storage and transmissivity. Therefore, areas which have highest drainage density and fractured basaltic have highest of all other places i.e. Holleta and Akaki catchment have fractured basaltic aquifer which showed significant increase in baseflow index compared to other areas in the basin. The evidence from baseflow in Akaki catchment/ upper basaltic aquifer and the Holleta catchment/ lower basaltic aquifer shows that these two areas have high baseflow of 23% and 31% respectively, when compared to other catchments. Both of these aquifers have contributed baseflow of 54% in the upper awash basin. However, the rest of the catchments have lower percentage of baseflow i.e. Teji River, Awash at Hombole, Awash at Melkakunture, Awash Bello and Hombole have 14%, 13%, 1% and 18% correspondingly.

According to (Andarge Yitbarek, 2008), the aquifers in the study area have two systems, the shallow and the deep system. Based on this evidence the shallow aquifer in upper awash basin formed near to the surface up to 150m depth and the deeper aquifer runs from nearly 150m to 452m; as it is confirmed from lithological log and borehole history data of upper awash basin. The shallow groundwater contour map shows that the groundwater flow system in the aquifers varies a little in the shallow. Measuring Static water level data provided a great deal of information about shallow groundwater dynamics in the study area. The shallow groundwater table contour map showed that groundwater dynamics of flow converges towards discharge areas such as Adaa and Becho plain and diverges in many places that are local and regional groundwater divides. Therefore, based on the shallow groundwater table contour map and groundwater flow lines, groundwater generally flows from high elevated areas to low lying direction. In areas where the water table or potentiometric surface has a shallow gradient, the groundwater contours were spaced well apart. The gradient was large in discharge areas, therefore, groundwater contours were spaced well away from each other and when the gradient is small in recharge areas, the groundwater contours were nearer collectively. The shallow groundwater was affected by local flow systems observed in the locality of elevated hills, central parts and margins of the catchment.

Groundwater well inventory methods used in this study includes; physical and electronic records searches and field reconnaissance to physically justify well actual place, access, depth, measurement of static water level and measurement of depth to water. During Groundwater well inventory time, 473 wells inventoried physically and 320 wells were accessible for measuring static water levels in the field however 153 wells were not accessible for static water level measurement due to the absence of observation wells during construction or a well construction caused the measurement impossible or not functioning after the well drilling due technical problem. Secondary data collection is being part of well inventory, 1073 wells are obtained from different water sectors found in the upper awash basin. The scheme types which found in the study area are boreholes, hand dug wells, and hand pump wells are mapped in their location in order to show spatial distribution of wells.

6.2 Recommendations

Accurate evaluation of the groundwater recharge and identifying the shallow groundwater dynamics is essential for sustainable planning of the groundwater resource. The accuracy of the groundwater evaluation and shallow groundwater dynamics in the upper awash basin could become better through further research. On the other hand, the results acquired in this work will need to be complemented by further detailed investigations at a local scale to allow a proper water management.

The following significant points, if dealt, will support in alleviating the difficult condition that happen in future groundwater investigation.

- There are many river gages in the upper awash basin, discharge records of most of the stations are unreliable and data is frequently missing. A few sub-basins of interest for studying water resources on a small scale should be selected and monitored continuously to provide high-quality hydrological data such as discharge for large-scale hydrological studies that support decision making on water resources in the catchment.
- Groundwater monitoring has been given a very little consideration in the country. However, it is a very fundamental step towards evaluating and managing shallow groundwater resources and deep groundwater resources. That is why it is essential to do more work on the groundwater monitoring. Therefore, more monitoring wells will need to be set up to provide more detail dynamic feature from special and temporal scale in detail.

- In spite of the fact, there are numerous boreholes constructed by different bodies either it is governmental, non-governmental organizations, individuals, firms, etc. Central groundwater database, either in a national and/or regional level is not established in the country to classify the records generated throughout the construction of the wells. Data have to be collected in a non standardized and non systematic method, most of the time not reliable to use for research and/or scientific intention.
- Observation pipes should be installed in the existing and newly constructed boreholes especially for the wells that could be significant for scientific purpose.

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Appendices

Appendix-1 Potential Evapotranspiration of Upper Awash Basin calculated by Penman method

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
T	17.2	17.5	18.0	18.1	18.0	17.8	17.4	17.6	17.5	16.8	16.4	16.5
K	290.4	290.7	291.2	291.2	291.1	291.0	290.6	290.7	290.6	289.9	289.5	289.6
n	8.6	8.4	7.6	6.5	7	5.2	3.2	3.5	5.1	8.1	9.2	8.8
N	11.6	11.8	12	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11.6	11.5
n/N	0.74	0.71	0.63	0.53	0.56	0.41	0.25	0.28	0.42	0.69	0.79	0.77
H(100)	57.90	56.35	55.55	59.20	58.80	66.65	76.20	77.65	72.40	58.30	56.70	57.45
U1(m/s)	1.5	1.7	1.7	1.7	1.8	1.6	1.4	1.3	1.3	1.5	1.5	1.6
U2(mil/da	3.4	3.7	3.8	3.8	4.0	3.5	3.0	2.8	2.8	3.2	3.4	3.5
Ea (mmh	14.7657	15.0502	15.5332	15.5603	15.4559	15.2949	14.9427	15.081	14.9683	14.3449	13.9595	14.059
Ed(mmhg	8.55	8.48	8.63	9.21	9.09	10.19	11.39	11.71	10.84	8.36	7.92	8.08
Ea-Ed	6.22	6.57	6.90	6.35	6.37	5.10	3.56	3.37	4.13	5.98	6.04	5.98
Δ/r	1.91	1.94	1.99	2	1.99	1.97	1.93	1.95	1.94	1.87	1.83	1.84
Ra(mm/d	12.8	13.9	14.8	15.2	15	14.8	14.9	15	14.8	14.2	13.1	12.5
Eat	2.25	2.38	2.51	2.31	2.32	1.85	1.28	1.21	1.49	2.16	2.19	2.17
F(ed)	0.25	0.25	0.25	0.24	0.24	0.23	0.22	0.21	0.22	0.25	0.26	0.26
F(b)	0.79	0.76	0.70	0.61	0.63	0.51	0.38	0.40	0.52	0.74	0.83	0.81
Ri(1-r)	5.95	6.27	6.13	5.56	5.68	4.59	3.55	3.77	4.68	6.24	6.40	5.95
Ro	2.73	2.67	2.44	2.07	2.16	1.64	1.15	1.20	1.61	2.58	2.94	2.84
Fa(n/N)	0.62	0.60	0.55	0.49	0.50	0.41	0.32	0.34	0.42	0.59	0.65	0.63
∂Ta4	13.87	13.92	14.02	14.03	14.00	13.97	13.90	13.93	13.91	13.78	13.70	13.72
Ht	3.22	3.60	3.70	3.49	3.52	2.95	2.40	2.57	3.06	3.66	3.46	3.11
PET(mm/	2.89	3.19	3.30	3.10	3.12	2.58	2.02	2.11	2.53	3.14	3.01	2.78
PET(mm/	89.45	89.29	102.33	89.78	96.65	77.39	58.52	65.35	75.82	90.94	90.39	86.13

Appendix-2 Potential Evapotrnaspiration calculated by Thornwaite method

	PET USING THORNWAITH METHOD											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Tm	18.3	19.2	20.2	20.4	20.5	19.9	19.9	18.9	19.0	18.4	17.8	17.5
N(posbl)	11.6	11.8	12	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11.6	11.5
Nm	0.97	0.98	1.00	1.03	1.05	1.06	1.05	1.03	1.01	0.98	0.97	0.96
i(m)	7.00	7.54	8.10	8.23	8.28	7.94	7.96	7.32	7.40	7.07	6.69	6.54
I	90.06											
a	1.98											
Em	68.35	74.81	81.67	83.23	83.90	79.69	79.91	72.21	73.12	69.24	64.79	62.94
PET	66.07	73.56	81.67	85.31	88.09	84.34	83.91	74.61	73.73	68.08	62.63	60.32

Appendix-3 Actual Evapotranspiration using Soil water balance method

Soilmiost Water Balance Thornwaithe method For deep rooted,Clay Soil, W=200

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
P	16.5	31.0	58.1	71.2	66.3	120.6	251.3	261.2	124.0	26.5	7.1	6.4	
PET	89.4	89.3	102.3	89.8	96.6	77.4	58.5	65.4	75.8	90.9	90.4	86.1	
P-PET	-72.9	-58.3	-44.2	-18.6	-30.3	43.2	192.8	195.8	48.2	-64.4	-83.3	-79.7	
APWL	-300.4	-58.3	-44.2	-18.6	-30.3	0.0	0.0	0.0	0.0	-64.4	-147.7	-227.5	
SM	44.5	149.4	160.3	182.3	171.8	200.0	200.0	200.0	200.0	144.9	95.6	64.1	
CSM	-19.6	104.9	10.9	21.9	-10.4	28.2	0.0	0.0	0.0	-55.1	-49.4	-31.4	
AET	36.1	-73.9	47.2	49.3	76.7	95.1	69.2	76.4	88.7	81.6	56.5	37.8	**640.7**
SMD	53.3	163.2	55.1	40.5	19.9	-17.7	-10.7	-11.0	-12.9	9.3	33.9	48.3	**371.4**
SMS	0.0	0.0	0.0	0.0	0.0	0.0	204.1	198.4	35.4	0.0	0.0	0.0	**437.9**
TAW	15.1	7.6	3.8	1.9	1.0	5.0	209.9	292.7	241.5	120.8	60.4	30.2	
RO	7.6	3.8	1.9	1.0	0.5	2.5	105.0	146.4	120.8	60.4	30.2	15.1	
Detention	7.6	3.8	1.9	1.0	0.5	2.5	105.0	146.4	120.8	60.4	30.2	15.1	

Appendix-4 Groundwater well inventory form

1. Groundwater Well- and Site-Inventory form

A. Latitude .... Longitude............ Elevation.............

B. Water Level: Can water level be measured? YES.... NO.... Why not?

C. Is the Site accessible? YES...........NO...........Remarks..........................

D. Sources of data...

2. Availability of Additional Information

A. Water-level records?

YES..

NO........... ....

Remarks..

Appendix-5 Metrological stations (Mean monthly Temperature data)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Addis Ababa	15.53	16.8	17.9	18.1	18.2	17.1	16.1	16	16.2	15.7	14.8	14.6	16.42
Debrezeit	18.2	19.5	20.6	21	21	20.2	19.1	18.9	19	18.3	17.7	17.3	19.23
Koka	21.7	22.6	23.7	24.1	24.4	24.1	22.8	22.7	23	22.1	21.6	21	22.82
Mojo	19.3	20.7	22.1	22.4	22.7	21.8	20.1	19.8	20.2	20	19.1	18.4	20.55
Tulubolo	17.4	17.4	17.4	17.1	17	17.2	17.4	17.6	17.5	18.2	17.5	17.4	17.43
Asigori	17.6	18.3	19.3	19.6	19.5	19	18.1	18.1	18	16.2	15.9	16.2	17.98
Average	18.29	19.22	20.17	20.38	20.47	19.9	18.93	18.85	18.98	18.42	17.767	17.48	19.07

Appendix -6 Metrological stations (Rainfall data)

Statio	Elevation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
AA.Obser	2405	15.5	38.7	66.8	89.4	83.0	130.7	259.5	276.5	170.9	36.5	7.9	9.5	1185.0
Akaki	2090	14.1	30.4	58.5	86.1	68.5	115.2	254.5	258.5	118.8	26.9	3.8	3.4	1038.6
Chafedons	1600	10.1	22.4	44.6	41.0	20.7	90.0	206.3	235.9	101.7	16.0	3.9	4.8	797.4
D/Zeit	1850	12.4	21.4	53.5	54.7	59.5	102.3	213.4	211.2	95.8	26.1	4.1	3.1	857.5
Intoto	2920	13.3	47.1	68.7	103.2	79.2	131.2	290.8	342.8	166.5	30.8	8.6	6.5	1288.6
Ginchi	2290	26.0	47.2	70.9	87.8	89.7	138.3	239.5	230.9	149.2	40.5	13.4	11.2	1144.7
Holleta	2380	27.1	46.2	62.7	84.5	66.6	110.6	243.7	263.2	129.6	14.9	6.0	9.4	1064.5
Mojo	1870	13.5	25.4	61.0	49.2	52.1	89.9	246.2	221.0	104.6	32.5	7.1	1.9	904.5
Sebeta	2569	16.2	60.9	80.9	104.9	102.1	185.3	327.6	361.2	140.9	39.9	8.7	6.5	1435.0
Sendafa	2560	20.4	28.6	56.7	78.8	55.6	111.9	314.5	326.2	121.8	22.2	6.1	7.7	1150.6
Tulubolo	2100	17.6	17.5	54.4	63.3	72.2	202.5	291.5	282.5	105.3	22.9	7.5	7.3	1144.6
Koka	1598	14.5704	23.1148	47.1926	51.7259	65.3963	81.5852	238.011	268.904	122.615	27.6259	9.76296	8.51481	959.0
Teji	2091	13.0	24.2	52.5	65.0	83.1	143.3	217.9	217.4	100.8	20.7	6.9	3.9	948.6

Appendix-7 Mean monthly Surface Runoff main rivers (m^3/s) in Upper Awash Basin

Months	Akaki	A@Bello	Berga	Holleta	Mojo	A@Ombole	Teji
January	0.25	0.10	0.03	0.03	0.09	0.93	0.034
February	0.41	0.19	0.06	0.05	0.22	1.18	0.06
March	0.57	0.30	0.08	0.07	1.63	2.63	0.140
April	1.22	0.81	0.167	0.11	1.86	5.96	0.30
May	1.18	0.79	0.19	0.07	4.02	5.72	0.38
June	2.50	2.58	0.74	0.26	8.80	11.12	1.51
July	16.83	5.86	5.59	2.12	37.85	47.34	7.72
August	46.10	3.34	8.50	4.47	57.14	66.54	12.00
September	16.64	4.49	3.98	2.81	25.08	43.49	3.94
October	0.923	1.68	0.39	0.53	2.78	3.88	0.189
November	0.17	0.25	0.07	0.03	0.072	1.37	0.038
December	0.18	0.06	0.05	0.023	0.04	0.49	0.015

Appendix- 8 Deep Boreholes i.e. above 150m

Well Name	utmE	utmN	Elv. (m)	Depth (m)	Well Name	utmE	utmN	Elv. (m)	Depth (m)
Ziquala-Abuloya	478772	958888	1911	220	Denkaka	506490	957774	1861	366
Ziquala-Abusera	475705	956271	1906	220	Denkaka	506490	957774	1861	366
Hirpo Qamo	454568	880156	1824	179	Denkaka	506490	957774	1861	366
Rosa Kontola	457077	888976	1793	200	A/Jegola	511524	956435	1824	424
Qiltu Ombole	475571	924071	1752	154	A/Jegola	511524	956435	1824	424
Red Fox Flowers	503210	930527	1610	100	A/Jegola	511524	956435	1824	424
Koka	506728	937459	1669	129.66	Liben	493136	942944	1850	361
Dukem MBI	483567	976037	2133	172.7	Liben	493136	942944	1850	361
Modj-Golge dildima	521269	949730	1914	283	Liben	493136	942944	1850	361
RMI Steel factory	494320	965101	1995	153	A/Jegola	513546	953365	1801	420
Nazereth tec College	536113	947062	1693	195	A/Jegola	513546	953365	1801	420
Awash Melkasa ELPA	537332	928166	1536	126	A/Jegola	513546	953365	1801	420
Nazereth Trans	530429	941358	1595	196	Liben	493128	943793	1880	374
Naz.rehab .center	530748	940960	1593	192	Liben	493128	943793	1880	374
Wonji Shewa	523310	928661	1553	114	Liben	493128	943793	1880	374
Nazereth-Yerer Flour	527667	941523	1626	152	Denkaka	510602	956528	1841	424
Nazereth Metal Works	526928	943518	1656	202	Denkaka	510602	956528	1841	424
Koye Jajaba	477019	917872	1724	123.4	Denkaka	510602	956528	1841	424
Holota-Agri Flowers	440110	1001337	2419	153	Lume	509971	959175	1850	420
Alem Gena-Geja Dera	461930	970844	2201	183.2	Lume	509971	959175	1850	420
Silti Boze	426788	887491	2102	173.68	Lume	509971	959175	1850	420

AA-Burayu Spring	462743	1002521	2620	250	Denkaka	506989	960627	1858	157
Soloke	458775	911576	1936	295	Denkaka	506989	960627	1858	157
Ziquala-Annate	481162	935226	1815	200	Denkaka	506989	960627	1858	157
Dire	494036	1010902	2549	154	Mudasenkele	507034	942864		
Gerbi	407400	972711	2140	172	Mudasenkele	507034	942864		
Addis Alem-Siet	436160	1000453	2370	153	Mudasenkele	507034	942864		
Addis Alem-Flower	435382	1000251	2358	206	Mudasenkele	506734	941867	1700	343
Berga	432432	1024464	2598	161	Mudasenkele	506734	941867	1700	343
AAWSA Kas Kassa	475000	1001300	2542	168	Mudasenkele	506734	941867	1700	343
Nazereth Soap F	530792	940526	1618	210	Mudasenkele	507999	942824	1714	340
AA-Ethio-Plastic	478450	995600	2353	171	Mudasenkele	507999	942824	1714	340
Malmalle	515109	943100	1772	160	Mudasenkele	507999	942824	1714	340
Holota-Dandi Boru	440595	1000333	2374	170	Beyo-beseke	510664	957391	1841	414
AA-Addis Tyre	473915	989015	2215	201	Beyo-beseke	510664	957391	1841	414
Road	475000	987800	2180	172	Beyo-beseke	510664	957391	1841	414
Factory-2	475335	980717	2075	179.4	Elu	426362	969316		341
AA-US Emba	473900	1001050	2564	200	Elu	426362	969316		341
AA-Anbessa	468400	1001016	2580	192	Elu	426362	969316		341
AA-National Palace-2	473400	996300	2352	249	Ude	426873	970945	2017	402
AA-Water III BH21	477856	976402	2063.6	151	Ude	426873	970945	2017	402
AA-Stars Business	481205	976968	2155	184	Ude	426873	970945	2017	402
AA-Anbessa	471200	995700	2343	192	Ude	426362	969316		420
AA-Sheraton BH-1	473334	997204	2360	355	Ude	426362	969316		420
AA-Cement Factory-2	473100	991900	2270	153.9	Elu	428420	969695	2025	347
AA-Addis Tyre	473900	989000	2224	201.5	Elu	428420	969695	2025	347
AA-Hilton Hotell	474050	996650	2373	400	Elu	428420	969695	2025	347
AA-Old Airport-2	470500	994500	2320	170	Elu	428539	970788	2092	380
AA-Kality Metal	474225	982650	2150	177.8	Elu	428539	970788	2092	380
AA-Prefabricatio n	474429	986829	2177	187	Elu	428539	970788	2092	380
AA-EELPA,Kote	480431	998457	2452	181	Elu	428060	972015	2083	415
AA-US Embassy-3	474050	1000875	2550	156	Elu	428060	972015	2083	415
Sunshine Terminal	483093	976323	2159	207	Elu	428060	972015	2083	415
AA-Water lll TestB14	480900	978800	2126.4	160	Weseri Abeti	428061	978061	2050	397
AA-Water lll Bh07	479405	976735	2086	151	Weseri Abeti	428061	978061	2050	397
AA-Water lll BH12	478808	976867	2070.6	152	Weseri Abeti	428061	978061	2050	397

D/Z-Dire Clinic	488391	961066	1940	180	Melka	454868	963109		352
AA-Kotebe , Submmit	483750	994550	2340	230	Melka	454868	963109		352
AA-Meta abo BH9	455550	983750	2138	181	Melka	454868	963109		352
AA-Bingham	468650	999800	2460	172	beyobeske	510664	957391	1841	436
AA-TW4	489950	976019	2067	220	beyobeske	510664	957391	1841	436
TW5 Test well No.5	485798	968308	1905	217	beyobeske	510664	957391	1841	436
AA-Tikur Abbay Shoe	466350	1001000	2550	153	Hara Jila	451632	979475	1877	482
AAWSA Mekanissa.3	470316	991064	2222	170	Hara Jila	451632	979475	1877	482
AA-Samson PLC near	469804	993691	2330	170	Hara Jila	451632	979475	1877	482
AA-Worwdw 17 k 17	476235	995275	2357	151	Hara Jila	450187	981027	1882	440
AA-Motor Engineering	477463	994346	2335	170	Kofe	418679	988365	2086	445
AA-usEmbassy-4	474000	1001000	2562	201	Kofe	418679	988365	2086	445
Legadadi-NAS Food	488150	1002300	2489	175	Necho	423439	988990	2079	450
AA-Burayu-1-99	463972	1000788	2514	174	Necho	423439	988990	2079	450
Alemgena	462260	984901	2294	180	Faqii	420071	983317	2065	350
AA-Lafto-99	471500	990500	2255	200	Faqii	420071	983317	2065	350
AA-Yekamichael-99	477515	997474	2388	216	Faji gelila	411777	989671	2119	250
AA-Burayu-99	464031	1002909	2584	200	Faji gelila	411777	989671	2119	250
AA-Asko-99	465578	999808	2434	193	Faji gelila	411777	989671	2119	250
AA-Kidane Mihret-99	466050	993650	2525	200	Bajiga woyecha	414489	983944	2091	300
AA-Mekanisa-1-99	470277	989578	2269	230	Bajiga woyecha	414489	983944	2091	300
AA-Mekanisa-2-99	469245	990260	2264	240	Berhe	495728	1056866	1817	255
AA-Repi-1-99	465295	990132	2282	200	Berhe	495728	1056866	1817	255
AA-Mikililand-99	466600	1001250	2274	196	Berhe	495728	1056866	1817	255

AA-Shegole Mesgid	469414	1001640	2571	240	Sululta	474421	1013070	2610	274
AA-Burayu-99	464090	1002920	2513	200	Sululta	474421	1013070	2610	274
AA-Keranio-99	463595	995915	2475	200	Gelan	481417	976193	2135	277
AA-Sebeta Fishery	460295	986769	2222	158	Gelan	481417	976193	2135	277
Holota	440274	1006055	2525	300	Gelan	481417	976193	2135	277
Asgori	427126	971361	2075	308	EPHARM	469320	993742	2316	154
Melkakunture	456314	962592	2014	290	Wesberi	466306	1008828	2200	460
Abusera	478990	955803	1830	330	Wesberi	466306	1008828	2200	460
Segnogebeya	455620	1026514	2610	273	Wesberi	466306	1008828	2200	460
Chancho	473911	1031930	2543	324	Teji	429167	944712		
Legadadi	493518	1004421	2468	354	Teji	430636	975971		
Bekie	507086	1012954	2578	300	Teji	420444	965014		
Woberi	501332	1068067	2654	209	Teji	427126	971361	2072	
Dukem	490336	970789	1924	282	Holleta	434019	1000122	2349	
Sululta	474421	1013070	2610	304	Holleta	434162	1000155	2348	
Tefki	450359	981037	2084	280	Holleta	435393	1000246	2363	
CMC	484821	994284	2320	368	Holleta	436130	1000470	2372	
Jawaro	433200	959670	2111	194	Berga	434019	1000122	2349	
Modjo Ude	506765	957179	1836	278	Berga	434162	1000155	2348	
Borora	504878	970766	1879	300	Berga	435393	1000246	2363	
Onodo	513157	1025381	2904	348	Berga	436130	1000470	2372	
Adulala	490444	951336	1765	225	Berga	427626	994817	2126	
Modjo Muda	506464	941989	1697	268	Berga	432447	1024466	2616	
Kimoye	427395	992768	2109	220	Bui	459759	920099	2164	205
Ferencay	474424	1001212	2505	260	Bui	457984	917743	2225	360
Ferencay	475068	1001254	2532	260	Bui	457285	932038	2301	210
Ferencay	475945	1000580	2473	252	AA	475750	993650	2310	
Ayer Tena	466842	993128	2307	250	AA	472500	999550	2496	
Summit	481681	994296	2280	250	AA	487800	1002200	2480	

Summit	485664	994125	2295	250	AA	495300	1012000	2560	
Kotebe	482994	998429	2437	203	AA	491000	1012600	2620	
Gojam Bar	470504	1002135	2639	232	AA	494600	1008000	2515	
Summit	482349	995063	2321	210	AA	462743	1002521	2620	
Gojam Bar	470218	1001886	2608	233	AA	462558	1002487	2620	
Gojam Bar	471026	1002023	2633	222	AA	465651	1001575	2540	
East Bole	481061	992052	2252	270	AA	465600	1001855	2545	
East Bole	480760	992453	2261	260	AA	497018	968076	1898	
Shiromeda	472608	1002066	2537	170	AA	495447	968068	1902	
Bolelemi	482696	990537	2222	270	AA	494040	968454	1922	
Ferencay	475945	1000580	2473	232	AA	493497	968497	1918	
Shiromeda	474238	1001465	2525	200	AA	493187	968626	1918	

Kotebe	481462	998906	2451	250	AA				
Kotebe	480321	997370	2399	180	AA				
Akaki	478050	981860	2115	250	AA	470228	972214	2060	
Burayu	480604	992935	2266	250	AA	475402	976807	2060	
Burayu	465836	999320	2457	280	AA	482950	963800	1860	
Shegole	468207	1001645	2565	250	AA	475780	956477	1885	
Sansuzi	465832	1002965	2590	250	AA	475800	981300	2090	
Alemgena	464527	990017	2278	260	AA	487700	973600	1985	
Summit	482109	993423	2278	250	AA				
East Bole	480604	992935	2266	250	AA				
Summit	484883	994701	2320	250	AA	472150	993300	2270	
Summit	485228	994341	2312	250	AA	477945	976985	2069	
Summit	482849	991509	2236	270	AA	473576	972821	2081	
East Bole	481101	991646	2250	250	AA	484475	975622	2104	
Legetafo	486790	1001357	2291	250	AA	489950	976019	2067	
CMC	482732	996914	2357	210	AA	485798	968308	1900	
Mekanissa	471085	988117	2212	280	AA	463266	1001971	2600	
Ayat	487881	997599	2367	250	AA	468875	993750	2298	
Gurdshola	481434	997787	2413	260	AA	473350	987450	2160	
Akaki	478077	981842	2110	250	AA	473900	993100	2310	
Burayu	466306	1000367	2490	250	AA	471925	995150	2330	
Kerssa Desso	480553	984520	2190	250	AA	471950	995050	2330	
Kerssa Desso	479591	984268	2170	280	AA	470950	993300	2290	
Kerssa Desso	480161	983987	2181	265	AA	470950	993400	2295	
old Airport	468505	995156	2296	250	AA	467250	999800	2510	
Keranyo	467660	996912	2334	250	AA	474250	996800	2370	
Mekanissa	466550	986929	2265	235	AA	474175	996550	2365	
Keranyo	468268	996584	2323	290	AA	472700	999800	2485	
Mekanissa	467059	987492	2264	240	AA	473550	1001450	2570	
Mekanissa	467103	987041	2269	230	AA	476800	994200	2337	
Legetafo	486775	1000441	2414	250	AA	477000	994450	2335	
Burayu	463431	1000712	2513	200	AA	483550	999250	2510	
Hidi	508991	969895	1892	350	AA	466550	993300	2340	
Hidi	508991	969895	1892	350	AA	471150	995550	2280	
Hidi	508991	969895	1892	350	AA	476105	1000050	2455	
Ude	426362	969316		350	AA	475050	985050	2110	
Hidi	506138	970846	1900	350	AA	475300	985325	2130	
Hidi	506138	970846	1900	350	AA	474900	985000	2125	
Mudasenkele	508552	943199	1884	462	AA	468100	1001625	2585	
Mudasenkele	508552	943199	1884	462	AA	463850	993100	2400	
Mudasenkele	508552	943199	1884	462	AA	466050	993650	2360	
Denkaka	507556	958248	1855	400	AA	470450	990125	2225	
Denkaka	507556	958248	1855	400	AA	480395	998100	2440	

Denkaka	507556	958248	1855	400	AA	471400	988250	2205	
Adaa	504305	960681	1869	364	AA	472900	1003550	2720	
Adaa	504305	960681	1869	364	AA	473900	987175	2175	
Adaa	503475	960957	1879	361	AA	475300	994800	2318	
Adaa	503475	960957	1879	361	AA	473225	1001450		
Bali-Abo	511723	958922	1850	420	AA	475650	984750	2120	
Kaliti	503717	971356	1897	356	AA	467150	992150	2275	
Kaliti	503717	971356	1897	356	AA	455350	985100	2220	
Kaliti	503717	971356	1897	356	AA	455300	985250	2218	
Byo-Bske	509308	95788	1801	351	AA	455525	984000	2140	
Byo-Bske	509308	95788	1801	351	AA	455550	983750	2138	
Byo-Bske	509308	95788	1801	351	AA	444000	977700	2055	
Mudasenkele	506187	943199	1884	455	AA	463675	987975	2280	
Mudasenkele	506187	943199	1884	455	AA	462200	986250	2278	
Mudasenkele	506187	943199	1884	455	AA	460850	985850	2260	
Beuo Beseke	511430	957362	1816	266	AA	460500	986500	2285	
Beuo Beseke	511430	957362	1816	266	AA	468650	995450	2330	
Beuo Beseke	511430	957362	1816	266	AA	468650	999800	2462	
Ada'a berga	653285	998617	2040	602	AA	466300	1001825	2560	
Ada'a berga	653285	998617	2040	602	AA	467100	1000550	2515	
Ada'a berga	653285	998617	2040	602	AA	464500	1003150	2590	
Hidi	508991	969895	1898	350	AA	466550	1000150	2510	
Hidi	508991	969895	1898	350	AA	474500	995450	2338	
Hidi	508991	969895	1898	350	AA	468800	996600	2360	
Denkaka	505863	960482	1877	422	AA	468200	1001600	2578	
Denkaka	505863	960482	1877	422	AA	468150	1001750	2585	
Denkaka	505863	960482	1877	422	AA	469050	994450	2260	
Hara Jila	451632	979475	1877	482	AA	468425	996350	2320	
Hara Jila	451632	979475	1877	482	AA	469280	993350	2295	
Hara Jila	451632	979475	1877	482	AA	468875	993750	2298	
Hara Jila	450187	981027	1882	440	AA	483250	999600	2540	
Denkaka	508432	959037	1850	420	AA	484190	998500	2480	
Denkaka	508432	959037	1850	420	AA	485925	1000975	2482	
Adaa	506615	961264	1841	365	AA	486000	1001115	2482	
Adaa	506615	961264	1841	365	AA	502015	1011100	2538	
Adaa	506615	961264	1841	365	AA	491300	1004800	2440	
Algae	508471	961147	1851	422	AA	481650	998650	2460	
Algae	508471	961147	1851	422	AA	481650	997725	2406	
Algae	508471	961147	1851	422	AA	478425	981350	2110	
Algae	507557	961072	1855	208	AA	466175	1001800	2560	
Algae	507557	961072	1855	208	AA	465900	1002875	2600	
Algae	507557	961072	1855	208	AA	465550	1003250	2620	
Girime Esilale	511510	958955	1842	364	AA	463200	1002650	2610	
Girime Esilale	511510	958955	1842	364	AA	461300	1002250		
Girime Esilale	511510	958955	1842	364	AA	464600	1003075	2620	
Katila	506220	968104	1880	366	AA	483750	994550	2340	
Katila	506220	968104	1880	366	AA	483550	995325	2350	
Katila	506220	968104	1880	366	AA	499160	1009646		
Katila	507157	977107	1877	367	AA	476750	995800	2342	
Katila	507157	977107	1877	367	AA	479450	996115	2358	
Katila	507157	977107	1877	367	AA	486075	1000865	2480	
Katila			1848	396	AA	486089	1000950	2480	

Tedecho yatu	491050	971817		420	AA	473760	987300	2180	
Tedecho yatu	491050	971817		420	AA	473925	987175	2175	
Tedecho yatu	491050	971817		420	AA	478462.8	977721.59	2090	
Denkaka	505273	966105	1882	420	AA	477608.9	978689.7	2090	
Denkaka	505273	966105	1882	420	AA	474225	982650	2150	
Denkaka	505273	966105	1882	420	AA			2177	
Serdo	506187	966105	1841	420	AA	475300	983800		
Serdo	506187	966105	1841	420	AA				
Serdo	506187	966105	1841	420	AA			2178	
Katila	508137	966205	1875	382	AA				
Katila	508137	966205	1875	382	AA	455500	985200	2200	
Katila	508137	966205	1875	382	AA	477100	994900	2305	
Denkaka	501572	968045		207	AA			2060	
Denkaka	501572	968045		207	AA	464300	990600	2290	
Denkaka	501572	968045		207	AA	479819.84	977155.55	2085	
Kora	497866	972874	1877	420	AA	473600	1001013	2550	
Kora	497866	972874	1877	420	AA	473000	992700	2292	
Kora	497866	972874	1877	420	AA	478462.8	977506.19	2090	
	505332	965079	1870	360	AA	476426.96	980749.41	2060	
	505332	965079	1870	360	AA	476430	980669.17	2060	
	505332	965079	1870	360	AA	476520.57	980710.52	2061	
Serdo	507153	965139	1844	356	AA	471700	986600	2190	
Serdo	507153	965139	1844	356	AA	502600	1011700	2550	
Serdo	507153	965139	1844	356	AA	489200	1001025	2455	
Katila	508185	965261	1873	358	AA	463600	988200	2280	
Katila	508185	965261	1873	358	AA	462500	987000	2300	
Katila	508185	965261	1873	358	AA	461900	974300	2120	
Adaa	509189	965087	1856	350	AA	451900	983000	2140	
Adaa	509189	965087	1856	350	AA	457300	1001008	2635	
Adaa	509189	965087	1856	350	AA	457700	1001008	2620	
Goro	502085	904206	1884	344	AA	459800	998250	2580	
Goro	502085	904206	1884	344	AA	459600	997500	2581	
Goro	502085	904206	1884	344	AA	459700	998075	2580	
Denkaka	504379	964125	1880	456	AA	459375	998350	2600	
Denkaka	504379	964125	1880	456	AA	473000	992700	2290	
Denkaka	504379	964125	1880	456	AA	476200	998600	2410	
Denkaka	506154	964148	1820	414	AA	488600	1001027	2470	
Denkaka	506154	964148	1820	414	AA	464000	997000	2480	
Denkaka	506154	964148	1820	414	AA	463700	988500	2280	
Dembelo	507372	969121		300	AA	486200	1001042	2450	
Dembelo	507372	969121		300	AA	481200	980000	2150	
Dembelo	507372	969121		300	AA	470800	982900	2090	
Katila	508223	964173	1841	422	AA	473566	978610	2070	
Ada'a	504784	959857	1863	340	AA	487300	995300	2350	
Ada'a	504784	959857	1863	340	AA	481600	982900	2205	
Ada'a	504784	959857	1863	340	AA	461500	1001023	2630	
Denkaka	508697	959616	1850	420	AA	466200	988800	2246	
Denkaka	508697	959616	1850	420	AA	466400	987600	2252.8	
Denkaka	508697	959616	1850	420	AA	481200	980000	2150.8	
Denkaka	507630	959592	1882	430	AA	481600	982900	2205	
Denkaka	507630	959592	1882	430	AA	479400	981400	2133.4	
Denkaka	507630	959592	1882	430	AA	480900	978800	2126.4	
Denkaka	502454	962792	1883	348	AA	479400	981400	2133.5	
Denkaka	502454	962792	1883	348	AA	479340	981400	2131.33	
Denkaka	502454	962792	1883	348	AA	481600	982850	2203.98	
Denkaka	504203	963155	1875	359	AA	479740	981400	2133.88	
Denkaka	504203	963155	1875	359	AA	473069	979881	2057.4	

Denkaka	504203	963155	1875	359	AA	473108	979851	2058.34	
Denkaka	505095	962950	1801	420	AA	477972	974859	2078.5	
Denkaka	505095	962950	1801	420	AA	478399	975589	2072.5	
Denkaka	505095	962950	1801	420	AA	480517	977974	2100	
Denkaka	506213	963103	1886	397	AA	478713	974977	2083	
Denkaka	506213	963103	1886	397	AA	477992	975552	2067.5	
Denkaka	506213	963103	1886	397	AA	476574	975607	2070.3	
Denkaka	504844	958692	1863	400	AA	479696	976936	2086.7	
Denkaka	504844	958692	1863	400	AA	479405	976735	2086	
Denkaka	504844	958692	1863	400	AA	479061	976370	2086.5	
Denkaka	505855	958505	1874	360	AA	479246	977104	2077.5	
Denkaka	505855	958505	1874	360	AA	479058	976020	2091.2	
Denkaka	505855	958505	1874	360	AA	478780	977307	2080	
Denkaka	503185	962173	1884	364	AA	478808	976867	2070.6	
Denkaka	503185	962173	1884	364	AA	478694	976490	2074.2	
Denkaka	503185	962173	1884	364	AA	478580	976051	2078.6	
Denkaka	504203	962102	1879	358	AA	478347	976752	2067.5	
Denkaka	504203	962102	1879	358	AA	478199	976361	2065.3	
Denkaka	504203	962102	1879	358	AA	478154	975966	2073.5	
Denkaka	505077	962102	1872	354	AA	478019	977985	2070.2	
Denkaka	505077	962102	1872	354	AA	477945	976985	2068.3	
Denkaka	505077	962102	1872	354	AA	477856	976402	2063.6	
Denkaka	506109	962140	1880	340	AA	477651	975923	2066.8	
Denkaka	506109	962140	1880	340	AA	477477	977216	2064.3	
Denkaka	506109	962140	1880	340	AA	477330	976793	2061.6	
Algae	507472	962097	1850	400	AA	477162	976038	2060.8	
Algae	507472	962097	1850	400	AA	477181	975680	2070.1	
Algae	507472	962097	1850	400	AA	476454	976951	2061.5	
Denkaka	503018	959480	1889	333	AA	476523	976374	2054.7	
Denkaka	503018	959480	1889	333	AA	476972	976152	2059.4	
Denkaka	503018	959480	1889	333	AA	477185	975729	2068.7	
Denkaka	506490	957774	1861	366	AA	479942	977322	2091	
Denkaka	506490	957774	1861	366	AA	478450	979950	2100	
Denkaka	506490	957774	1861	366	AA	479526	977468	2090	
A/Jegola	511524	956435	1824	424	AA	479021	977596	2090	
A/Jegola	511524	956435	1824	424	AA	478998	977937	2090	
A/Jegola	511524	956435	1824	424	AA	472870	980925	2060	
Liben	493136	942944	1850	361	AA	477900	982875	2130	
Liben	493136	942944	1850	361	AA	478775	983133	2165	
Liben	493136	942944	1850	361	AA	481205	976968		
A/Jegola	513546	953365	1801	420	AA	482480	976133	2150	
A/Jegola	513546	953365	1801	420	AA	486006	974882	2052.7	
A/Jegola	513546	953365	1801	420	AA	487900	972421	1948.4	
Liben	493128	943793	1880	374	AA	485745	973864		
Liben	493128	943793	1880	374	AA	481694	965913	1920.2	
Liben	493128	943793	1880	374	AA	484325	969692	1950	
Denkaka	510602	956528	1841	424	AA	483878	968041		
Denkaka	510602	956528	1841	424	AA	475300	985080	2120	
Denkaka	510602	956528	1841	424	AA	475430	984955	2123	
Lume	509971	959175	1850	420	AA	473600	1001013	2550	
Lume	509971	959175	1850	420	AA	473700	1001012	2555	
Lume	509971	959175	1850	420	AA	473500	1001013	2560	
Mudasenkele	507034	942864			AA	473400	1001014	2562	
Mudasenkele	507034	942864			AA	473400	1001013	2562	
Mudasenkele	507034	942864			AA	476900	1001014		
Mudasenkele	506734	941867	1700	343	AA	474300	1001005	2523	
Mudasenkele	506734	941867	1700	343	AA	466200	1001008	2562	
Mudasenkele	506734	941867	1700	343	AA	467200	1001017	2517	
Mudasenkele	507999	942824	1714	340	AA	468400	1001016	2580	
Mudasenkele	507999	942824	1714	340	AA	466600	1001003	2500	
Mudasenkele	507999	942824	1714	340	AA	468300	1001003	2525	
Beyo-beseke	510664	957391	1841	414	AA	468800	1001007	2529	
Beyo-beseke	510664	957391	1841	414	AA	468900	1001007	2540	

Beyo-beseke	510664	957391	1841	414	AA	469900	1001000	2525	
Elu	426362	969316		341	AA	471400	997400	2416	
Elu	426362	969316		341	AA	466700	997700	2400	
Elu	426362	969316		341	AA	474000	999400	2473	
Ude	426873	970945	2017	402	AA	475000	1001300	2542	
Ude	426873	970945	2017	402	AA	473400	999600	2490	
Ude	426873	970945	2017	402	AA	474000	999900	2500	
Ude	426362	969316		420	AA	473300	999300	2482	
Ude	426362	969316		420	AA	473300	999300	2480	
Elu	428420	969695	2025	347	AA	475600	998900		
Elu	428420	969695	2025	347	AA	480400	998500	2455	
Elu	428420	969695	2025	347	AA	476500	998250	2425	
Elu	428539	970788	2092	380	AA	476450	998100	2420	
Elu	428539	970788	2092	380	AA	476100	998300	2440	
Elu	428539	970788	2092	380	AA	476100	998300		
Elu	428060	972015	2083	415	AA	477500	997300		
Elu	428060	972015	2083	415	AA	474200	997400	2415	
Elu	428060	972015	2083	415	AA	474300	997300	2410	
Weseri Abeti	428061	978061	2050	397	AA	472100	998200	2430	
Weseri Abeti	428061	978061	2050	397	AA	471300	998200	2445	
Weseri Abeti	428061	978061	2050	397	AA	470600	998100	2450	
Melka	454868	963109		352	AA	469800	996300	2350	
Melka	454868	963109		352	AA	470000	996400	2335	
Melka	454868	963109		352	AA	470000	996400	2338	
beyobeske	510664	957391	1841	436	AA	469900	996000	2335	
beyobeske	510664	957391	1841	436	AA	470100	996100	2352	
beyobeske	510664	957391	1841	436	AA	469800	996200	2342	
Faji gelila	411777	989671	2119	250	AA	472600	997400	2370	
Faji gelila	411777	989671	2119	250	AA	478450	995600	2353	
Faji gelila	411777	989671	2119	250	AA	479400	496800	2430	
Berhe	495728	1056866	1817	255	AA	476500	996100		
Berhe	495728	1056866	1817	255	AA	474500	996200	2352	
Berhe	495728	1056866	1817	255	AA	473800	996600	2373	
Sululta	474421	1013070	2610	274	AA	473400	996400	2350	
Sululta	474421	1013070	2610	274	AA	473400	996300	2352	
Gelan	481417	976193	2135	277	AA	473100	996400	2340	
Gelan	481417	976193	2135	277	AA	473200	996300	2340	
Gelan	481417	976193	2135	277	AA	473200	996400	2340	
EPHARM	469320	993742	2316	154	AA	473300	996100	2342	
Wesberi	466306	1008828	2200	460	AA	473300	996200	2344	
Wesberi	466306	1008828	2200	460	AA	473300	996300	2342	
Wesberi	466306	1008828	2200	460	AA	473400	995800	2338	
Hidi	508991	969895	1892	350	AA	473900	995500	2350	
Hidi	508991	969895	1892	350	AA	472900	995900	2335	
Hidi	508991	969895	1892	350	AA	473000	995900		
Ude	426362	969316		350	AA	473000	996300	2345	
Hidi	506138	970846	1900	350	AA	472700	996300	2343	
Hidi	506138	970846	1900	350	AA	472500	996300	2348	
Mudasenkele	508552	943199	1884	462	AA	472900	996400	2343	
Mudasenkele	508552	943199	1884	462	AA	472400	996400	2360	
Mudasenkele	508552	943199	1884	462	AA	471700	995900	2352	

Denkaka	507556	958248	1855	400	AA	471600	995800	2345	
Denkaka	507556	958248	1855	400	AA	471500	995900	2345	
Denkaka	507556	958248	1855	400	AA	471400	995800	2345	
Adaa	504305	960681	1869	364	AA	471400	996000	2345	
Adaa	504305	960681	1869	364	AA	471500	996000	2345	
Adaa	503475	960957	1879	361	AA	471550	995950	2346	
Adaa	503475	960957	1879	361	AA	471500	995800	2345	
Bali-Abo	511723	958922	1850	420	AA	471300	995800	2345	
Kaliti	503717	971356	1897	356	AA	472300	995700	2352	
Kaliti	503717	971356	1897	356	AA	472300	995600	2352	
Kaliti	503717	971356	1897	356	AA	472200	995600	2352	
Byo-Bske	509308	95788	1801	351	AA	472000	995100	2320	
Byo-Bske	509308	95788	1801	351	AA	471800	995200	2303	
Byo-Bske	509308	95788	1801	351	AA	471800	995500	2335	
Mudasenkele	506187	943199	1884	455	AA	471300	995400	2330	
Mudasenkele	506187	943199	1884	455	AA	471300	995050	2326	
Mudasenkele	506187	943199	1884	455	AA	471300	994800	2318	
Beuo Beseke	511430	957362	1816	266	AA	470900	994800	2302	
Beuo Beseke	511430	957362	1816	266	AA	471700	995100	2320	
Beuo Beseke	511430	957362	1816	266	AA	471700	995000	2320	
Ada'a berga	653285	998617	2040	602	AA	471700	994900	2320	
Ada'a berga	653285	998617	2040	602	AA	469700	994500	2332	
Ada'a berga	653285	998617	2040	602	AA	469300	995500	2347	
Hidi	508991	969895	1898	350	AA	471600	996100		
Hidi	508991	969895	1898	350	AA	471700	986600	2220	
Hidi	508991	969895	1898	350	AA	471200	995700		
Denkaka	505116	969081		370	AA				
Denkaka	505116	969081		370	AA	471300	996200	2340	
Denkaka	505116	969081		370	AA	470700	995900		
Denkaka	508432	959037	1850	420	AA	471400	995700		
Denkaka	508432	959037	1850	420	AA	471700	996300	2342	
Denkaka	508432	959037	1850	420	AA	466200	493000		
Adaa	506615	961264	1841	365	AA	466300	993100	2317	
Adaa	506615	961264	1841	365	AA	471704.7	973385.9	2062	
Adaa	506615	961264	1841	365	AA	466250	993050	2335	
Algae	508471	961147	1851	421	AA	467200	993600	2330	
Algae	508471	961147	1851	421	AA	468000	993200	2315	
Algae	508471	961147	1851	421	AA	468100	993100	2320	
Algae	511610	958955	1842	208	AA	468100	993200	2325	
Algae	511610	958955	1842	208	AA	471000	993800	2305	
Algae	511610	958955	1842	208	AA	471200	993700	2300	
Bali-Abo	511610	958955	1842	364	AA	472000	993500	2260	
Bali-Abo	511610	958955	1842	364	AA	473000	992700	2292	
Bali-Abo	511610	958955	1842	364	AA	473100	992600	2290	
Katila	506220	968104	1880	366	AA	473500	992900	2280	
Katila	506220	968104	1880	366	AA	472900	992500	2280	
Katila	506220	968104	1880	366	AA	474300	993300	2325	
Katila	507157	977107	1877	367	AA	474300	992700	2381	
Katila	507157	977107	1877	367	AA	475600	994500		
Katila	507157	977107	1877	367	AA	473200	992400	2287	
Katila			1848	396	AA	473200	992400	2287	
Katila			1848	396	AA	473100	991800	2280	
Katila			1848	396	AA	473100	991900	2270	
Katila	509241	967123	1841	420	AA	473050	991800	2270	
Katila	509241	967123	1841	420	AA	468900	991900	2270	
Katila	509241	967123	1841	420	AA	470465	991100	2220	
Tedecho yatu	491050	971817		420	AA	470400	991300	2220	
Tedecho yatu	491050	971817		420	AA	470250	991500	2225	
Tedecho yatu	491050	971817		420	AA	469900	990300	2225	

Denkaka	505273	966105	1882	420	AA	469800	991200	2225	
Denkaka	505273	966105	1882	420	AA	470400	992100	2230	
Denkaka	505273	966105	1882	420	AA	470400	992000		
Serdo	506187	966105	1841	420	AA	471400	991000	2240	
Serdo	506187	966105	1841	420	AA	473800	990250	2247	
Serdo	506187	966105	1841	420	AA	473848	990072	2260	
Katila	508137	966205	1875	382	AA	473900	990100	2270	
Katila	508137	966205	1875	382	AA	473800	990200	2265	
Katila	508137	966205	1875	382	AA	473750	990050	2250	
Katila	509163	966079		420	AA	473500	987900	2195	
Katila	509163	966079		420	AA	473600	988300	2195	
Katila	509163	966079		420	AA	473500	987900	2190	
Denkaka	501572	968045		207	AA	473230	988878	2200	
Denkaka	501572	968045		207	AA	473900	989000	2224	
Denkaka	501572	968045		207	AA	473900	989000	2215	
Kora	497866	972874	1877	420	AA	474000	989100	2225	
Kora	497866	972874	1877	420	AA	474100	989000	2220	
Kora	497866	972874	1877	420	AA	475000	987800	2180	
	505332	965079	1870	360	AA	473225	989850	2205	
	505332	965079	1870	360	AA	473500	987600	2180	
	505332	965079	1870	360	AA	473300	987700		
Serdo	507153	965139	1844	356	AA	473300	987300	2163	
Serdo	507153	965139	1844	356	AA	476762	980541	2062	
Serdo	507153	965139	1844	356	AA				
Katila	508185	965261	1873	358	AA	475000	985800	2112	
Katila	508185	965261	1873	358	AA	473900	985100	2165	
Katila	508185	965261	1873	358	AA	477800	979500	2085	
Adaa	509189	965087	1856	350	AA	475662.32	980783.83	2055	
Adaa	509189	965087	1856	350	AA	475335.59	980717.33	2075	
Adaa	509189	965087	1856	350	AA	476500	981300	2055	
Goro	502085	904206	1884	344	AA	476600	981500	2070	
Goro	502085	904206	1884	344	AA	476369.03	981717.33	2062	
Goro	502085	904206	1884	344	AA	481507.4	976220.97	2100	
Denkaka	504379	964125	1880	456	AA	476400	980600	2056	
Denkaka	504379	964125	1880	456	AA	476400	980700	2058	
Denkaka	504379	964125	1880	456	AA	482400	983000	2230	
Denkaka	506154	964148	1820	414	AA	476400	984800	2125	
Denkaka	506154	964148	1820	414	AA	474800	984700	2140	
Denkaka	506154	964148	1820	414	AA	477400	979500	2080	
Dembelo	507372	969121		300	AA	477500	979300	2080	
Dembelo	507372	969121		300	AA	475400	982500	2137	
Dembelo	507372	969121		300	AA	477446.27	978851.17	2070	
Katila	508223	964173	1/14/1905	420	AA	477232.61	978999.84	2070	

Katila	508223	964173	1/14/1905	421	AA	476500	981500	2070	
Katila	508223	964173	1841	422	AA	476600	978200	2065	
Ada'a	504784	959857	1863	340	AA			2350	
Ada'a	504784	959857	1863	340	AA	476000	980900	2060	
Ada'a	504784	959857	1863	340	AA	474900	983800	2130	
Denkaka	508697	959616	1850	420	AA	475300	983800	2105	
Denkaka	508697	959616	1850	420	AA	475300	984000	2100	
Denkaka	508697	959616	1850	420	AA	474900	983600	2147	
Denkaka	507630	959592	1882	430	AA	475200	999200	2440	
Denkaka	507630	959592	1882	430	AA	473800	1001018	2580	
Denkaka	507630	959592	1882	430	AA	473600	1001018	2570	
Denkaka	502454	962792	1883	348	AA	474300	1001014	2500	
Denkaka	502454	962792	1883	348	AA	474500	999500	2470	
Denkaka	502454	962792	1883	348	AA	472500	998700	2465	
Denkaka	504203	963155	1875	359	AA	474100	998500	2440	
Denkaka	504203	963155	1875	359	AA	472400	998500	2450	
Denkaka	504203	963155	1875	359	AA	472600	997500	2800	
Denkaka	505095	962950	1801	420	AA	472500	997600	2390	
Denkaka	505095	962950	1801	420	AA	477800	997200	2380	
Denkaka	505095	962950	1801	420	AA	469000	996800	2380	
Denkaka	506213	963103	1886	397	AA	470300	996800	2380	
Denkaka	506213	963103	1886	397	AA	472500	996600	2360	
Denkaka	506213	963103	1886	397	AA	472600	996400	2350	
Denkaka	504844	958692	1863	400	AA	472500	996500	2355	
Denkaka	504844	958692	1863	400	AA	472900	995300	2340	
Denkaka	504844	958692	1863	400	AA	472000	995500	2340	
Denkaka	505855	958505	1874	360	AA	471800	995700	2340	
Denkaka	505855	958505	1874	360	AA	470500	996000	2200	
Denkaka	505855	958505	1874	360	AA	469200	995800	2360	
Denkaka	503185	962173	1884	364	AA	471700	994400	2300	
Denkaka	503185	962173	1884	364	AA	468700	994800	2300	
Denkaka	503185	962173	1884	364	AA	467500	992800	2280	
Denkaka	504203	962102	1879	358	AA	473700	992700	2300	
Denkaka	504203	962102	1879	358	AA	473400	997200	2360	
Denkaka	504203	962102	1879	358	AA	472200	995700	2310	
Denkaka	505077	962102	1872	354	AA	470950	995225	2300	
Denkaka	505077	962102	1872	354	AA	472700	996500	2540	
Denkaka	505077	962102	1872	354	AA	470500	994500	2320	
Denkaka	506109	962140	1880	340	AA	470900	995075	2295	
Denkaka	506109	962140	1880	340	AA	470500	994500	2320	
Denkaka	506109	962140	1880	340	AA	466900	1001005	2517	
Algai	507472	62097		400	AA	471400	995900	2345	
Algai	507472	62097		400	AA	478462.8	977721.59	2090	
Algai	507472	62097		400	Denkaka	503018	959480	1889	333
Denkaka	503018	959480	1889	333	Denkaka	503018	959480	1889	333

Appendix-9 springs used for Groundwater Table Contour Map

No	WATER_POINT	UTME	UTMN	Z_DEM	DEPTH	SWL_M	RWL__MAS	Types
1	Chefefonsa Bombas	513,000	991,000	2,413	0	0	2,413.00	Springs
2	Chefedonsa , kidane	514,000	992,000	2,359	0	0	2,358.80	Springs
3	Girai Abo spr.	519,000	987,000	2,314	0	0	2,314.10	Springs
4	Chefedonsa, Butuli	512,000	991,000	2,441	0	0	2,441.20	Springs
5	Chefedonsa, Ichicha	509,000	983,000	2,252	0	0	2,252.20	Springs
6	Chefedosa, Syntaya	511,000	991,000	2,429	0	0	2,428.70	Springs
7	Chefedosa, Jejema s	516,000	992,000	2,336	0	0	2,336.30	Springs
8	Sodere copper spr	542,000	929,000	1,396	0	0	1,396.40	Springs
9	Sodere middle spr.	542,000	929,000	1,396	0	0	1,396.40	Springs
10	Sodere veinming poo	542,000	929,000	1,396	0	0	1,396.40	Springs
11	sodere outside fenc	542,000	929,000	1,396	0	0	1,396.40	Springs
12	Deneba , Burkitu sp	513,000	885,000	1,883	0	0	1,882.70	Springs
13	Lugo Burkitu spr.	513,000	885,000	1,883	0	0	1,882.70	Springs
14	Boko fumarole	521,000	936,000	1,550	0	0	1,549.90	Springs
15	Gergedi , Hipoo poo	521,000	936,000	1,550	0	0	1,549.90	Springs
16	Gergedi, Medehane A	520,000	936,000	1,563	0	0	1,562.80	Springs
17	Gergedi, Tekle haim	520,000	936,000	1,563	0	0	1,562.80	Springs
18	Gergedi, Gerle haim	520,000	936,000	1,563	0	0	1,562.80	Springs
19	Geergedi , Abo spr.	520,000	936,000	1,563	0	0	1,562.80	Springs
20	Gergedi, Amanuel sp	520,000	936,000	1,563	0	0	1,562.80	Springs
21	Gergeedi, eyessus T	520,000	936,000	1,563	0	0	1,562.80	Springs
22	S.E. boneya , ulu s	538,000	888,000	2,677	0	0	2,677.30	Springs
23	East of Boneya, Kid	539,000	893,000	2,371	0	0	2,370.50	Springs
24	Goade debritu spr.	525,000	888,000	2,400	0	0	2,400.10	Springs
25	Haile spr .m gonde	525,000	887,000	2,484	0	0	2,483.60	Springs
26	Walenkomi, wokie sp	528,000	889,000	2,411	0	0	2,411.00	Springs
27	Walenkome, Boreu sp	529,000	887,000	2,614	0	0	2,614.10	Springs
28	Boneya, fitawerari	535,000	888,000	2,618	0	0	2,618.20	Springs
29	Walenkome, South-bo	531,000	889,000	2,441	0	0	2,441.00	Springs
30	Walenkome southh, w	534,000	887,000	2,651	0	0	2,651.30	Springs
31	Huruta, Fursa spr.	539,000	897,000	2,119	0	0	2,119.40	Springs
32	Huruta Fursa spr. 2	539,000	897,000	2,119	0	0	2,119.40	Springs
33	Huuta, fursa spr. 1	539,000	897,000	2,119	0	0	2,119.40	Springs
34	Benben chanecho spr	558,000	900,000	2,595	0	0	2,595.20	Springs
35	Hamus Gebeya, shaya	550,000	890,000	2,911	0	0	2,911.20	Springs
36	Sira aadere spr.	551,000	910,000	2,040	0	0	2,040.10	Springs
37	Siea East reged spr	558,000	914,000	2,338	0	0	2,337.90	Springs
38	Beneben, Kerktcho s	560,000	905,000	2,493	0	0	2,493.30	Springs
39	Huruta, East Hymp s	543,000	899,000	2,257	0	0	2,256.70	Springs
40	sire Abo spr.	555,000	915,000	2,023	0	0	2,022.90	Springs
41	tich Abo spr.	542,000	900,000	2,168	0	0	2,168.30	Springs
42	Sira e, Weast Tefe	550,000	908,000	2,179	0	0	2,178.90	Springs
43	Hamus Gebeya, Mener	548,000	890,000	2,857	0	0	2,857.10	Springs
44	hamus Gebeya Karo	545,000	887,000	2,881	0	0	2,880.80	Springs
45	kalata Burkitu spr.	543,000	892,000	2,554	0	0	2,554.00	Springs
46	Hamus Gebeya Karo s	546,000	886,000	3,073	0	0	3,073.10	Springs

47	Doni, Hora spr.	558,000	938,000	1,338	0	0	1,338.40	Springs
48	Bollo, Agassa spr.	553,000	913,000	1,977	0	0	1,977.00	Springs
49	Bollo, Wosheba spr.	569,000	922,000	2,267	0	0	2,266.50	Springs
50	Sire, Kobo spr	560,000	913,000	2,485	0	0	2,484.50	Springs
51	wesheba. Tefers or	565,000	921,000	2,135	0	0	2,135.20	Springs
52	Arboye, Yirba spr.	575,000	923,000	2,332	0	0	2,331.60	Springs
53	Sire north East, Be	560,000	919,000	2,057	0	0	2,056.90	Springs
54	Sire South Debra sp	550,000	906,000	2,386	0	0	2,386.40	Springs
55	Sire south, Lugo sp	548,000	906,000	2,157	0	0	2,157.00	Springs
56	Arboye, Abay spr.	573,000	923,000	2,271	0	0	2,270.90	Springs
57	Arboye, Ketema spr.	576,000	924,000	2,211	0	0	2,211.30	Springs
58	Abo Bollo spr. 1	563,000	917,000	2,305	0	0	2,305.10	Springs
59	Abo Bollo spr. 2	563,000	917,000	2,305	0	0	2,305.10	Springs
60	Birri , Abo spr.	502,000	925,000	1,606	0	0	1,605.80	Springs
61	koka, kefle spr.	505,000	934,000	1,613	0	0	1,613.10	Springs
62	koka,tifu spr.	518,000	935,000	1,599	0	0	1,598.50	Springs
63	koka, Abo spr.	520,000	936,000	1,563	0	0	1,562.80	Springs
64	koka, haile mariam	520,000	937,000	1,553	0	0	1,553.40	Springs
65	Gonde, Giorgis spr.	521,000	887,000	2,320	0	0	2,320.30	Springs
66	Mito	429,469	848,820	1,763	0	30	1,732.70	Springs
67	Children village	429,503	841,996	1,717	0	81	1,636.30	Springs
68	Jido Kimbolo	441,257	852,390	1,645	0	90	1,555.00	Springs
69	Bekele Mola	464,460	834,226	1,597	0	6	1,591.10	Springs
70	haroresa	454,331	832,210	1,610	0	28	1,581.60	Springs
71	Adami tulu	467,618	868,830	1,655	0	45	1,610.30	Springs
72	Aneno	465,769	866,769	1,663	0	64	1,599.20	Springs
73	Bulbula	462,033	853,564	1,612	0	21	1,591.40	Springs
74	kersa	496,239	830,841	2,756	0	105	2,651.50	Springs

Appendix 10 Groundwater Well Inventory Photographs during field time

Plate1. Shallow GW near dried Chelekleka Lake

Plate 2. Swampy Chelekleka Lake

Plate 3 Hand Pump in Asgori

Plate 4 Lacustrine Deposit near Koka Lake

Plate 5 Borehole

Appendix-11 Shallow wells used for Groundwater table contour map (≤150m Deep)

NO	ID	Easting	Northing	Elevation	Depth	SWL	NO	ID	Easting	Northing	Elevation	Depth	SWL
1	BHC26	441,901.00	981,393.00	2,046.00	7	6	824	AdBh0293A	496,646	967,481	1,896	60	20
2	Koka	503,012.00	934,454.00	1,600.00	8	5	825	AdBh0294A	507,408	1,013,586	2,587	110	29
3	Koka	505,004.00	932,524.00	1,599.00	8	5	826	AdBh0295	509,969	952,000	1,796	16	15
4	Koka	504,767.00	932,056.00	1,592.00	8	5	827	AdBh0295B	492,803	969,204	1,907	116	64
5	Koka	505,873.00	931,477.00	1,600.00	8	5	828	AdBh0299	463,204	1,038,645	2,413	62	2
6	koka	506,021.00	932,769.00	1,592.00	8	5.3	829	AdBh0300	442,842	977,555	2,067	100	14
7	Koka	506,218.00	931,358.00	1,600.00	8	5.5	830	AdBh0301	442,811	977,625	2,065	179	10
8	Koka	504,422.00	932,636.00	1,598.00	8	6	831	AdBh0305B	386,183	943,986	2,032	108	0
9	koka	506,226.00	932,875.00	1,590.00	9	4.75	832	AdBh0306	386,987	945,156	2,053	133	0
10	koka	505,938.00	932,788.00	1,588.00	9	5.7	833	AdBh0307	387,305	945,410	2,055	100	0
11	Koka	504,633.00	932,612.00	1,598.00	9	5.8	834	AdBh0308	387,549	945,858	2,059	93	0
12	Koka	504,855.00	932,124.00	1,600.00	9	6	835	AdBh0310	389,339	940,715	1,995	50	29
13	koka	506,765.00	933,362.00	1,589.00	9	6	836	AdBh0312	408,475	952,876	2,271	50	10
14	Holleta	458,783.00	1,003,841.00	2,633.00	9	6	837	AdBh0313	407,460	953,526	2,276	36	9
15	Koka	505,398.00	931,751.00	1,600.00	9	6.2	838	AdBh0314	404,050	980,200	2,225	99	10
16	koka	503,691.00	931,854.00	1,582.00	9	6.2	839	AdBh0315	404,051	980,357	2,222	83	4
17	Koka	504,973.00	932,629.00	1,599.00	9	6.9	840	AdBh0318	407,400	972,711	2,134	172	19
18	Koka	505,246.00	931,742.00	1,602.00	9	7	841	AdBh0323	447,966	980,422	2,064	80	54
19	Koka	503,105.00	934,366.00	1,602.00	9	7.5	842	AdBh0324	461,412	986,324	2,277	145	45
20	Koka	503,095.00	934,368.00	1,602.00	9	7.5	843	AdBh0325	459,676	984,947	2,204	96	28
21	Koka	503,923.00	932,898.00	1,616.00	9	10	844	AdBh0326	460,937	986,565	2,277	114	46
22	Koka	504,700.00	932,581.00	1,599.00	10	4.8	845	AdBh0328	463,599	988,583	2,283	130	19
23	Koka	504,861.00	932,595.00	1,597.00	10	5.8	846	AdBh0329	463,742	985,378	2,363	125	18
24	Koka	505,659.00	931,597.00	1,602.00	10	6	847	AdBh0334	427,635	994,816	2,119	125	7
25	koka	505,464.00	932,715.00	1,591.00	10	6	848	AdBh0335	429,252	993,949	2,110	45	15
26	Koka	502,989.00	934,328.00	1,603.00	10	7	849	AdBh0339	436,160	1,000,453	2,360	153	37
27	Koka	503,318.00	933,714.00	1,605.00	10	7.5	850	AdBh0340	435,382	1,000,251	2,356	206	10
28	Koka	505,304.00	931,771.00	1,602.00	10	7.5	851	AdBh0345	383,469	948,467	2,086	60	0
29	Koka	502,760.00	934,856.00	1,606.00	10	7.8	852	AdBh0347	488,408	973,431	1,980	150	43
30	BHC14	441,366.00	977,899.00	2,049.00	10	8	853	Adbh0349	502,364	970,907	1,884	74	24
31	Koka	502,442.00	934,571.00	1,605.00	10	8.5	854	Adbh0351	512,282	951,356	1,774	150	7
32	Teji	432,604.00	977,624.00	2,067.00	11	5.5	855	AdBh0352	512,282	951,356	1,774	123	7
33	koka	504,308.00	932,275.00	1,609.00	11	6	856	AdBh0353	512,355	951,516	1,776	125	9
34	Teji	432,585.00	977,477.00	2,069.00	11	6	857	AdBh0354	512,356	947,895	1,753	114	26
35	koka	500,756.00	932,740.00	1,588.00	11	6.6	858	AdBh0355B	466,050	993,650	2,366	137	71
36	koka	505,180.00	932,602.00	1,592.00	11	6.8	859	AdBh0357	445,180	1,002,459	2,390	101	23
37	Koka	503,627.00	933,856.00	1,601.00	11	7	860	AdBh0358	454,730	928,240	2,154	206	170
38	Koka	502,497.00	934,612.00	1,604.00	11	8	861	AdBh0361B	471,400	988,250	2,208	88	6
39	Koka	502,727.00	934,169.00	1,608.00	11	8.5	862	AdBh0362	432,432	1,024,464	2,607	161	11
40	Koka	503,236.00	933,980.00	1,612.00	11	9	863	AdBh0372	561,897	1,069,503	2,793	125	9
41	AAWSA Kality	475,000.00	985,800.00	2,112.00	12	0	864	AdBh0378	496,234	939,700	1,659	12	6
42	koka	504,354.00	932,274.00	1,590.00	12	6.1	865	AdBh0379	498,233	939,885	1,645	8	5
43	koka	503,219.00	931,848.00	1,590.00	12	6.5	866	AdBh0386	494,598	967,157	1,926	80	67
44	Koka	502,695.00	934,850.00	1,605.00	12	7.5	867	AdBH0393A	474,125	1,001,050	2,565	154	28
45	Koka	503,360.00	933,478.00	1,608.00	12	8	868	AdBh0395A	466,200	1,001,008	2,540	53	23
46	Koka	503,211.00	934,073.00	1,606.00	12	8	869	AdBh0396A	467,200	1,001,017	2,536	152	35
47	Koka	502,938.00	934,331.00	1,603.00	12	8	870	AdBh0398	412,826	949,736	2,261	50	0
48	Koka	502,882.00	934,317.00	1,605.00	12	8	871	AdBh0399	424,094	968,971	2,099	24	22
49	Koka	502,862.00	934,250.00	1,605.00	12	8	872	AdBh0400	428,566	961,644	2,134	24	22
50	Rob gebeya	437,892.00	1,008,952.00	2,587.00	13	4	873	AdBh0401	429,969	952,736	2,161	0	0
51	koka	503,543.00	931,917.00	1,591.00	13	6.5	874	AdBh0402	409,122	975,187	2,103	15	14
52	koka	504,498.00	932,331.00	1,589.00	13	6.5	875	AdBh0403	415,528	977,263	2,075	8	7
53	Koka	502,595.00	934,137.00	1,610.00	13	9	876	AdBh0403A	475,000	1,001,300	2,545	168	74
54	BHC9	409,122.00	975,187.00	2,107.00	15	14	877	AdBh0404	416,140	977,209	2,074	8	7
55	Teji	427,600.00	965,072.00	2,111.00	16	11.5	878	AdBh0404A	473,400	999,600	2,498	58	21
56	Teji	426,797.00	962,881.00	2,126.00	18	10	879	AdBh0405	415,715	976,666	2,076	7	6
57	Holleta	456,856.00	1,001,081.00	2,069.00	20	18	880	AdBh0406	418,707	974,898	2,077	12	10
58	Holleta	456,212.00	1,005,371.00	2,675.00	20	18	881	AdBh0407	423,375	973,439	2,086	20	19
59	Teji	423,501.00	968,410.00	2,102.00	21	15.5	882	AdBh0408	441,366	977,899	2,062	10	8
60	Teji	419,790.00	961,061.00	2,150.00	24	18.5	883	AdBh0409	441,901	981,393	2,064	7	6

61	AA-Brewery-4	471,400.00	996,000.00	2,345.00	32.4	23	884	AdBh0409A	474,200	997,400	2,427	200	0
62	AA-Brewery-2	471,500.00	995,900.00	2,345.00	34	17	885	AdBh0410	441,831	983,807	2,078	50	6
63	AA-Brewey-1	471,600.00	995,800.00	2,345.00	34	19	886	AdBh0410A	471,300	998,200	2,453	88	17
64	Teji	407,454.00	953,575.00	2,280.00	36	3	887	AdBh0411	530,792	940,526	1,610	210	173
65	Wajitu1	436,632.00	993,521.00	2,186.00	39	11.7	888	AdBh0411A	469,800	996,300	2,368	52	17
66	Military camp	444,626.00	1,001,031.00	2,366.00	40	0.5	889	AdBh0412A	469,900	996,000	2,350	67	14
67	Adwa Elour Mlil	476,000.00	980,900.00	2,060.00	40	13	890	AdBh0413	491,300	1,004,800	2,448	95	5
68	AA-Ethio iron B	476,426.00	980,749.00	2,060.00	43.7	4	891	AdBh0413A	469,800	996,200	2,369	60	7
69	Ethiopian Iron A	476,426.96	980,749.41	2,060.00	43.7	4	892	AdBh0414	478,007	971,121	2,183	186	137
70	AA-Coca Cola f	470,000.00	996,400.00	2,338.00	44	14	893	AdBh0414A	478,450	995,600	2,358	171	87
71	BHC57	429,252.00	993,949.00	2,099.00	45	15	894	AdBh0416	427,000	1,095,000	2,577	100	7
72	Teji	430,099.00	974,305.00	2,078.00	46	1.8	895	AdBh0417	515,109	943,100	1,738	160	68
73	Albergo Italia	471,300.00	996,200.00	2,340.00	47	6	896	AdBh0426	440,595	1,000,333	2,386	170	81
74	ALERT-1 Gate	468,000.00	993,200.00	2,315.00	47.9	16.8	897	AdBh0427	469,725	994,250	2,328	142	17
75	Kawo giyrgis1	445,271.00	990,389.00	2,225.00	50	5	898	AdBh0428	402,350	951,544	2,442	60	27
76	BHC35	441,831.00	983,807.00	2,041.00	50	6	899	AdBh0429	393,964	957,477	2,501	61	39
77	Geresu seda1	446,166.00	992,510.00	2,261.00	50	7	900	AdBh0430	397,276	954,511	2,401	61	17
78	Nano gelgel	441,584.00	1,003,445.00	2,453.00	50	11	901	AdBh0430A	472,000	995,100	2,331	56	44
79	Holleta	441,584.00	1,003,445.00	2,446.00	50	11	902	AdBh0431	397,540	953,574	2,381	60	18
80	Berga	432,360.00	1,024,158.00	2,612.00	50	12	903	AdBh0432	396,861	952,816	2,383	36	20
81	Geresu seda2	446,120.00	990,922.00	2,249.00	50	13	904	AdBh0433	398,182	951,093	2,372	62	14
82	Teji	429,208.00	973,367.00	2,075.00	51	13	905	AdBh0433A	471,300	995,050	2,326	114	0
83	Minilik Hospital	475,200.00	999,200.00	2,440.00	51	39	906	AdBh0434	400,409	954,207	2,374	48	22
84	Meher Fiber Fac	475,662.00	980,783.00	2,055.00	51.8	27.4	907	AdBh0435	398,901	951,499	2,395	60	24
85	Meher Fiber Fac	475,662.32	980,783.83	2,055.00	51.8	27.4	908	AdBh0436	400,317	931,223	2,143	66	38
86	AA-Armay hosp	469,800.00	996,300.00	2,350.00	51.9	16.5	909	AdBh0437	394,200	944,338	2,210	62	37
87	Berga	433,354.00	1,026,420.00	2,634.00	52	13	910	AdBh0438	562,106	1,070,685	2,793	108	13
88	AA-Darge-Suq,	464,300.00	990,600.00	2,290.00	52	14.4	911	AdBh0439	562,015	1,071,000	2,795	95	12
89	Darge - Suq, WS	464,300.00	990,600.00	2,290.00	52	14.4	912	AdBh0439A	469,700	994,500	2,339	152	7
90	AA-Brewery-7	471,500.00	995,800.00	2,345.00	52	16	913	AdBh0440	559,369	1,067,725	2,773	100	6
91	Holleta	439,145.00	984,613.00	2,066.00	53	12	914	AdBh0441	559,318	1,066,823	2,755	93	6
92	Akaki Indo-Euro	476,500.00	981,300.00	2,055.00	53.3	3.7	915	AdBh0442	559,432	1,066,077	2,760	102	3
93	Akaki Indo-Euro	476,500.00	981,300.00	2,055.00	53.3	3.7	916	AdBh0443	560,802	1,070,783	2,786	76	11
94	Gegel Kuyu	444,580.00	1,003,443.00	2,447.00	54	9	917	AdBh0444	424,000	952,736	2,176	112	5
95	Legadadi-Dini	486,000.00	1,000,707.00	2,485.00	54	12	918	AdBh0445	381,500	933,000	1,921	100	7
96	Teji	426,628.00	974,181.00	2,083.00	55	14	919	AdBh0446	474,395	995,211	2,352	153	59
97	Holleta	443,668.00	996,174.00	2,242.00	56	5	920	AdBh0449A	468,000	993,200	2,295	48	17
98	Holleta	450,781.00	1,003,650.00	2,628.00	56	10	921	AdBh0450	393,191	944,399	2,152	47	0
99	D/Z-Veternary C	500,078.00	968,505.00	1,880.00	56	14.5	922	AdBh0451	471,200	993,700	2,305	85	23
100	AA-Ghion Hotel	473,300.00	996,200.00	2,344.00	56.4	7.6	923	AdBh0453	473,000	992,700	2,289	121	111
101	Genet Hotel	472,000.00	995,100.00	2,320.00	56.4	44	924	AdBh0456	472,900	992,500	2,280	156	90
102	Holleta	445,586.00	980,715.00	2,063.00	57	12	925	AdBh0458	474,300	992,700	2,280	129	89
103	Teji	424,930.00	969,669.00	2,092.00	57	18	926	AdBh0459	475,600	994,500	2,323	139	41
104	Holleta	454,717.00	1,008,229.00	2,704.00	57	30	927	AdBh0461A	473,200	992,400	2,287	72	40
105	Teji	428,912.00	972,242.00	2,080.00	58	9	928	AdBh0462A	473,200	992,400	2,287	69	29
106	SEDE(Plant B)-1	474,000.00	989,100.00	2,225.00	58	18	929	AdBh0463	473,100	991,900	2,285	154	113
107	AA-Civil Aviatio	469,800.00	996,200.00	2,342.00	60	7	930	Adbh0468A	473,848	990,072	2,255	100	39
108	Teji	418,607.00	938,096.00	2,383.00	60	7	931	AdBh0471A	473,600	988,300	2,192	102	11
109	Holleta	441,387.00	1,006,352.00	2,525.00	60	9	932	AdBh0474	473,900	989,000	2,225	201	35
110	Holleta	442,841.00	984,089.00	2,080.00	60	9	933	AdBh0477	475,000	987,800	2,164	172	28
111	Holleta	442,852.00	994,420.00	2,240.00	60	12	934	AdBh0485	475,335	980,717	2,074	179	17
112	Holleta	458,973.00	1,006,847.00	2,676.00	60	12	935	Adbh0486	476,500	981,300	2,065	53	4
113	Holleta	443,048.00	982,810.00	2,070.00	60	12	936	AdBh0487	476,600	981,500	2,061	126	4
114	Holleta	445,155.00	989,387.00	2,233.00	60	12	937	AdBh0489	481,507	976,220	2,130	132	120
115	Teji	415,757.00	950,641.00	2,247.00	60	17	938	AdBh0491	476,400	980,700	2,062	126	53
116	Teji	418,098.00	953,728.00	2,202.00	60	18	939	AdBh0495	477,400	979,500	2,084	96	27
117	Teji	416,967.00	949,964.00	2,235.00	60	19	940	AdBh0497	477,232	978,999	2,077	82	52
118	Teji	423,548.00	968,423.00	2,103.00	60	19	941	AdBh0499	476,600	978,200	2,071	79	46
119	Teji	405,805.00	956,128.00	2,286.00	60	31.5	942	Adbh0500	475,300	983,800	2,122	93	0
120	Water III monito	476,523.00	976,374.00	2,054.70	60	35.55	943	AdBh0501	473,900	1,001,050	2,566	200	15
121	D/Z-Girma Gebr	495,561.00	968,574.00	1,906.00	60	49.9	944	AdBh0501A	475,300	984,000	2,115	129	0

122	BHC4	451,420.00	971,692.00	2,050.00	60	58	945	AdBh0507	474,300	1,001,005	2,521	83	22
123	Holleta	436,595.00	1,009,670.00	2,568.00	61	30	946	AdBh0509	467,200	1,001,017	2,536	150	35
124	BHC8	460,464.00	974,637.00	2,081.00	61	38	947	AdBh0510	468,400	1,001,016	2,548	192	3
125	AA-Ethio Iron B	476,430.00	980,669.00	2,060.00	62	6.5	948	AdBh0511	466,600	1,001,003	2,518	153	23
126	Ethiopian Iron A	476,430.00	980,669.17	2,060.00	62	6.5	949	AdBh0512	468,300	1,001,003	2,545	63	41
127	Ministry of Mine	471,800.00	995,500.00	2,335.00	62	7.5	950	AdBh0513	468,800	1,001,007	2,540	42	18
128	Teji	417,672.00	961,937.00	2,152.00	62.5	16	951	AdBh0514	468,900	1,001,007	2,548	116	72
129	Teji	420,920.00	961,055.00	2,152.00	62.5	24	952	AdBh0515	469,900	1,001,000	2,589	80	7
130	Teji	423,439.00	988,990.00	2,079.00	63	21.5	953	AdBh0518	474,000	999,400	2,475	50	7
131	Teji	427,444.00	971,000.00	2,087.00	63	23	954	AdBh0522	473,300	999,300	2,479	27	18
132	AAWSA/IAEA	475,402.00	976,807.00	2,060.00	63	31.4	955	AdBh0524	475,600	998,900	2,422	90	20
133	Akaki Indo-Euro	476,369.00	981,717.00	2,062.00	63.7	7	956	AdBh0525	480,400	998,500	2,458	47	30
134	Akaki Indo-Euro	476,369.03	981,717.33	2,062.00	63.7	7	957	AdBh0526	476,500	998,250	2,448	58	22
135	AA-Brewery-3	471,400.00	995,800.00	2,345.00	64	12	958	AdBh0527	476,450	998,100	2,437	85	11
136	Alem Gena-	463,600.00	988,200.00	2,280.00	64	27.5	959	AdBh0527A	463,600	988,200	2,281	64	28
137	BHC51	463,600.00	988,200.00	2,248.00	64	28	960	AdBh0528	476,100	998,300	2,435	54	17
138	Holleta	447,370.00	1,012,723.00	2,659.00	64	47	961	AdBh0536	486,200	1,001,042	2,472	100	18
139	Akaki Textile Mi	476,350.00	981,300.00	2,060.00	65	7.4	962	AdBh0538	470,000	996,400	2,353	44	14
140	AA-Batu Tanner	473,466.00	987,247.00	2,165.00	65	9.25	963	AdBh0540	470,100	996,100	2,351	45	30
141	BHC15	444,624.00	978,143.00	2,048.00	65	10	964	AdBh0548	473,400	996,400	2,354	200	0
142	Teji	418,601.00	950,317.00	2,215.00	65	23	965	AdBh0549	473,400	996,300	2,352	249	0
143	Tefki	444,624.00	978,143.00	2,074.00	65.4	9.6	966	AdBh0550	473,100	996,400	2,348	249	0
144	Teji	444,624.00	978,143.00	2,074.00	65.4	9.6	967	AdBh0551	473,200	996,300	2,347	0	57
145	Kokebe Thebah	476,200.00	998,600.00	2,410.00	66	10	968	AdBh0552	473,200	996,400	2,347	100	0
146	Holleta	444,642.00	1,002,960.00	2,409.00	66	49	969	AdBh0553	473,300	996,100	2,347	78	0
147	Mulugeta Buli	444,642.00	1,002,960.00	2,427.00	66	49.4	970	AdBh0554	473,300	996,200	2,348	56	8
148	AA-Burayu Sima	465,161.00	1,003,103.00	2,610.00	66.7	18.24	971	AdBh0555	473,300	996,300	2,347	60	59
149	BHC72	459,700.00	998,075.00	2,562.00	67	10	972	AdBh0556	473,400	995,800	2,347	50	6
150	Tatek Tor Sefer-	459,700.00	998,075.00	2,580.00	67	10.2	973	AdBh0558	472,900	995,900	2,359	32	2
151	Tatek Tor Sefer-	459,700.00	998,075.00	2,580.00	67	10.2	974	AdBh0560	473,000	996,300	2,348	80	2
152	Koka	507,540.00	938,099.00	1,665.00	67	28	975	AdBh0561	472,700	996,300	2,355	20	7
153	AA-Awash Wine	469,900.00	996,000.00	2,335.00	67.1	13.7	976	AdBh0562	472,500	996,300	2,361	41	9
154	Kokeb Flour and	473,230.00	988,878.00	2,200.00	67.6	13.7	977	AdBh0565	471,400	995,900	2,346	67	26
155	AA-kality Elsa F	474,641.00	985,622.00	2,155.00	68	8.2	978	AdBh0566	471,600	995,800	2,352	34	19
156	D/Z-Almaz Ayel	499,320.00	970,175.00	1,890.00	68	18.9	979	AdBh0567	471,500	995,900	2,349	34	17
157	Korea Embassy	468,425.00	996,350.00	2,320.00	68	19.6	980	AdBh0568	471,400	995,800	2,344	64	12
158	Korea Embassy,	468,425.00	996,350.00	2,320.00	68	19.6	981	AdBh0569	471,400	996,000	2,348	32	23
159	Akaki BABRGU	474,645.00	985,501.00	2,130.00	68	92.3	982	AdBh0570	471,500	996,000	2,350	46	19
160	AA-United Oil n	473,200.00	992,400.00	2,287.00	68.5	29	983	AdBh0571	471,550	995,950	2,352	44	23
161	Mulugeta Buli	443,984.00	999,625.00	2,306.00	70	10	984	AdBh0572	471,500	995,800	2,348	52	16
162	Holleta	443,984.00	999,625.00	2,298.00	70	10	985	AdBh0573	471,300	995,800	2,342	85	8
163	Teji	430,472.00	971,529.00	2,092.00	70	25	986	AdBh0575A	477,162	976,038	2,066	135	42
164	Koka	507,356.00	937,804.00	1,655.00	70	40	987	AdBh0575B	477,856	976,402	2,068	151	45
165	Lome	502,000.00	933,000.00	1,600.00	70	45	988	AdBh0579	471,800	995,500	2,345	62	8
166	Genesis Farm, D	495,447.00	968,068.00	1,902.00	70	49.68	989	AdBh0580	471,300	995,400	2,332	101	0
167	Galetti Project	474,800.00	984,700.00	2,140.00	71.3	0.5	990	AdBh0582	471,300	994,800	2,315	62	4
168	Galetti Project	474,800.00	984,700.00	2,140.00	71.3	0.5	991	AdBh0583	470,900	994,800	2,307	119	1
169	Peacock Park, B	475,300.00	994,800.00	2,318.00	71.5	60.9	992	AdBh0584	471,700	995,100	2,326	62	7
170	AA-Military Foo	473,900.00	985,100.00	2,165.00	72	8	993	AdBh0585	471,700	995,000	2,321	80	11
171	Military Food Se	473,900.00	985,100.00	2,165.00	72	8	994	AdBh0587	471,700	994,900	2,316	56	10
172	Berga	427,355.00	994,914.00	2,125.00	72	14	995	AdBh0588	469,300	995,500	2,356	107	16
173	Holleta	427,355.00	994,914.00	2,125.00	72	14.25	996	AdBh0590	471,700	986,600	2,259	81	26
174	D/Z-Airforce No	499,500.00	964,500.00	1,890.00	72	30.5	997	AdBh0590A	481,205	976,968	2,143	184	121
175	AA-Water lll Tes	479,400.00	981,400.00	2,133.50	74	2.8	998	AdBh0591	471,200	995,700	2,343	192	3
176	Water III Testwe	479,400.00	981,400.00	2,133.50	74	2.8	999	AdBh0593	471,300	996,200	2,353	47	6
177	D/Z-Dugda PLC	502,364.00	970,907.00	1,893.00	74	23.78	1000	AdBh0596	471,700	996,300	2,358	96	41
178	ARI	445,773.00	1,001,323.00	2,388.00	74.5	30.35	1001	AdBh0598	466,300	993,100	2,336	112	60
179	Holleta	445,773.00	1,001,323.00	2,380.00	75	30	1002	AdBh0600	466,250	993,050	2,338	142	50
180	Adey Abebe Co	473,800.00	990,250.00	2,247.00	75	37.8	1003	AdBh0601	467,200	993,600	2,331	84	48
181	AA-Gulele Misio	465,651.00	1,001,575.00	2,540.00	76	7.3	1004	AdBh0603	468,100	993,100	2,303	80	50

182	Progress/Edget (	471,000.00	993,800.00	2,305.00	76	68	1005	AdBh0604	468,100	993,200	2,299	83	45
183	AA-Ghion Hotel	473,300.00	996,100.00	2,342.00	77.7	0	1006	AdBh0605	471,000	993,800	2,306	76	68
184	Kurtusi flower	448,290.00	1,002,698.00	2,413.00	78	10.2	1007	AdBh0606	473,334	997,204	2,371	355	4
185	Akaki Tele	476,600.00	978,200.00	2,065.00	79.2	46.4	1008	AdBh0607	472,000	993,500	2,281	92	51
186	Akaki Telecomn	476,600.00	978,200.00	2,065.00	79.2	46.4	1009	AdBh0609	473,100	992,600	2,289	84	36
187	Akaki Metal Pro	476,500.00	981,500.00	2,070.00	79.2	73	1010	AdBh0610	473,500	992,900	2,306	162	123
188	BHC29	453,538.00	982,154.00	2,068.00	80	8	1011	AdBh0611	481,650	997,725	2,416	145	43
189	Shimbira Meda	500,766.00	973,335.00	1,905.00	80	22.64	1012	AdBh0612	474,300	993,300	2,319	214	126
190	Shimbra Meda	501,422.00	973,727.00	1,910.00	80	24.1	1013	AdBh0617	473,100	991,800	2,283	94	56
191	Tafo, Ropack	487,800.00	1,002,200.00	2,488.00	80	24.8	1014	AdBh0618	473,100	991,900	2,285	154	113
192	Modjo#3	512,408.00	948,682.00	1,782.00	80	34.14	1015	AdBh0619	473,050	991,800	2,281	136	94
193	Modjo#2	511,976.00	948,671.00	1,786.00	80	35.34	1016	Adbh0621	470,465	991,100	2,223	124	16
194	D/Z-Airforce	499,228.00	964,796.00	1,910.00	80	43.07	1017	AdBh0623	470,250	991,500	2,235	40	8
195	ALERT-2 West	468,100.00	993,100.00	2,320.00	80	50	1018	AdBh0625	470,300	991,200	2,229	20	10
196	BHC24	447,966.00	980,422.00	2,052.00	80	54	1019	AdBh0626	470,400	992,100	2,240	91	11
197	D/Z-Sahilu	494,829.00	967,088.00	1,917.00	80	64.1	1020	AdBh0629	471,400	991,000	2,248	38	26
198	D/Z-Green Star	494,598.00	967,157.00	1,896.00	80	66.78	1021	AdBh0630	473,800	990,250	2,260	75	38
199	Shimbira Meda	500,494.00	974,376.00	1,914.00	80.5	24.87	1022	AdBh0633	473,750	990,050	2,253	146	52
200	Ginchi	404,656.00	997,733.00	2,235.00	81	21.5	1023	AdBh0634	473,500	987,900	2,184	91	9
201	BHC71	404,656.00	997,733.00	2,230.00	81	22	1024	AdBh0636	482,770	997,150	2,387	137	35
202	AA-Hana Mariar	471,700.00	986,600.00	2,220.00	81	26.1	1025	AdBh0638	473,230	988,879	2,210	68	14
203	Shimbira meda	500,424.00	974,376.00	1,914.00	81.7	30.6	1026	AdBh0639	473,900	989,000	2,225	202	45
204	Akaki Metal Pro	477,232.61	978,999.84	2,070.00	82.3	51	1027	AdBh0640	474,000	989,100	2,226	58	18
205	Akaki Metal Pro	477,446.27	978,851.17	2,070.00	82.3	52.4	1028	AdBh0641	474,100	989,000	2,221	126	35
206	Berga	427,749.00	995,048.00	2,132.00	82.8	10	1029	AdBh0644	474,050	996,650	2,382	400	10
207	Holleta	427,749.00	995,048.00	2,132.00	82.8	11	1030	AdBh0645	473,300	987,700	2,160	103	45
208	Sebeta-Aztoki In	463,635.00	988,675.00	2,296.00	83	26.82	1031	AdBh0646	473,300	987,300	2,157	120	35
209	Dewara Gua NW	471,704.70	973,385.90	2,062.00	83	42.6	1032	AdBh0648A	468,100	1,016,250	2,579	193	3
210	AA-Alert-3 Well	468,100.00	993,200.00	2,300.00	83	45	1033	AdBh0649	475,000	985,800	2,164	120	0
211	ALERT-3 East V	468,100.00	993,200.00	2,325.00	83	45	1034	AdBh0650	466,050	993,650	2,366	140	71
212	Akaki Koye Air (	482,400.00	983,000.00	2,230.00	83.3	56.15	1035	AdBh0652	475,662	980,783	2,071	52	27
213	AAWSA, Lafto	471,400.00	988,250.00	2,205.00	84	12.5	1036	AdBh0656	476,369	981,717	2,089	64	7
214	Voice of Revolu	467,200.00	993,600.00	2,330.00	84	48	1037	AdBh0658	476,400	980,600	2,062	120	17
215	AA-Brewery-8	471,300.00	995,800.00	2,345.00	85	7.6	1038	AdBh0660	465,600	1,001,855	2,555	83	56
216	AA-Anbessa/Wa	471,200.00	993,700.00	2,300.00	85	23.3	1039	AdBh0661	476,400	984,800	2,133	90	12
217	Anbessa/Walya '	471,200.00	993,700.00	2,300.00	85	23.3	1040	AdBh0662	474,800	984,700	2,146	71	1
218	Tatek Tor Sefer-	459,375.00	998,350.00	2,600.00	86	24.5	1041	AdBh0666	477,446	978,851	2,081	82	52
219	St. Gabriel Hosp	476,750.00	995,800.00	2,342.00	86	53.2	1042	AdBh0668	476,500	981,500	2,062	79	73
220	Bui	465,566.00	922,885.00	1,799.00	86	56	1043	AdBh0671	476,000	980,900	2,068	40	13
221	Aa-Ethio-Meat	473,326.00	986,813.00	2,180.00	86.7	25.2	1044	AdBh0675	465,243	1,003,393	2,635	115	26
222	Ethio-Meat Conc	473,500.00	987,600.00	2,180.00	86.7	25.2	1045	AdBh0676	475,200	999,200	2,450	51	39
223	AA-Anwar Mos	471,300.00	998,200.00	2,445.00	87.5	16.5	1046	AdBh0683	472,400	998,500	2,458	43	5
224	AA-Brewery-9	471,400.00	995,900.00	2,345.00	88	16.8	1047	AdBh0689	472,500	996,600	2,369	29	7
225	Addis Beer-9	471,400.00	995,900.00	2,345.00	88	18.75	1048	AdBh0694	465,507	1,002,282	2,562	178	2
226	Berga	427,195.00	994,947.00	2,125.00	89.7	15	1049	AdBh0703	470,950	995,225	2,319	115	0
227	Holleta	427,195.00	994,947.00	2,125.00	89.75	16.73	1050	AdBh0706	472,700	996,500	2,356	186	3
228	Townw.supply2	446,155.00	1,003,073.00	2,388.00	90	7	1051	AdBh0708	480,629	998,771	2,487	96	14
229	Holleta	446,155.00	1,003,073.00	2,367.00	90	7	1052	AdBh0710	470,500	994,500	2,326	170	42
230	AA-Kality Airfor	476,400.00	984,800.00	2,125.00	90	12	1053	AdBh0711	466,900	1,001,005	2,537	150	20
231	Kality Airforce-1	476,400.00	984,800.00	2,125.00	90	12	1054	AdBh0713	471,400	995,900	2,346	88	17
232	AA-Abay Mesk	473,010.00	992,710.00	2,292.00	90	23.67	1055	AdBh0715	478,462	977,721	2,084	150	50
233	Modjo#1	512,011.00	949,196.00	1,785.00	90	31.77	1056	AdBh0716	477,608	978,689	2,082	116	58
234	AA-National Bar	472,541.00	996,743.00	2,378.00	90	51.75	1057	AdBh0717	474,225	982,650	2,155	178	31
235	Teji	427,117.00	971,583.00	2,082.00	90.3	3	1058	AdBh0718	474,429	986,829	2,183	187	41
236	Awash Tannery-	473,500.00	987,900.00	2,195.00	90.5	9.1	1059	AdBh0719	475,300	983,800	2,122	140	0
237	Holleta	444,997.00	1,000,718.00	2,326.00	91	38	1060	AdBh0720	476,350	981,300	2,068	65	7
238	AAWSA/IAEA	482,950.00	963,800.00	1,860.00	91	67.11	1061	AdBh0722	480,431	998,457	2,455	181	15
239	Townw.supply3	444,997.00	1,000,718.00	2,356.00	91.2	37.5	1062	AdBh0723	455,000	985,200	2,238	126	51
240	D/Z-Health Coll	497,100.00	968,198.00	1,901.00	92	36.4	1063	AdBh0726	464,300	990,600	2,292	52	14

241	Sloughter House	472,000.00	993,500.00	2,260.00	92	50.5	1064	AdBh0727	473,000	992,700	2,289	90	24
242	Sidamo Awash \	479,819.84	977,155.55	2,085.00	92	62.5	1065	AdBh0728	474,050	1,000,875	2,560	156	15
243	AA-Kality Milita	475,310.00	983,810.00	2,105.00	93	0	1066	AdBh0729	473,326	986,813	2,157	87	25
244	AA-Cement Fac	473,100.00	991,800.00	2,280.00	93.9	56.4	1067	AdBh0730	478,462	977,506	2,081	123	50
245	AA-Repi Enyi G	464,538.00	991,302.00	2,300.00	94	5.33	1068	AdBh0730A	474,648	985,501	2,144	117	86
246	Abune Yosef Sc	467,150.00	992,150.00	2,275.00	94	29	1069	AdBh0731	476,426	980,749	2,063	44	4
247	D/Z-Blue Nile Pl	495,765.00	966,397.00	1,910.00	94	46.6	1070	AdBh0732	476,430	980,669	2,062	62	7
248	Legadadi	491,300.00	1,004,800.00	2,456.00	94.55	5.42	1071	AdBh0735	502,600	1,011,700	2,569	124	82
249	AA-Kotebe meta	480,629.00	998,771.00	2,471.00	96	13.6	1072	AdBh0736	489,200	1,001,025	2,446	0	31
250	AA-Burayu, ethi	464,600.00	1,003,075.00	2,620.00	96	14.45	1073	AdBh0737	483,093	976,323	2,156	207	138
251	Sendafa-Said Al	488,243.00	1,002,102.00	2,486.00	96	25.93	1074	AdBh0738	462,500	987,000	2,309	137	84
252	Akaki Ethio-Fibe	477,400.00	979,500.00	2,080.00	96	27.4	1075	AdBh0739	461,900	974,300	2,127	0	38
253	Akaki Ethio-fibe	477,400.00	979,500.00	2,080.00	96	27.4	1076	AdBh0745	459,700	998,075	2,581	67	10
254	BHC41	459,676.00	984,947.00	2,196.00	96	28	1077	AdBh0748	476,200	998,600	2,473	66	10
255	AA-Mekanisa-Sa	470,983.00	992,553.00	2,235.00	96	32.58	1078	AdBh0750	464,000	997,000	2,510	100	51
256	Africa Hotel	471,700.00	996,300.00	2,342.00	96	40.95	1079	AdBh0751	463,700	988,500	2,278	130	19
257	Dire high land	445,168.00	997,226.00	2,239.00	98	0	1080	AdBh0752	486,200	1,001,042	2,472	100	10
258	Holleta	444,168.00	998,992.00	2,278.00	98	7	1081	AdBh0753	481,200	980,000	2,159	150	11
259	BHC74	444,209.00	998,733.00	2,275.00	98	7	1082	AdBh0754	470,800	982,900	2,109	114	0
260	Agriservice flow	444,168.00	998,992.00	2,288.00	98	7.2	1083	AdBh0755	473,566	978,610	2,066	122	24
261	Galiyee	485,970.00	935,007.00	1,712.00	98	56.56	1084	AdBh0756	487,300	995,300	2,364	120	88
262	Busa-Boda#2	404,050.00	980,200.00	2,150.00	98.5	9.95	1085	AdBh0757	481,600	982,900	2,211	120	35
263	Holota-MetroLu	445,942.00	1,001,323.00	2,250.00	99	0	1086	AdBh0758	461,500	1,001,023	2,590	110	82
264	Metrolux flower.	445,942.00	998,199.00	2,394.00	99	0	1087	AdBh0759	466,200	988,800	2,249	100	0
265	AA-Water lll Tes	466,200.00	988,800.00	2,246.00	100	0	1088	AdBh0760	466,400	987,600	2,255	125	18
266	Water III Testw	466,200.00	988,800.00	2,246.00	100	0	1089	AdBh0761	481,200	980,000	2,159	173	9
267	AA-Water lll Tes	479,425.00	981,425.00	2,133.40	100	2.7	1090	AdBh0762	481,600	982,900	2,211	120	37
268	Water III Testw	479,400.00	981,400.00	2,133.40	100	2.7	1091	AdBh0763	479,400	981,400	2,130	100	3
269	BHC27	479,400.00	981,400.00	2,114.00	100	3	1092	AdBh0764	480,900	978,800	2,134	160	86
270	Top internationa	445,114.00	998,215.00	2,385.00	100	5.9	1093	AdBh0765	479,400	981,400	2,130	74	3
271	BHC73	444,677.00	998,215.00	2,274.00	100	6	1094	AdBh0766	479,340	981,400	2,130	109	1
272	Total Ras Hotel	472,700.00	996,300.00	2,343.00	100	6.8	1095	AdBh0767	481,600	982,850	2,210	136	33
273	Red Fox Flower	503,210.00	930,527.00	1,610.00	100	7.8	1096	AdBh0768	479,740	981,400	2,144	126	3
274	AA-Water lll Tes	486,200.00	1,001,042.00	2,450.00	100	10	1097	AdBh0769	473,069	979,881	2,061	116	6
275	Water III Testw	486,200.00	1,001,042.00	2,450.00	100	10	1098	AdBh0770	473,108	979,851	2,063	103	7
276	BHC11	442,842.00	977,555.00	2,052.00	100	14	1099	AdBh0771	477,972	974,859	2,084	133	59
277	Tafki golden Ro	442,842.00	977,555.00	2,074.00	100	14.15	1100	AdBh0772	478,399	975,589	2,078	122	53
278	BHC13	444,000.00	977,700.00	2,058.00	100	17	1101	AdBh0773	480,517	977,974	2,106	170	65
279	Tefki-Golden Ro	444,000.00	977,700.00	2,055.00	100	17.12	1102	AdBh0774	478,713	974,977	2,087	130	64
280	Teji	444,000.00	977,700.00	2,055.00	100	17.12	1103	AdBh0775	477,992	975,552	2,073	132	48
281	BHC75	444,677.00	998,808.00	2,293.00	100	21	1104	AdBh0776	476,574	975,607	2,074	142	51
282	Ama flower	444,677.00	998,888.00	2,306.00	100	21.3	1105	AdBh0777	479,696	976,936	2,093	145	68
283	BHC46	460,500.00	986,500.00	2,256.00	100	27	1106	AdBh0778	479,405	976,735	2,090	151	67
284	AA-Sebeta Agro	460,500.00	986,500.00	2,285.00	100	27.12	1107	AdBh0779	479,061	976,370	2,091	144	67
285	Modjo Bekele M	513,423.00	948,940.00	1,784.00	100	37.2	1108	AdBh0780	479,246	977,104	2,081	146	59
286	AA-Adey Abeba	473,848.00	990,072.00	2,247.00	100	39.3	1109	AdBh0781	479,058	976,020	2,095	130	72
287	Adey Abebe Co	473,848.00	990,072.00	2,260.00	100	40.7	1110	AdBh0782	478,780	977,307	2,084	138	61
288	Water III Testw	464,000.00	997,000.00	2,480.00	100	51	1111	AdBh0783	478,808	976,867	2,076	152	48
289	Holleta	445,180.00	1,002,459.00	2,381.00	101	23	1112	AdBh0784	478,694	976,490	2,078	119	50
290	Holota-Agri	445,180.00	1,002,459.00	2,393.00	101	23.3	1113	AdBh0785	478,580	976,051	2,085	130	59
291	AA-Meta Abo B	455,300.00	985,250.00	2,218.00	101	37.5	1114	AdBh0786	478,347	976,752	2,071	148	48
292	Meta Abo Brew	455,300.00	985,250.00	2,218.00	101	68	1115	AdBh0787	478,199	976,361	2,070	144	46
293	Awash Tannery-	473,600.00	988,300.00	2,195.00	101.8	11.3	1116	AdBh0788	478,154	975,966	2,079	140	54
294	Ethio- Pickling a	473,225.00	989,850.00	2,205.00	102	12	1117	AdBh0789	478,019	977,985	2,077	150	52
295	Gafat#1	507,491.00	952,694.00	1,862.00	102	40.1	1118	AdBh0790	477,945	976,985	2,073	148	50
296	BHC28	460,810.00	981,473.00	2,203.00	102	67	1119	AdBh0792	477,651	975,923	2,072	142	48
297	BHC20	473,108.00	979,851.00	2,049.00	103	7	1120	AdBh0793	477,477	977,216	2,068	145	44
298	AA-Watet lll Tes	473,108.00	979,851.00	2,058.34	103	7.07	1121	AdBh0794	477,330	976,793	2,066	130	43
299	Water III Testw	473,108.00	979,851.00	2,058.34	103	7.07	1122	AdBh0796	477,181	975,680	2,072	116	51
300	AA-Ethio-Spice	473,300.00	987,700.00	2,161.00	103	44.7	1123	AdBh0797	476,454	976,951	2,063	129	42
301	Holleta	457,823.00	1,002,833.00	2,601.00	104	3	1124	AdBh0798	476,523	976,374	2,060	60	36
302	AA-Gulele Misic	465,600.00	1,001,855.00	2,545.00	104	13.2	1125	AdBh0799	476,972	976,152	2,065	120	40

303	Akaki Beverly	480,895.00	977,403.00	2,120.00	104	84.8	1126	AdBh0800	477,185	975,729	2,071	114	47
304	Sino-Ethiopia Su	493,497.00	968,497.00	1,918.00	105	66.6	1127	AdBh0801	479,942	977,322	2,088	0	64
305	AA-Sebeta Agro	460,850.00	985,850.00	2,260.00	106	43	1128	AdBh0802	478,450	979,950	2,117	0	56
306	Berga	427,626.00	994,817.00	2,126.00	108	13	1129	AdBh0803	479,526	977,468	2,094	129	72
307	Holleta	427,626.00	994,817.00	2,126.00	108	14.1	1130	AdBh0804	479,021	977,596	2,088	126	73
308	D/Z-Hospital	492,987.00	967,055.00	1,928.00	108	42.45	1131	AdBh0805	478,998	977,937	2,099	130	73
309	D/Z-Oxford	493,179.00	968,613.00	1,919.00	108	74.37	1132	AdBh0807	477,900	982,875	2,135	52	20
310	Akaki Water S. I	479,340.00	981,400.00	2,131.33	108.7	0.73	1133	AdBh0808	478,775	983,133	2,164	50	24
311	Akaki Water Sup	479,340.00	981,400.00	2,131.33	108.7	0.73	1134	AdBh0811	486,006	974,882	2,068	0	96
312	AA-Sansuzi, AA	465,900.00	1,002,875.00	2,600.00	110	15.75	1135	AdBh0812	487,900	972,421	1,951	135	76
313	Holleta	465,900.00	1,002,875.00	2,607.00	110	16	1136	AdBh0814	481,694	965,913	1,925	0	95
314	AA-Water lll Tes	461,500.00	1,001,023.00	2,630.00	110	82	1137	AdBh0815	484,325	969,692	1,953	0	118
315	Water III Testwe	461,500.00	1,001,023.00	2,630.00	110	82	1138	AdBh0822	488,391	961,066	1,951	180	148
316	Ethio Drim	440,079.00	1,000,151.00	2,410.00	112	0	1139	AdBh0833	499,700	1,008,450	2,517	0	4
317	Bantu-Areda Lek	424,000.00	952,736.00	2,169.00	112	5.37	1140	AdBh0835	496,147	967,674	1,888	0	40
318	Hope Enterprise	466,300.00	993,100.00	2,317.00	112	60	1141	AdBh0838	473,350	1,003,000	2,685	150	10
319	Modjo#4	511,927.00	948,292.00	1,770.00	113.5	8.3	1142	AdBh0849	496,159	966,870	1,900	74	41
320	AA-Water lll Tes	470,800.00	982,900.00	2,110.00	114	0	1143	AdBh0855	484,190	998,500	2,492	140	45
321	AA-Defence Inst	471,300.00	995,050.00	2,326.00	114	0	1144	AdBh0856	485,925	1,000,975	2,486	200	8
322	Water III Testwe	470,800.00	982,900.00	2,090.00	114	0	1145	AdBh0857	486,000	1,001,115	2,483	130	10
323	AA-Tibebu Hos	471,799.00	999,371.00	2,484.00	114	8.45	1146	AdBh0859	491,300	1,004,800	2,448	95	5
324	BHC47	460,937.00	986,565.00	2,275.00	114	46	1147	AdBh0860	482,070	999,823	2,539	117	80
325	Water III monito	477,185.00	975,729.00	2,068.70	114	46.5	1148	AdBh0863	466,175	1,001,800	2,566	0	26
326	Gafat#2	508,079.00	952,013.00	1,822.00	114.5	7.9	1149	AdBh0864	465,900	1,002,875	2,613	110	16
327	Holleta	457,162.00	1,001,115.00	2,615.00	115	7	1150	AdBh0868	464,600	1,003,075	2,633	96	14
328	AA-Tadele Gele	465,243.00	1,003,930.00	2,615.00	115	26.17	1151	AdBh0869	483,750	994,550	2,346	230	51
329	Holleta	453,522.00	1,001,474.00	2,550.00	115	58	1152	AdBh0872	476,750	985,800	2,142	86	53
330	Menagaesha flov	453,145.00	1,001,365.00	2,551.00	115	73	1153	AdBh0873	479,450	995,800	2,353	0	32
331	Dukem-Industria	490,000.00	968,000.00	1,900.00	115	94.85	1154	AdBh0878	466,440	1,001,760	2,564	66	18
332	Holota-Jerico flo	453,522.00	1,001,474.00	2,562.00	115.25	57.84	1155	AdBh0879	474,075	989,600	2,236	60	24
333	Jordan R.herbs	453,522.00	1,001,417.00	2,556.00	115.3	57.84	1156	AdBh0881	473,760	987,300	2,182	0	23
334	AA-water lll Tes	473,069.00	979,881.00	2,057.40	116	5.8	1157	AdBh0882	473,925	987,175	2,182	72	16
335	Water III Testwe	473,069.00	979,881.00	2,057.40	116	5.8	1158	AdBh0884	455,475	994,995	2,838	152	61
336	BHC21	473,069.00	979,881.00	2,048.00	116	6	1159	AdBh0886	475,650	984,750	2,119	0	57
337	Holleta	443,132.00	1,000,869.00	2,375.00	116	30	1160	AdBh0887	467,150	992,150	2,280	94	29
338	Water III Boreho	477,181.00	975,680.00	2,070.10	116	51	1161	AdBh0888	455,350	985,100	2,188	128	70
339	AA-NMWC Pur	477,608.00	978,689.00	2,090.00	116	57.7	1162	AdBh0889	455,300	985,250	2,198	101	38
340	NMWC Pump F	477,608.90	978,689.70	2,090.00	116	57.7	1163	AdBh0890	455,525	984,000	2,146	124	63
341	AA-Jehova Well	483,350.00	999,064.00	2,487.00	116	59	1164	AdBh0891	455,550	983,750	2,138	181	47
342	D/Z-New well	492,803.00	969,204.00	1,906.00	116.3	64.3	1165	AdBh0892	444,000	977,700	2,068	100	17
343	AA-Kotebe, Sela	482,070.00	999,823.00	2,526.00	117	79.56	1166	AdBh0895	460,850	985,850	2,251	106	43
344	Kotebe, Selam V	481,650.00	998,650.00	2,460.00	117	79.56	1167	AdBh0896	460,500	986,500	2,296	100	27
345	Water III Boreho	478,694.00	976,490.00	2,074.20	119	50.2	1168	AdBh0897	468,650	995,450	2,342	126	26
346	AAWSA Kality	475,000.00	985,800.00	2,112.00	120	0	1169	AdBh0898	468,650	999,800	2,488	172	69
347	AAWSA F1 at F	479,000.00	981,400.00	2,120.00	120	10	1170	AdBh0900	467,100	1,000,550	2,514	142	12
348	AA-Nigeria Emb	472,700.00	999,800.00	2,485.00	120	11.7	1171	AdBh0901	464,500	1,003,150	2,629	0	6
349	Sebeta Tal Flow	455,450.00	983,014.00	2,110.00	120	14.56	1172	AdBh0902	482,400	983,000	2,243	83	56
350	BHC50	465,419.00	987,294.00	2,249.00	120	15	1173	AdBh0903	474,500	995,450	2,346	201	66
351	BHC32	455,450.00	983,014.00	2,091.00	120	15	1174	AdBh0904	468,800	996,600	2,372	124	50
352	AA-Ethio-Metal	476,400.00	980,600.00	2,056.00	120	16.9	1175	AdBh0905	468,200	1,001,600	2,572	150	46
353	Ethio-Metal Mea	476,400.00	980,600.00	2,056.00	120	16.9	1176	AdBh0907	469,050	994,450	2,329	120	27
354	AA-Vatican	470,950.00	993,300.00	2,290.00	120	18.93	1177	AdBh0908	468,425	996,350	2,329	68	20
355	AA-Algeria emb	469,727.00	993,542.00	2,324.00	120	22.24	1178	AdBh0909	469,280	993,350	2,303	122	20
356	WWDA Ware h	473,300.00	987,300.00	2,163.00	120	25.2	1179	AdBh0910	468,875	993,750	2,304	130	11
357	Ato Temesgen C	469,050.00	994,450.00	2,260.00	120	26.5	1180	AdBh0912	473,900	993,100	2,313	201	118
358	BHC58	469,050.00	994,450.00	2,297.00	120	27	1181	AdBh0915	470,950	993,300	2,298	120	19
359	Water III Testwe	481,600.00	982,900.00	2,205.00	120	35.1	1182	AdBh0917	467,250	999,800	2,513	70	59
360	AA-Water lll Tes	481,615.00	982,915.00	2,205.00	120	35.1	1183	AdBh0918	474,250	996,800	2,386	205	40

361	AA-WWDA Wa	473,300.00	987,300.00	2,163.00	120	35.39	1184	AdBh0919	474,175	996,550	2,377	120	40
362	AA-Water lll Tes	481,600.00	982,900.00	2,205.00	120	37.33	1185	AdBh0920	472,700	999,800	2,503	120	12
363	Water III Testwe	481,600.00	982,900.00	2,205.00	120	37.33	1186	AdBh0922	476,800	994,200	2,344	151	52
364	Alem Gena-Balz	460,121.00	985,966.00	2,239.00	120	39.7	1187	AdBh0927	476,105	1,000,050	2,477	105	50
365	BHC44	460,121.00	985,966.00	2,240.00	120	40	1188	AdBh0928	475,050	985,050	2,124	24	5
366	AA-Hillton Hote	474,175.00	996,550.00	2,365.00	120	40.2	1189	AdBh0931	468,100	1,001,625	2,582	150	32
367	Water III monito	476,972.00	976,152.00	2,059.40	120	40.3	1190	AdBh0932	463,850	993,100	2,403	150	84
368	Water III Testwe	487,300.00	995,300.00	2,350.00	120	88	1191	AdBh0933	466,050	993,650	2,366	136	71
369	BHC63	487,300.00	995,300.00	2,347.00	120	88	1192	AdBh0934	470,450	990,125	2,224	0	15
370	AA-Abay Mesk	473,000.00	992,700.00	2,292.00	121.2	110.6	1193	AdBh0935	480,395	998,100	2,440	0	9
371	Dima Jalewa	413,137.00	973,900.00	2,090.00	122	8.5	1194	AdBh0936	471,400	988,250	2,208	84	13
372	Donbosco, Bisra	469,280.00	993,350.00	2,295.00	122	19.64	1195	AdBh0937	472,900	1,003,550	2,710	0	4
373	AA-Water lll test	473,566.00	978,610.00	2,070.00	122	23.5	1196	AdBh0938	475,750	993,650	2,313	149	97
374	BHC18	473,566.00	978,610.00	2,056.00	122	24	1197	AdBh0940	487,800	1,002,200	2,478	80	25
375	Water III Testwe	473,566.00	978,610.00	2,070.00	122	29.68	1198	AdBh0946	465,651	1,001,575	2,545	76	7
376	AA-Water lll BH	478,399.00	975,589.00	2,072.50	122	53	1199	AdBh0947	465,600	1,001,855	2,555	104	13
377	Water III Boreho	478,399.00	975,589.00	2,072.50	122	53	1200	AdBh0949	495,447	968,068	1,912	70	50
378	Modjo lume#1(	512,282.00	951,356.00	1,762.00	123	7.34	1201	AdBh0954	478,347	976,752	2,071	200	48
379	NMWC Spare P	478,462.80	977,506.19	2,090.00	123	50	1202	AdBh0956	475,402	976,807	2,053	63	31
380	Holleta	465,410.00	1,002,944.00	2,575.00	124	11	1203	AdBh0957	482,950	963,800	1,870	91	67
381	AA-Ato Tahas E	465,410.00	1,002,944.00	2,560.00	124	11.22	1204	AdBh0958	475,780	956,477	1,904	132	89
382	AA-Kality-Get-a	474,788.00	982,924.00	2,150.00	124	23.54	1205	AdBh0961	467,853	999,379	2,467	0	3
383	AA-Netherlands	468,800.00	996,600.00	2,360.00	124	50.35	1206	AdBh0963	472,150	993,300	2,278	150	51
384	BHC37	455,525.00	984,000.00	2,133.00	124	63	1207	AdBh0965	473,576	972,821	2,095	150	74
385	Meta Abo Brewe	455,525.00	984,000.00	2,140.00	124	63.3	1208	AdBh0966	484,475	975,622	2,110	220	100
386	Modjo Lume#2(	512,355.00	951,516.00	1,777.00	124.83	9.25	1209	AdBh0967	489,950	976,019	2,071	220	91
387	BHC60	427,635.00	994,816.00	2,107.00	125	7	1210	AdBh0968	485,798	968,308	1,905	217	69
388	BHC70	446,338.00	997,431.00	2,236.00	125	13	1211	AdBh0969	463,266	1,001,971	2,604	111	53
389	Guntuta	446,338.00	997,431.00	2,256.00	125	13.2	1212	AdBh0970	465,243	1,003,930	2,689	115	26
390	Water III Testwe	488,600.00	1,001,027.00	2,470.00	125	16	1213	AdBh0971	470,110	993,850	2,322	150	35
391	BHC43	463,742.00	985,378.00	2,347.00	125	18	1214	AdBh0977	474,957	982,383	2,147	135	24
392	AA-Water lll Tes	466,400.00	987,600.00	2,252.00	125	18.3	1215	AdBh0978	483,350	999,064	2,501	116	59
393	Water III Testwe	466,400.00	987,600.00	2,252.80	125	18.3	1216	AdBh0979	466,350	1,001,000	2,541	153	16
394	Holota-Tsedey	447,200.00	998,889.00	2,290.00	126	0	1217	AdBh0980	469,727	993,542	2,314	120	22
395	Tseday fruit	447,200.00	998,889.00	2,294.00	126	0	1218	AdBh0981	460,121	985,966	2,254	120	40
396	Akaki Water S. I	479,740.00	981,400.00	2,133.88	126	3.38	1219	AdBh0983	470,316	991,064	2,228	170	10
397	Akaki Water Sup	479,740.00	981,400.00	2,133.88	126	3.38	1220	AdBh0984	467,000	996,300	2,364	132	52
398	SEDE(Plant B)-2	474,100.00	989,000.00	2,220.00	126	35	1221	AdBh0985	463,908	995,127	2,463	147	40
399	AA-Meta Abo B	455,000.00	985,200.00	2,200.00	126	50.86	1222	AdBh0988	465,410	1,002,944	2,604	124	11
400	BHC42	455,000.00	985,200.00	2,204.00	126	51	1223	AdBh0989	476,963	994,106	2,341	132	73
401	AA-Ethio-Metal	476,400.00	980,700.00	2,058.00	126	53.4	1224	AdBh0991	490,000	968,000	1,905	115	95
402	Ethio-Metal Mea	476,400.00	980,700.00	2,058.00	126	53.4	1225	AdBh0992	465,161	1,003,103	2,613	67	18
403	Akaki Water S. I	479,021.00	977,596.00	2,090.00	126	73.48	1226	AdBh0993	472,541	996,743	2,371	90	52
404	Akaki Water S. I	479,021.00	977,596.00	2,090.00	126	73.48	1227	AdBh0994	464,538	991,302	2,309	94	5
405	Meta Abo Brewe	455,500.00	985,200.00	2,200.00	126	75.9	1228	AdBh0995	475,800	1,001,500	2,570	210	97
406	Akaki Indo-Euro	476,600.00	981,500.00	2,070.00	126.2	3.5	1229	AdBh0996	469,804	993,691	2,322	170	27
407	Akaki Indo-Euro	476,600.00	981,500.00	2,070.00	126.2	3.5	1230	AdBh0998	476,235	995,275	2,353	151	84
408	Meta Abo Brewe	455,350.00	985,100.00	2,220.00	128	70	1231	AdBh1001	477,463	994,346	2,328	170	92
409	AA-Kality Milita	475,300.00	984,000.00	2,100.00	128.5	0	1232	AdBh1003	474,556	983,625	2,162	219	39
410	Water III monito	476,454.00	976,951.00	2,061.50	129	42.2	1233	AdBh1006	499,500	964,500	1,898	72	31
411	Akaki Water s. E	479,526.00	977,468.00	2,090.00	129	71.7	1234	AdBh1020	494,829	967,088	1,916	80	64
412	Akaki Water s. E	479,526.00	977,468.00	2,090.00	129	71.7	1235	AdBh1022	495,561	968,574	1,906	60	50
413	Koka	506,728.00	937,459.00	1,669.00	129.66	53.27	1236	AdBh1023	499,320	970,175	1,891	68	19
414	Koka Ethi-Cuttin	502,329.00	929,321.00	1,606.00	130	5.4	1237	AdBh1024	495,765	966,397	1,905	94	47
415	AA-Hagbes PLC	468,875.00	993,750.00	2,298.00	130	11.16	1238	AdBh1026	498,633	970,028	1,889	74	34
416	Hagbes PLC., B	468,875.00	993,750.00	2,298.00	130	11.16	1239	AdBh1027	500,078	968,505	1,905	56	15
417	AA-Water lll Tes	463,700.00	988,500.00	2,280.00	130	19	1240	AdBh1030	481,878	1,000,148	2,577	140	76
418	Water III Testwe	463,700.00	988,500.00	2,280.00	130	19	1241	AdBh1032	474,000	1,001,000	2,570	201	40
419	BHC52	463,700.00	988,500.00	2,249.00	130	19	1242	AdBh1036	488,150	1,002,300	2,476	175	26
420	AA-Sebeta Shoe	463,599.00	988,583.00	2,283.00	130	19.46	1243	AdBh1037	457,030	984,617	2,218	140	89
421	Garad flower	443,050.00	1,001,649.00	2,403.00	130	24	1244	AdBh1038	480,895	977,403	2,124	104	85

422	Holleta	443,050.00	1,001,649.00	2,388.00	130	24	1245	AdBh1040	474,788	982,924	2,159	124	24
423	Dairy farm	445,099.00	1,003,816.00	2,400.00	130	30	1246	AdBh1042	473,466	987,247	2,170	65	9
424	Holleta	445,099.00	1,003,816.00	2,378.00	130	30	1247	AdBh1044	458,646	984,363	2,190	161	44
425	AA-Water lll BH	477,330.00	976,793.00	2,061.60	130	42.9	1248	AdBh1045	488,243	1,002,102	2,475	96	26
426	Water III Boreho	477,330.00	976,793.00	2,061.60	130	42.9	1249	AdBh1046	470,983	992,553	2,261	96	33
427	AA-Water lll BH	478,580.00	976,051.00	2,078.60	130	59.2	1250	AdBh1047	486,000	1,000,707	2,485	54	12
428	Water III Boreho	478,580.00	976,051.00	2,078.60	130	59.2	1251	AdBh1049	474,645	985,501	2,144	68	92
429	AA-Water BH3b	478,713.00	974,977.00	2,083.00	130	64	1252	AdBh1051	474,641	985,622	2,154	68	8
430	Dragados, Debre	494,040.00	968,454.00	1,922.00	130	66.11	1253	AdBh1059	472,975	1,011,144	2,614	114	12
431	Water III Boreho	479,058.00	976,020.00	2,091.20	130	72.2	1254	AdBh1060	480,965	977,576	2,129	132	99
432	Akaki Water S. I	478,998.00	977,937.00	2,090.00	130	73.48	1255	AdBh1063	471,799	999,371	2,478	114	8
433	Akaki Water S. I	478,998.00	977,937.00	2,090.00	130	73.48	1256	AdBh1068	481,337	982,304	2,199	135	23
434	AA-ZAF	480,965.00	977,576.00	2,139.00	131.5	98.87	1257	AdBh1069	479,700	981,700	2,141	116	20
435	Water III Boreho	477,992.00	975,552.00	2,067.50	132	48	1258	AdBh1070	479,000	981,400	2,128	120	10
436	AAWSA Kerani	467,000.00	996,300.00	2,340.00	132	51.75	1259	AdBh1071	500,084	1,006,594	2,502	10	9
437	AA-Woreda 17 I	476,963.00	994,106.00	2,349.00	132	72.5	1260	AdBh1087	472,200	995,700	2,358	67	15
438	AAWSA/IAEA	475,780.00	956,477.00	1,885.00	132	89.34	1261	AdBh1092	473,209	996,728	2,355	300	0
439	Akaki Mesfin Ze	481,507.00	976,220.00	2,100.00	132	120	1262	AdBh1095	472,500	998,700	2,479	0	14
440	Akaki Dairy Farı	481,507.40	976,220.97	2,100.00	132	120	1263	AdBh1096	373,700	990,500	2,162	0	33
441	AA-Water lll BH	477,972.00	974,859.00	2,078.50	133	59	1264	AdBh1099	465,600	1,001,855	2,555	153	23
442	Water III Boreho	477,972.00	974,859.00	2,078.50	133	59	1265	AdBh1100	473,900	985,100	2,171	72	8
443	Dukem Gedera I	487,881.00	973,470.00	1,995.00	133.4	59.63	1266	AdBh1101	463,972	1,000,788	2,517	174	0
444	BHC53	465,741.00	989,188.00	2,239.00	134	3	1267	AdBh1102	464,721	996,788	2,480	200	200
445	Modjo Lume#3	512,957.00	947,774.00	1,783.00	134	36.7	1268	AdBh1103	462,260	984,901	2,284	180	83
446	Suden Muchuch	459,928.00	941,554.00	2,175.00	134	77.9	1269	AdBh1104	471,500	990,500	2,224	200	12
447	Dukem NOC	480,641.00	977,009.00	2,121.00	134	98.3	1270	AdBh1105	477,515	997,474	2,405	216	19
448	AAWSA F7 at K	481,337.00	982,304.00	2,190.00	135	23.35	1271	AdBh1106	464,031	1,002,909	2,586	200	0
449	AA-Zak Ethiopia	474,957.00	982,383.00	2,140.00	135	24	1272	AdBh1107	465,578	999,808	2,471	193	0
450	AA-Water III BI	477,162.00	976,038.00	2,060.80	135	42	1273	AdBh1108	466,050	993,650	2,366	200	71
451	Water III Boreho	477,162.00	976,038.00	2,060.80	135	42	1274	AdBh1109	483,453	994,606	2,337	182	1
452	Dukem-Arena	487,900.00	972,421.00	1,948.40	135	75.75	1275	AdBh1110	482,896	991,871	2,248	205	14
453	Dukem-Arena	487,900.00	972,421.00	1,948.40	135	75.75	1276	AdBh1111	484,152	989,566	2,206	182	0
454	Akaki Water S. I	481,600.00	982,850.00	2,203.98	136	33.48	1277	AdBh1112	481,230	992,312	2,262	200	22
455	Akaki Water Sup	481,600.00	982,850.00	2,203.98	136	33.48	1278	AdBh1113	467,135	989,840	2,243	213	3
456	AAWSA, Ayer	466,050.00	993,650.00	2,360.00	136	71.28	1279	AdBh1114	484,900	990,700	2,233	177	4
457	BHC49	462,500.00	987,000.00	2,299.00	137	84	1280	AdBh1115	468,261	990,357	2,240	213	4
458	Water III Boreho	478,780.00	977,307.00	2,080.00	138	61.1	1281	AdBh1116	470,277	989,578	2,218	230	13
459	AA-Artificial	475,300.00	983,800.00	2,120.00	140	0	1282	AdBh1117	469,245	990,260	2,232	240	0
460	Rose flower	444,577.00	998,364.00	2,290.00	140	2	1283	AdBh1118	465,741	989,188	2,254	134	3
461	AAWSA/Kotebe	484,190.00	998,500.00	2,480.00	140	45.02	1284	AdBh1119	468,512	989,680	2,230	130	0
462	AA-Water lll Bh	478,154.00	975,966.00	2,073.50	140	54.1	1285	AdBh1121	469,458	990,594	2,233	181	0
463	Water III Boreho	478,154.00	975,966.00	2,073.50	140	54.1	1286	AdBh1122	468,196	990,422	2,241	180	5
464	AA-Kotebe Sela	481,878.00	1,000,148.00	2,546.00	140	75.95	1287	AdBh1123	467,723	990,028	2,236	161	4
465	AA-Sebeta-Drag	457,030.00	984,617.00	2,200.00	140	88.52	1288	AdBh1124	470,790	990,330	2,219	240	0
466	BHC39	457,030.00	984,617.00	2,186.00	140	89	1289	AdBh1125	465,591	989,872	2,267	257	8
467	Modjo Abudab	512,159.00	946,729.00	1,792.00	141	72.52	1290	AdBh1126	465,295	990,132	2,273	200	10
468	AA-Watter lll BI	477,651.00	975,923.00	2,066.80	142	47.9	1291	AdBh1127	463,985	991,540	2,323	185	25
469	Water III Boreho	477,651.00	975,923.00	2,066.80	142	47.9	1292	AdBh1128	489,127	999,697	2,441	280	39
470	Repi Soap Facto	466,250.00	993,050.00	2,335.00	142	50	1293	AdBh1129	480,029	998,401	2,466	144	20
471	AA-Water lll BH	476,574.00	975,607.00	2,070.30	142	51.4	1294	AdBh1130	466,600	1,001,250	2,532	196	7
472	Water III Boreho	476,574.00	975,607.00	2,070.30	142	51.4	1295	AdBh1131	486,712	1,001,378	2,448	133	0
473	AA-Water lll BH	478,199.00	976,361.00	2,065.30	144	45.9	1296	AdBh1133	470,450	990,125	2,224	140	16
474	Water III Boreho	478,199.00	976,361.00	2,065.30	144	45.9	1297	AdBh1134	471,125	989,636	2,211	153	11
475	AA-Water lll BH	479,061.00	976,370.00	2,086.50	144	67.2	1298	AdBh1135	470,070	991,000	2,233	170	10
476	Water III Boreho	479,061.00	976,370.00	2,086.50	144	67.2	1299	AdBh1136	469,500	989,600	2,224	150	4
477	Kotebe, Selam C	481,650.00	997,725.00	2,406.00	145	42.79	1300	AdBh1137	463,800	994,650	2,460	147	41
478	AA-Water lll BH	477,477.00	977,216.00	2,064.30	145	44	1301	AdBh1138	463,595	995,915	2,486	158	66
479	Water III Boreho	477,477.00	977,216.00	2,064.30	145	44	1302	AdBh1139	482,850	989,900	2,222	168	0
480	BHC45	461,412.00	986,324.00	2,267.00	145	45	1303	AdBh1140	466,308	989,421	2,249	185	4
481	AA-Water lll BH	479,696.00	976,936.00	2,086.70	145	67.8	1304	AdBh1141	466,200	988,800	2,249	100	0
482	Water III Boreho	479,696.00	976,936.00	2,086.70	145	67.8	1305	AdBh1144	469,322	1,001,428	2,571	240	0
483	ECAFCO	473,750.00	990,050.00	2,250.00	146	51.6	1306	AdBh1145	464,031	1,002,909	2,586	200	0
484	AA-Water lll e B	479,246.00	977,104.00	2,077.50	146	58.7	1307	AdBh1146	491,980	965,840	1,958	250	140

485	Water III Boreho	479,246.00	977,104.00	2,077.50	146	58.7	1308	AdBh1148	468,196	998,300	2,425	200	26
486	Gafat#9	508,684.00	951,058.00	1,806.00	146.2	23.91	1309	AdBH1149	520,353	939,385	1,650	200	89
487	Addis Alem TW	434,015.00	1,000,129.00	2,554.00	147	4.8	1310	AdBh1151	470,530	991,988	2,235	170	35
488	Holleta	434,019.00	1,000,122.00	2,349.00	147	4.8	1311	AdBh1152	460,295	986,769	2,314	158	31
489	Holleta	434,015.00	1,000,129.00	2,334.00	147	5	1312	AdBh1153	447,549	1,007,893	2,509	203	24
490	AAWSA Kerani	463,908.00	995,127.00	2,450.00	147	40	1313	AdBh1158	473,090	1,062,210	2,646	60	10
491	Townw.supply1	446,266.00	1,004,147.00	2,388.00	147.5	2.2	1314	AMW1	421,795	1,040,108	2,447	146	20
492	Holleta	446,266.00	1,004,147.00	2,384.00	148	37	1315	AMW10	507,086	1,012,954	2,583	300	26
493	Modjo Ethio Jap	513,773.00	949,998.00	1,795.00	148	39.52	1316	AMW11	501,332	1,068,067	2,579	209	71
494	AA-Water lll BH	478,347.00	976,752.00	2,067.50	148	47.5	1317	AMW12A	477,741	965,964	2,025	188	86
495	Water III Boreho	478,347.00	976,752.00	2,067.50	148	47.5	1318	AMW12B	490,336	970,789	1,930	282	89
496	AA-Water lll BH	477,945.00	976,985.00	2,068.30	148	49.9	1319	AMW13	474,421	1,013,070	2,608	304	18
497	Water III Boreho	477,945.00	976,985.00	2,068.30	148	49.9	1320	AMW14	450,359	981,037	2,076	280	11
498	Japan Embassy	475,750.00	993,650.00	2,310.00	149	97.15	1321	AMW15	484,821	994,284	2,324	368	42
499	AAWSA Near C	470,900.00	994,800.00	2,302.00	150	0.5	1322	AMW18	433,200	959,670	2,112	194	0
500	Gandi Memorial	473,000.00	996,300.00	2,345.00	150	1.83	1323	AMW2	440,274	1,006,055	2,530	300	12
501	Cigarette Factor	471,300.00	994,800.00	2,318.00	150	4.1	1324	AMW20	413,137	973,900	2,086	311	10
502	Holleta	406,722.00	1,009,647.00	2,993.00	150	6	1325	AMW21	506,765	957,179	1,855	278	19
503	Defence Inustry-	471,300.00	995,050.00	2,326.00	150	6.5	1326	AMW22A	505,014	970,969	1,884	126	21
504	Former Golf Clu	469,700.00	994,500.00	2,332.00	150	6.7	1327	AMW22B	504,878	970,766	1,883	300	20
505	ETHARSO-3	469,800.00	991,200.00	2,225.00	150	7.1	1328	AMW23	513,157	1,025,381	2,906	348	97
506	Ras Hotel	472,500.00	996,300.00	2,348.00	150	8.7	1329	AMW24A	490,513	951,595	1,774	178	101
507	SEDE(plant-A) -	471,700.00	994,900.00	2,320.00	150	10.4	1330	AMW24B	490,444	951,336	1,772	225	98
508	SEDE(plant-A) -	471,700.00	995,000.00	2,320.00	150	10.8	1331	AMW25	506,464	941,989	1,698	268	85
509	AA-Water lll Tes	481,210.00	980,010.00	2,150.00	150	11	1332	AMW26	427,395	992,768	2,101	220	6
510	Water III Testwe	481,200.00	980,000.00	2,150.00	150	11	1333	AMW3	427,126	971,361	2,084	308	4
511	Addis Abeba Br	471,400.00	995,800.00	2,345.00	150	12	1334	AMW4	456,314	962,592	2,019	290	0
512	Addis Abeba Br	471,500.00	995,800.00	2,345.00	150	16	1335	AMW5	478,990	955,803	1,834	330	38
513	Mekane Iyesus	470,465.00	991,100.00	2,220.00	150	16	1336	AMW6	455,620	1,026,514	2,603	273	8
514	BHC30	455,426.00	982,736.00	2,085.00	150	16	1337	AMW7	473,911	1,031,930	2,519	324	1
515	Sebeta Tal Flow	455,426.00	982,736.00	2,099.00	150	16.33	1338	AMW8	493,518	1,004,421	2,464	354	28
516	Addis Abeba Br	471,500.00	995,900.00	2,345.00	150	17	1339	AMW9	476,790	981,229	2,078	328	0
517	ETHARSO-1	470,250.00	991,500.00	2,225.00	150	19	1340	1	525,252	938,189	1,553	45	10
518	Addis Abeba Br	471,500.00	996,000.00	2,345.00	150	19.4	1341	7	530,060	946,622	1,700	20	172
519	AA-Gulele Glass	466,900.00	1,001,005.00	2,517.00	150	20.4	1342	11	536,681	929,942	1,577	153	125
520	Addis Abeba Br	471,400.00	996,000.00	2,345.00	150	23	1343	13	536,123	929,756	1,547	62	16
521	Addis Abeba Br	471,550.00	995,950.00	2,346.00	150	23	1344	19	524,787	935,587	1,552	41	16
522	Gafat#7	509,385.00	950,325.00	1,994.00	150	26.08	1345	31	527,133	933,241	1,541	69	14
523	Gafat#8	509,020.00	950,736.00	1,795.00	150	28.9	1346	32	529,224	943,393	1,628	120	100
524	Gafat#4	508,995.00	951,614.00	1,810.00	150	31.26	1347	36	528,318	941,952	1,611	159	104
525	AAWSA Shegol	468,100.00	1,001,625.00	2,585.00	150	31.69	1348	38	527,435	942,998	1,633	128	108
526	AA-Glass and B	467,200.00	1,001,017.00	2,517.00	150	35.3	1349	2	546,000	986,000	1,801	134	129
527	Abay Mesk Soft	473,100.00	992,600.00	2,290.00	150	36	1350	4	540,000	978,000	1,896	184	116
528	D/Z-Sunshine C	488,408.00	973,431.00	1,984.00	150	42.52	1351	5	557,000	989,000	1,728	198	189
529	AA-Dire Tanner	468,200.00	1,001,600.00	2,578.00	150	45.9	1352	6	540,000	978,000	1,896	184	116
530	AA-Beverage	478,462.00	977,721.00	2,090.00	150	50	1353	19	512,000	948,000	1,752	114	35
531	NMWC Spare P	478,462.80	977,721.59	2,090.00	150	50	1354	19	512,000	948,000	1,752	114	39
532	AA-Kera	472,150.00	993,300.00	2,270.00	150	50.5	1355	22	513,000	951,000	1,779	62	87
533	AA-Water BH19	478,019.00	977,985.00	2,070.20	150	51.5	1356	23	512,000	951,000	1,779	70	58
534	Water III Boreho	478,019.00	977,985.00	2,070.20	150	51.5	1357	26	529,000	944,000	1,619	120	100
535	Cement Factory-	473,100.00	991,800.00	2,280.00	150	56.4	1358	27	529,000	944,000	1,619	140	100
536	AA-TW2	473,576.00	972,821.00	2,081.00	150	74	1359	28	530,000	944,000	1,624	151	31
537	BHC5	473,576.00	972,821.00	2,076.00	150	74	1360	31	528,000	941,000	1,620	117	104
538	AAWSA, Repi b	463,850.00	993,100.00	2,400.00	150	83.71	1361	32	527,000	944,000	1,650	105	95
539	Cement Factory-	473,050.00	991,800.00	2,270.00	150	94	1362	39	506,000	935,000	1,626	93	24
540	Cement Factory-	473,100.00	991,900.00	2,270.00	150	112.7	1363	42	502,000	933,000	1,602	70	45

541	Misrak Flour and	473,500.00	992,900.00	2,280.00	150	123.3	1364		43	525,000	924,000	1,568	76	57
542	AA-Water III BH	477,856.00	976,402.00	2,063.60	151	44.7	1365		45	520,000	935,000	1,595	61	29
543	Water III Boreho	477,856.00	976,402.00	2,063.60	151	44.7	1366		49	518,000	934,000	1,577	81	23
544	AA-Water lll Bh	479,405.00	976,735.00	2,086.00	151	67.2	1367		50	519,000	936,000	1,613	100	45
545	Water III Boreho	479,405.00	976,735.00	2,086.00	151	67.2	1368		51	518,000	935,000	1,598	100	31
546	AA-Worwdw 17	476,235.00	995,275.00	2,357.00	151	84	1369		52	517,000	935,000	1,628	80	50
547	Waliya Tannery	473,925.00	987,175.00	2,175.00	152	15.6	1370		53	518,000	935,000	1,598	100	27
548	AA-Water lll BH	478,808.00	976,867.00	2,070.60	152	47.5	1371		54	521,000	935,000	1,554	108	29
549	Water III Boreho	478,808.00	976,867.00	2,070.60	152	47.5	1372		55	520,000	934,000	1,578	74	31
550	Addis Alem-Siet	436,160.00	1,000,453.00	2,370.00	153	36.62	1373		56	519,000	931,000	1,618	92	62
551	Holleta	436,130.00	1,000,470.00	2,372.00	153	36.62	1374		57	519,000	935,000	1,611	42	11
552	AA-Bambis Sun	474,395.00	995,211.00	2,335.00	153	59	1375		58	525,000	937,000	1,550	24	10
553	Legadadi-Dire	494,036.00	1,010,902.00	2,549.00	154	21.35	1376		65	525,000	935,000	1,548	41	16
554	AA-US Embassy	474,050.00	1,000,875.00	2,550.00	156	14.6	1377		75	524,000	933,000	1,543	45	7
555	AA-Misrak flour	472,900.00	992,500.00	2,280.00	156.2	89.6	1378		77	528,000	934,000	1,542	33	9
556	BHC61	427,193.00	994,953.00	2,113.00	0	2	1379		78	528,000	930,000	1,543	69	14
557	Campo Asmara	471,800.00	995,200.00	2,303.00	0	5	1380		79	526,000	930,000	1,543	81	11
558	Bishoftu	507,861.00	960,487.00	1,848.00	0	6.91	1381		82	528,000	930,000	1,543	50	12
559	Modjo	512,282.00	951,356.00	1,762.00	0	7.34	1382		84	525,000	928,000	1,543	84	7
560	Bishoftu	499,605.00	968,199.00	1,857.00	0	7.5	1383		89	526,000	925,000	1,544	69	7
561	Bishoftu	496,240.00	968,757.00	1,889.00	0	8	1384		90	526,000	925,000	1,544	77	13
562	Modjo	511,927.00	948,292.00	1,770.00	0	8.3	1385		91	529,000	926,000	1,541	70	6
563	AAWSA,near K	480,395.00	998,100.00	2,440.00	0	8.51	1386		96	526,000	934,000	1,546	49	9
564		429,908.00	979,336.00	2,069.00	0	9	1387		98	523,000	928,000	1,549	52	13
565	Modjo	512,355.00	951,516.00	1,777.00	0	9.25	1388		105	535,000	920,000	1,675	268	256
566	Teji	432,617.00	978,471.00	2,069.00	0	11	1389		106	510,000	885,000	1,775	34	17
567		432,616.00	978,607.00	2,061.00	0	11	1390		108	518,000	887,000	2,190	120	90
568		431,784.00	978,275.00	2,066.00	0	11	1391		111	525,000	898,000	2,196	266	245
569		430,518.00	978,937.00	2,069.00	0	11	1392		114	521,000	887,000	2,320	75	57
570		429,134.00	979,500.00	2,069.00	0	11	1393		117	500,000	890,000	1,688	63	27
571		428,549.00	979,093.00	2,072.00	0	11	1394		119	501,000	892,000	1,692	102	83
572		428,458.00	978,824.00	2,069.00	0	11	1395		120	502,000	891,000	1,707	64	43
573		432,561.00	978,477.00	2,070.00	0	11.5	1396		121	503,000	893,000	1,701	78	53
574		431,332.00	978,494.00	2,066.00	0	11.5	1397		122	507,000	901,000	1,794	160	128
575		430,807.00	978,666.00	2,069.00	0	11.5	1398		124	518,000	887,000	2,190	105	80
576		430,582.00	978,853.00	2,063.00	0	11.5	1399		126	510,000	886,000	1,801	70	23
577		429,688.00	979,459.00	2,066.00	0	11.5	1400		132	523,000	935,000	1,572	1	24
578		427,813.00	978,779.00	2,075.00	0	11.75	1401	BH-5		543,079	942,366	1,503	236	151
579		427,746.00	978,715.00	2,068.00	0	11.75	1402	BH-9		560,297	968,988	1,185	261	173
580		432,050.00	978,445.00	2,067.00	0	12	1403	BH-10		547,922	959,185	1,466	183	145
581		431,828.00	978,285.00	2,070.00	0	12	1404	BH-13		546,420	933,081	1,343	83	26
582		430,841.00	978,704.00	2,067.00	0	12	1405	BH-14		538,774	953,120	1,514	157	91
583		430,762.00	978,678.00	2,070.00	0	12	1406	BH-16		538,498	950,940	1,495	164	84
584		429,734.00	979,908.00	2,069.00	0	12	1407	BH-18		535,918	945,906	1,483	126	100
585	Mojo	507,296.00	941,463.00	1,694.00	0	12.5	1408	BH-20		537,928	957,417	1,572	145	104
586		431,919.00	978,445.00	2,069.00	0	12.5	1409	BH-21		537,294	959,643	1,622	199	138
587		428,934.00	979,420.00	2,070.00	0	12.5	1410	BH-24		534,890	932,712	1,582	160	133
588	Mojo	508,030.00	943,076.00	1,711.00	0	13	1411	BH-25		532,673	932,328	1,558	132	82
589	Mojo	506,801.00	946,442.00	1,739.00	0	14	1412	BH-26		536,580	929,743	1,549	150	113
590	Mojo	509,619.00	953,910.00	1,815.00	0	15	1413	BH-27		536,813	930,293	1,556	145	116
591	Mojo	509,531.00	954,026.00	1,816.00	0	15	1414	BH-29		539,213	940,271	1,523	205	176
592	Mojo	510,565.00	954,590.00	1,814.00	0	15	1415	BH-31		530,954	949,680	1,712	229	178
593	Mojo	510,365.00	954,125.00	1,810.00	0	15	1416	BH-35		547,062	958,304	1,467	182	120
594	Mojo	509,961.00	953,356.00	1,802.00	0	15	1417	BH-36		541,516	949,046	1,465	199	132
595	Mojo	512,802.00	952,082.00	1,778.00	0	15	1418	BH-38		542,960	956,854	1,482	145	95
596	Mojo	510,372.00	947,373.00	1,754.00	0	15	1419	BH-39		544,896	938,818	1,421	168	153
597	Mojo	511,654.00	950,667.00	1,780.00	0	16	1420	BH-46		538,581	929,142	1,553	180	150
598	Mojo	512,933.00	952,129.00	1,784.00	0	16	1421	BH-47		536,761	930,841	1,569	154	125
599		430,092.00	979,252.00	2,065.00	0	16	1422	BH-48		536,336	930,961	1,567	180	127
600		427,639.00	978,875.00	2,073.00	0	16	1423	BH-49		537,322	928,164	1,529	126	88

601	Old Airport (Arr	469,300.00	995,500.00	2,347.00	0	16	1424	HD-3	525,328	936,530	1,561	23	22
602	Mojo	510,614.00	952,023.00	1,804.00	0	16.5	1425	HD-4	526,208	936,077	1,559	17	15
603	Mojo	513,568.00	957,880.00	1,841.00	0	17	1426	Girmi shano dug w	519,000	988,000	2,340	2	1
604		427,357.00	978,083.00	2,067.00	0	17	1427	GirmiAdemi dug w	519,000	987,000	2,314	1	1
605		427,493.00	977,927.00	2,072.00	0	17	1428	Debre Zeit, Hora k	510,000	973,000	1,903	2	1
606	Mojo	514,334.00	954,970.00	1,880.00	0	17.5	1429	Bokan Tseiti dug w	534,000	984,000	2,149	1	1
607	Mojo	508,447.00	952,941.00	1,814.00	0	18	1430	Bokan Tebel dug w	534,000	982,000	2,153	1	1
608	Mojo	508,194.00	952,954.00	1,814.00	0	18.5	1431	Bokab Abo Chorg	532,000	980,000	2,226	1	1
609	Mojo	510,245.00	953,283.00	1,800.00	0	19	1432	Bokab Abo Chorg	532,000	980,000	2,226	2	1
610	Modjo	506,765.00	957,179.00	1,836.00	0	19	1433	Ejere, dug well	528,000	969,000	2,200	1	1
611	Mojo	506,730.00	937,464.00	1,651.00	0	19.5	1434	Ejere, mitikora	528,000	974,000	2,335	1	1
612	Mojo	509,800.00	952,640.00	1,798.00	0	20	1435	Boklan Kuntushule	529,000	979,000	2,382	1	1
613	Mojo	508,165.00	953,217.00	1,815.00	0	20	1436	Girmi dug well 1	514,000	960,000	1,913	34	32
614	Mojo	506,569.00	938,054.00	1,661.00	0	20	1437	Girmi Gebeyehu d	513,000	960,000	1,899	33	32
615	Bishoftu	501,470.00	974,992.00	1,911.00	0	20	1438	Girnu Basna eirgu	513,000	960,000	1,899	28	28
616		427,222.00	977,254.00	2,069.00	0	20	1439	Keraro, Gima Bor	512,000	952,000	1,784	32	31
617	Mojo	509,806.00	953,792.00	1,819.00	0	21	1440	Keraro, Gima Tes	511,000	952,000	1,804	35	33
618	Mojo	509,677.00	953,088.00	1,807.00	0	21	1441	Debandiba Bune D	510,000	953,000	1,808	36	35
619	Bishoftu	507,013.00	968,324.00	1,877.00	0	21	1442	Momo, Tewahde V	509,000	952,000	1,808	30	28
620	Mojo	509,891.00	952,058.00	1,797.00	0	22	1443	Momo, Tewahde I	509,000	951,000	1,799	30	29
621	Mojo	508,823.00	957,924.00	1,850.00	0	23	1444	Momo Kuibi Meku	509,000	952,000	1,808	25	24
622	Mojo	508,994.00	955,227.00	1,831.00	0	24	1445	Momo Kuibi Meku	509,000	952,000	1,808	26	25
623	Mojo	509,913.00	952,151.00	1,795.00	0	24	1446	Biyo Abebe Geme	509,000	953,000	1,815	21	20
624	Bishoftu	503,928.00	965,114.00	1,885.00	0	24	1447	Biyo Woing guda	509,000	953,000	1,815	18	18
625	Mojo	509,597.00	958,520.00	1,844.00	0	25	1448	Biyo Geole dug w	509,000	953,000	1,815	18	17
626	Mojo	509,917.00	953,997.00	1,810.00	0	25.5	1449	Biyo Hata Tesfaye	509,000	955,000	1,833	19	17
627	Mojo	509,905.00	958,275.00	1,842.00	0	27	1450	Biyo Shewaye dug	509,000	955,000	1,833	18	18
628	Mojo	510,614.00	952,023.00	1,804.00	0	27	1451	Biyo Derse indersh	507,000	954,000	1,844	21	21
629	Mojo	510,372.00	947,373.00	1,754.00	0	31	1452	Biyo Bume Busha	507,000	954,000	1,844	26	25
630	Modjo	512,011.00	949,196.00	1,785.00	0	31.77	1453	Biyo Mamo Seyou	507,000	955,000	1,843	32	32
631	Mojo	510,679.00	954,123.00	1,817.00	0	32	1454	Biyo Mamo seyou	507,000	955,000	1,843	37	35
632	Modjo	512,408.00	948,682.00	1,782.00	0	34.14	1455	Biyo Mengiste G/S	507,000	954,000	1,844	32	31
633	Mojo	510,895.00	952,183.00	1,800.00	0	35	1456	Biyo Mengiste G/S	507,000	954,000	1,844	30	29
634	Mojo	514,334.00	954,970.00	1,880.00	0	35	1457	Biyo Kebede Yako	507,000	954,000	1,844	29	29
635	Mojo	509,134.00	939,939.00	1,682.00	0	35	1458	Biyo Abera Mikre	507,000	953,000	1,835	29	28
636	Modjo	511,976.00	948,671.00	1,786.00	0	35.34	1459	Biyo Tukala dug w	507,000	953,000	1,835	23	23
637	Modjo	512,957.00	947,774.00	1,783.00	0	36.7	1460	Biyo Telahun Ayel	507,000	954,000	1,844	45	44
638	Modjo	513,423.00	948,940.00	1,784.00	0	37.2	1461	Amenese, Alemu A	506,000	954,000	1,864	55	53
639	Mojo	510,599.00	952,248.00	1,806.00	0	38	1462	Amenese, Negash	506,000	954,000	1,864	52	51
640	Mojo	509,134.00	939,939.00	1,682.00	0	38	1463	Amenese, Lakech	506,000	954,000	1,864	52	51
641	BHC7	461,900.00	974,300.00	2,081.00	0	38	1464	Amenese, Habte K	506,000	954,000	1,864	46	46
642	Modjo	513,773.00	949,998.00	1,795.00	0	39.52	1465	Amenese, Lema G	506,000	954,000	1,864	45	44
643	Mojo	506,730.00	937,464.00	1,651.00	0	40	1466	Amenese, Asrat G	507,000	954,000	1,844	37	37
644	Mojo	507,296.00	941,463.00	1,694.00	0	41	1467	Amenese, Kebede	506,000	954,000	1,864	43	42
645	Mojo	506,569.00	938,054.00	1,661.00	0	48	1468	Amenese, Mengeh	504,000	955,000	1,903	40	40
646	Bishoftu	510,700.00	967,019.00	1,908.00	0	51	1469	Amenese, Demisse	504,000	955,000	1,903	40	39
647	Modjo	512,159.00	946,729.00	1,792.00	0	72.52	1470	Amenese, Getahur	504,000	955,000	1,903	41	40
648	AdBh0001	478,772	958,888	1,906	220	102	1471	Amenese, Keba Ka	504,000	955,000	1,903	41	40
649	AdBh0002	475,705	956,271	1,902	220	104	1472	Amenese, Beyene	506,000	956,000	1,878	40	40
650	AdBh0003	481,178	958,488	1,848	140	58	1473	Amenese, Tefera T	506,000	957,000	1,869	30	30
651	AdBh0004	488,305	960,746	1,956	180	121	1474	Amenese, Mengist	507,000	957,000	1,853	28	27
652	AdBh0005	454,568	880,156	1,816	179	131	1475	Bahara dug w	505,000	957,000	1,899	31	30
653	AdBh0008	457,077	888,976	1,782	200	136	1476	Tesema Araga	505,000	957,000	1,899	31	31
654	AdBh0011	462,052	883,164	1,706	108	81	1477	Negatua Hail	505,000	957,000	1,899	30	30
655	AdBh0014	471,214	891,136	1,669	61	33	1478	Negatua Hail	505,000	957,000	1,899	34	33
656	AdBh0015	469,210	888,248	1,669	75	53	1479	Bezunesh H.Se	504,000	959,000	1,877	21	21
657	AdBh0016	469,799	886,240	1,657	51	32	1480	Biro Bati	504,000	951,000	1,961	21	21
658	AdBh0017	484,764	920,771	1,687	165	90	1481	Blacha Girma d	504,000	956,000	1,907	25	24
659	AdBh0019	475,571	924,071	1,745	154	92	1482	Shiferaw Mersh	504,000	956,000	1,907	24	24
660	AdBh0021	490,632	918,070	1,646	127	79	1483	Demu Tuffa d.w	504,000	956,000	1,907	28	28

661	AdBh0029	503,210	930,527	1,600	100	8	1484	Yemane Tamrat	504,000	956,000	1,907	30	30
662	AdBh0030	506,728	937,459	1,660	130	53	1485	Yilma Derssa d	504,000	958,000	1,898	37	32
663	AdBh0031	512,159	946,729	1,770	141	73	1486	Bekele Abebe d	504,000	958,000	1,898	33	18
664	AdBh0032	489,485	943,724	1,723	140	75	1487	Bayu Desta dug	504,000	958,000	1,898	19	15
665	AdBh0036	493,185	946,241	1,708	67	36	1488	Kujbursa, Muluget	503,000	959,000	1,890	16	12
666	AdBh0037	480,641	977,009	2,119	134	98	1489	Bizunesh d.w	504,000	960,000	1,870	13	17
667	AdBh0038	483,567	976,037	2,133	173	125	1490	Betru Wosen	503,000	960,000	1,883	17	26
668	AdBh0039	496,479	965,700	1,907	104	57	1491	Yebdar Biru d.	502,000	961,000	1,898	26	26
669	AdBh0042	521,269	949,730	1,899	283	208	1492	Feyisa Garedew	501,000	960,000	1,913	22	22
670	AdBh0044	493,545	968,537	1,916	105	67	1493	""	500,000	960,000	1,911	34	34
671	AdBh0045	482,463	976,154	2,156	181	73	1494	Yiilma Deres	501,000	962,000	1,881	34	33
672	AdBh0049	483,243	961,360	1,880	170	99	1495	Lema Amine d.	501,000	962,000	1,881	30	30
673	AdBh0050	488,463	965,890	1,902	115	94	1496	Dejazmach Sah	502,000	962,000	1,888	27	26
674	AdBh0052	494,320	965,101	1,982	153	110	1497	Kidane Belhu d	502,000	962,000	1,888	28	28
675	AdBh0053	495,447	968,060	1,912	92	48	1498	Yai Hawassa d.	501,000	963,000	1,877	30	30
676	AdBh0054	494,054	968,452	1,925	130	66	1499	Magra Abdi d.w	501,000	963,000	1,877	31	31
677	AdBh0055	493,179	968,613	1,912	108	74	1500	Yimenu d.w.	502,000	964,000	1,873	30	29
678	AdBh0056	488,798	972,371	1,957	132	30	1501	Major Wubsher	504,000	963,000	1,877	27	26
679	AdBh0057	487,881	973,470	1,986	133	60	1502	Sofinas Kebede	504,000	963,000	1,877	25	24
680	AdBh0060	492,987	967,055	1,948	108	42	1503	Bekele Bogale	504,000	963,000	1,877	24	24
681	AdBh0062	501,422	973,727	1,895	80	24	1504	Girma Chuko d.	504,000	961,000	1,875	19	18
682	AdBh0063	500,766	973,335	1,894	80	23	1505	Asegid Bantiwa	504,000	960,000	1,870	17	15
683	AdBh0064	500,494	974,376	1,902	81	25	1506	Ayelech d.w.	504,000	961,000	1,875	19	18
684	AdBh0065	500,424	974,376	1,903	82	31	1507	Gashu W/yohane	504,000	959,000	1,877	18	17
685	AdBh0067	500,204	963,672	1,889	47	32	1508	Betru Adafre d	504,000	959,000	1,877	17	17
686	AdBh0068	499,131	965,767	1,895	38	28	1509	Senbetu Gelass	504,000	959,000	1,877	16	15
687	AdBh0069	499,228	964,796	1,899	80	43	1510	Begashu d.w.	503,000	960,000	1,883	19	18
688	AdBh0070	500,909	964,676	1,885	36	24	1511	Girmu Benti d.	503,000	960,000	1,883	19	19
689	AdBh0071	499,148	965,330	1,898	62	34	1512	Aboye Chenka d	503,000	960,000	1,883	18	17
690	AdBh0072	507,491	952,694	1,827	102	40	1513	Yiheyis H.Sela	506,000	959,000	1,855	15	14
691	AdBh0073	508,079	952,013	1,818	115	8	1514	Biyo Nadi Gobe	507,000	960,000	1,856	15	13
692	AdBh0075	508,995	951,614	1,804	150	31	1515	Asefa Metaferi	507,000	960,000	1,856	13	13
693	AdBh0078	509,385	950,325	1,792	150	26	1516	Biyo, Taye Kidane	508,000	961,000	1,849	10	10
694	AdBh0079	509,020	950,736	1,796	150	29	1517		508,000	961,000	1,849	9	9
695	AdBh0080	508,684	951,058	1,802	146	24	1518		509,000	961,000	1,845	9	8
696	AdBh0081	507,950	951,364	1,816	150	26	1519	Zewdnesh W/H	509,000	961,000	1,845	11	10
697	AdBh0082	503,886	958,637	1,887	37	30	1520	Yisak Mingistu	506,000	958,000	1,859	27	26
698	AdBh0084	507,722	955,887	1,851	50	32	1521	East Bizunesh	507,000	956,000	1,851	23	21
699	AdBh0085	507,714	955,875	1,851	33	32	1522	East Belda Be	507,000	956,000	1,851	21	20
700	AdBh0087	512,957	947,774	1,773	134	37	1523	"" Bajiga T	507,000	956,000	1,851	23	22
701	AdBh0089	512,602	947,821	1,761	117	39	1524	"" Bizunesh	509,000	958,000	1,849	19	19
702	AdBh0090	511,927	948,292	1,764	114	8	1525	"" ""	509,000	958,000	1,849	20	19
703	AdBh0091	511,976	948,671	1,770	80	35	1526	"" Zebyider	509,000	958,000	1,849	18	18
704	AdBh0092	512,408	948,682	1,773	80	34	1527	"" Dinku Ab	509,000	958,000	1,849	16	15
705	AdBh0093	512,011	949,196	1,765	90	32	1528	"" Terefe W	509,000	958,000	1,849	19	18
706	AdBh0094	513,423	948,940	1,779	100	37	1529	"" Terefe W	509,000	958,000	1,849	20	19
707	AdBh0095	513,773	949,998	1,787	148	40	1530	Kumburse, Fitawra	507,000	959,000	1,854	18	17
708	AdBh0099	493,500	916,800	1,657	93	62	1531	Ayele Jema	507,000	959,000	1,854	17	15
709	AdBh0100	472,335	901,797	1,706	92	74	1532	Biyo N. East, Asal	509,000	959,000	1,844	10	8
710	AdBh0101	474,683	942,441	1,827	80	65	1533	Biyo N. East, Dirib	509,000	959,000	1,844	14	13
711	AdBh0103	471,448	898,126	1,706	93	78	1534	Biyo N. East, Fika	509,000	959,000	1,844	15	15
712	AdBh0104	478,200	920,000	1,727	75	60	1535	Biyo N. East, Yesh	509,000	959,000	1,844	19	18
713	AdBh0105	483,833	904,045	1,666	52	34	1536	Biyo N. East,	509,000	959,000	1,844	21	21
714	AdBh0107	469,342	901,807	1,724	100	85	1537	Biyo N. East, Senb	509,000	959,000	1,844	26	25
715	AdBh0113	479,131	900,450	1,662	32	31	1538	Biyo N. East, Sori	509,000	959,000	1,844	28	27
716	AdBh0114	479,766	901,046	1,662	32	29	1539	Biyo N. East, Balc	509,000	959,000	1,844	23	23
717	AdBh0115	498,754	922,389	1,602	43	30	1540	Biyo N. East, Abe	510,000	958,000	1,847	23	23
718	AdBh0116	530,525	947,181	1,677	280	186	1541	Biyo N. East, Giza	510,000	958,000	1,847	25	24
719	AdBh0117	536,113	947,062	1,503	195	160	1542	Biyo N. East, Geb	510,000	958,000	1,847	21	20
720	AdBh0118	534,801	932,504	1,578	145	116	1543	Biyo N. East, Shif	510,000	958,000	1,847	24	23

721	AdBh0120	536,492	929,529	1,549	150	113	1544	Biyo East, Gebeya	507,000	958,000	1,854	39	39
722	AdBh0121	536,720	930,085	1,554	136	111	1545	Biyo East, Dibab V	507,000	958,000	1,854	37	36
723	AdBh0122	537,332	928,166	1,523	126	88	1546	Biyo East, Fitawra	507,000	958,000	1,854	34	33
724	AdBh0124	532,590	932,122	1,548	130	83	1547	Biyo East, Fitawra	507,000	958,000	1,854	32	31
725	AdBh0125	530,429	941,358	1,601	196	162	1548	Biyo East, Demise	509,000	956,000	1,884	25	24
726	AdBh0126	530,748	940,960	1,600	192	150	1549	Biyo East, Tekle T	509,000	956,000	1,884	26	25
727	AdBh0127	523,531	936,474	1,550	50	11	1550	Biyo East, Kebede	509,000	956,000	1,884	26	25
728	AdBh0128	523,310	928,661	1,547	114	7	1551	Biyo East, Kebede	509,000	956,000	1,884	25	25
729	AdBh0129	527,667	941,523	1,613	152	99	1552	Biyo East, Etagene	508,000	956,000	1,869	25	24
730	AdBh0130	526,928	943,518	1,645	202	163	1553	Biyo East, Negatu	508,000	956,000	1,869	26	25
731	AdBh0133	481,495	909,593	1,698	105	84	1554	Biyo East, Tase A	508,000	956,000	1,869	26	26
732	AdBh0135	477,019	917,872	1,721	123	79	1555	Biyo East, Acham	510,000	956,000	1,839	23	23
733	AdBh0136	480,351	901,718	1,666	41	34	1556	Biyo East, Gdagne	509,000	955,000	1,833	18	17
734	AdBh0138	480,387	901,435	1,666	54	30	1557	Biyo East, Yimi W	509,000	955,000	1,833	21	20
735	AdBh0139	480,199	901,430	1,665	54	30	1558	Biyo East, Kebede	509,000	955,000	1,833	19	18
736	AdBh0140	471,672	892,227	1,670	50	30	1559	Biyo East, Seifu B	509,000	955,000	1,833	20	19
737	AdBh0141	467,748	894,665	1,712	99	81	1560	Biyo East, Mislal M	509,000	955,000	1,833	19	18
738	AdBh0142	469,725	895,830	1,708	110	79	1561	Girmu Bent	504,000	943,000	1,692	58	57
739	AdBh0143	472,898	893,416	1,669	54	33	1562	Negatu Be	504,000	947,000	1,732	40	39
740	AdBh0144	474,554	908,761	1,720	120	96	1563	Kimbibit, Gesese Y	504,000	947,000	1,732	28	28
741	AdBh0145	477,286	906,903	1,707	92	81	1564	Kake, Shegena Ab	504,000	935,000	1,627	18	18
742	AdBh0146	479,313	905,790	1,707	102	85	1565	Koka, Abate Testa	504,000	935,000	1,627	19	18
743	AdBh0147	502,329	929,321	1,598	130	5	1566	Koka, Messerete K	504,000	935,000	1,627	14	12
744	AdBh0149	457,823	1,002,833	2,619	104	3	1567	Asela, Silinge, Keb	515,000	885,000	2,151	1	1
745	AdBh0150	448,290	1,002,698	2,412	0	10	1568	Abura, Bawa d.w.	503,000	893,000	1,702	20	19
746	AdBh0152	449,177	1,002,158	2,477	0	0	1569	Munessa, Wako G	500,000	888,000	1,687	26	25
747	Adbh0153	447,200	998,889	2,295	126	0	1570	Munesa, Bedaso B	500,000	885,000	1,717	47	46
748	AdBh0154	446,338	997,431	2,259	125	13	1571	Gonde d.w.	523,000	886,000	2,417	2	2
749	AdBh0155	446,632	994,813	2,242	80	1	1572	Chefefonsa Bomb	513,000	991,000	2,413	0	0
750	AdBh0156	453,522	1,001,474	2,568	115	58	1573	Chefedonsa , kida	514,000	992,000	2,359	0	0
751	AdBh0157	457,162	1,001,115	2,625	115	7	1574	Girai Abo spr.	519,000	987,000	2,314	0	0
752	AdBh0158	459,689	998,340	2,593	48	0	1575	Chefedonsa, Butul	512,000	991,000	2,441	0	0
753	AdBh0159	446,266	1,004,147	2,391	148	37	1576	Chefedonsa, Ichic	509,000	983,000	2,252	0	0
754	AdBh0160	446,155	1,003,073	2,389	90	7	1577	Chefedosa, Syntay	511,000	991,000	2,429	0	0
755	AdBh0161	444,997	1,000,718	2,360	91	38	1578	Chefedosa, Jejema	516,000	992,000	2,336	0	0
756	AdBh0162	444,626	1,001,034	2,386	0	40	1579	Sodere copper spr	542,000	929,000	1,396	0	0
757	AdBh0163	444,168	998,992	2,294	98	7	1580	Sodere middle spr	542,000	929,000	1,396	0	0
758	AdBh0165	445,168	997,226	2,239	98	0	1581	Sodere veinming p	542,000	929,000	1,396	0	0
759	AdBh0166	445,942	1,001,323	2,395	99	0	1582	sodere outside fen	542,000	929,000	1,396	0	0
760	AdBh0167	445,773	1,001,323	2,388	75	30	1583	Deneba , Burkitu s	513,000	885,000	1,883	0	0
761	AdBh0168	445,099	1,003,816	2,400	130	30	1584	Lugo Burkitu spr.	513,000	885,000	1,883	0	0
762	AdBh0169	443,050	1,001,649	2,407	130	24	1585	Boko fumarole	521,000	936,000	1,550	0	0

763	AdBh0170	442,635	1,001,366	2,409	220	25	1586	Gergedi , Hipoo p	521,000	936,000	1,550	0	0
764	AdBh0171	443,132	1,000,869	2,386	116	30	1587	Gergedi, Medehan	520,000	936,000	1,563	0	0
765	AdBh0172	444,677	998,215	2,288	100	6	1588	Gergedi, Tekle hai	520,000	936,000	1,563	0	0
766	AdBh0173	444,677	998,808	2,309	100	21	1589	Gergedi, Gerle hai	520,000	936,000	1,563	0	0
767	AdBh0174	444,642	1,002,960	2,426	66	49	1590	Geergedi , Abo sp	520,000	936,000	1,563	0	0
768	AdBh0175	443,984	999,625	2,311	70	10	1591	Gergedi, Amanuel	520,000	936,000	1,563	0	0
769	AdBh0176	444,209	998,733	2,286	98	7	1592	Gergeedi, eyessus	520,000	936,000	1,563	0	0
770	AdBh0176A	481,337	1,001,017	2,637	135	23	1593	S.E. boneya , ulu s	538,000	888,000	2,677	0	0
771	AdBh0177	441,584	1,003,445	2,456	50	11	1594	East of Boneya, K	539,000	893,000	2,371	0	0
772	AdBh0178	437,892	1,008,952	2,591	13	4	1595	Goade debritu spr	525,000	888,000	2,400	0	0
773	AdBh0182	378,447	991,365	2,183	130	33	1596	Haile spr .m gonde	525,000	887,000	2,484	0	0
774	AdBh0187	404,656	997,733	2,232	81	22	1597	Walenkomi, wokie	528,000	889,000	2,411	0	0
775	AdBh0190	427,193	994,953	2,125	0	2	1598	Walenkome, Boreu	529,000	887,000	2,614	0	0
776	AdBh0191	427,164	996,290	2,157	37	0	1599	Boneya, fitawerari	535,000	888,000	2,618	0	0
777	AdBh0193	434,015	1,000,129	2,341	147	5	1600	Walenkome, South	531,000	889,000	2,441	0	0
778	AdBh0194	440,110	1,001,337	2,422	153	37	1601	Walenkome southl	534,000	887,000	2,651	0	0
779	AdBh0195	465,419	987,294	2,263	120	15	1602	Huruta, Fursa spr.	539,000	897,000	2,119	0	0
780	AdBh0196	460,810	981,473	2,229	102	67	1603	Huruta Fursa spr.	539,000	897,000	2,119	0	0
781	AdBh0197	460,464	974,637	2,093	61	38	1604	Huuta, fursa spr. 1	539,000	897,000	2,119	0	0
782	AdBh0198	461,930	970,844	2,204	183	144	1605	Benben chanecho	558,000	900,000	2,595	0	0
783	AdBh0199	456,740	962,388	2,006	39	3	1606	Hamus Gebeya, sh	550,000	890,000	2,911	0	0
784	AdBh0200	454,852	962,780	2,005	56	2	1607	Sira aadere spr.	551,000	910,000	2,040	0	0
785	AdBh0203	458,959	953,532	2,027	130	67	1608	Siea East reged sp	558,000	914,000	2,338	0	0
786	AdBh0208	448,328	957,872	2,130	139	85	1609	Beneben, Kerktch	560,000	905,000	2,493	0	0
787	AdBh0210	460,062	948,743	2,103	109	48	1610	Huruta, East Hym	543,000	899,000	2,257	0	0
788	AdBh0211	459,658	946,538	2,126	103	50	1611	sire Abo spr.	555,000	915,000	2,023	0	0
789	AdBh0212	444,245	956,023	2,219	158	96	1612	tich Abo spr.	542,000	900,000	2,168	0	0
790	AdBh0214	462,875	950,361	2,075	187	119	1613	Sira e, Weast Tef	550,000	908,000	2,179	0	0
791	Adbh0216	462,554	944,481	2,111	127	91	1614	Hamus Gebeya, M	548,000	890,000	2,857	0	0
792	AdBh0217	459,928	941,554	2,167	134	78	1615	hamus Gebeya Ka	545,000	887,000	2,881	0	0
793	AdBh0218	457,905	936,566	2,263	211	134	1616	kalata Burkitu spr.	543,000	892,000	2,554	0	0
794	AdBh0219A	479,021	977,596	2,088	126	66	1617	Hamus Gebeya Ka	546,000	886,000	3,073	0	0
795	AdBh0222	426,788	887,491	2,098	174	72	1618	Doni, Hora spr.	558,000	938,000	1,338	0	0
796	AdBh0223	435,268	897,823	2,000	105	41	1619	Bollo, Agassa spr.	553,000	913,000	1,977	0	0
797	AdBh0224	439,018	898,838	1,898	85	26	1620	Bollo, Wosheba s	569,000	922,000	2,267	0	0
798	AdBh0227	442,332	895,470	1,851	50	12	1621	Sire, Kobo spr	560,000	913,000	2,485	0	0
799	AdBh0228	441,680	895,480	1,855	50	12	1622	wesheba. Tefers o	565,000	921,000	2,135	0	0
800	AdBh0234	430,858	896,035	2,064	80	8	1623	Arboye, Yirba spr	575,000	923,000	2,332	0	0
801	AdBh0236B	462,743	1,002,521	2,626	250	35	1624	Sire north East, Be	560,000	919,000	2,057	0	0
802	AdBh0238	444,828	911,727	1,896	48	12	1625	Sire South Debra s	550,000	906,000	2,386	0	0
803	AdBh0241	458,775	911,576	1,936	295	152	1626	Sire south, Lugo s	548,000	906,000	2,157	0	0
804	AdBh0247	463,635	988,675	2,283	83	27	1627	Arboye, Abay spr.	573,000	923,000	2,271	0	0
805	AdBh0248	469,672	993,830	2,324	167	17	1628	Arboye, Ketema s	576,000	924,000	2,211	0	0
806	AdBh0249	455,450	983,014	2,110	120	15	1629	Abo Bollo spr. 1	563,000	917,000	2,305	0	0
807	AdBh0250	455,426	982,736	2,105	150	16	1630	Abo Bollo spr. 2	563,000	917,000	2,305	0	0
808	AdBh0253	453,850	973,096	2,055	59	56	1631	Birri , Abo spr.	502,000	925,000	1,606	0	0
809	AdBh0254	451,420	971,692	2,066	60	58	1632	koka, kefle spr.	505,000	934,000	1,613	0	0
810	AdBh0255	444,624	978,143	2,064	65	10	1633	koka,tifu spr.	518,000	935,000	1,599	0	0
811	AdBh0257	445,354	969,451	2,092	71	39	1634	koka, Abo spr.	520,000	936,000	1,563	0	0
812	AdBh0258	445,144	969,045	2,088	86	45	1635	koka, haile mariam	520,000	937,000	1,553	0	0
813	AdBh0259	453,538	982,154	2,088	80	8	1636	Gonde, Giorgis sp	521,000	887,000	2,320	0	0
814	AdBh0261	497,100	968,198	1,898	92	36	1637	Mito	429,469	848,820	1,763	0	30
815	AdBh0262	485,970	935,007	1,707	98	57	1638	Children village	429,503	841,996	1,717	0	81
816	AdBh0263	481,162	935,226	1,809	200	152	1639	Jido Kimbolo	441,257	852,390	1,645	0	90
817	AdBh0264	478,740	933,707	1,772	155	117	1640	Bekele Mola	464,460	834,226	1,597	0	6
818	AdBh0279	482,263	1,038,145	2,571	66	22	1641	haroresa	454,331	832,210	1,610	0	28
819	AdBh0282	466,233	1,031,004	2,575	117	55	1642	Adami tulu	467,618	868,830	1,655	0	45
820	AdBh0290	488,161	1,002,129	2,475	102	63	1643	Aneno	465,769	866,769	1,663	0	64
821	AdBh0291A	494,036	1,010,902	2,541	154	21	1644	Bulbula	462,033	853,564	1,612	0	21
822	AdBh0292A	517,022	947,564	1,810	318	110	1645	kersa	496,239	830,841	2,756	0	105
823	AdBh0292B	502,554	1,011,850	2,572	200	95	1646	sagure	516,697	852,135	2,450	0	79