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An overall assessment of Geological and Hydro Geological Parameters and resources of surface and groundwater in Wama- A case study of Wama Catchments East Wollega zone of Oromia region, Western Ethiopia

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ABSTRACT

This study aims to evaluate the groundwater potential resources of Wama catchment based on hydrogeological and geological data analysis. The study area is located in southern parts of Abay river basin, Upper part of Didessa sub basin, and bounded between 8^{0}24′0″N-9^{0}0′0″N latitude and 36^{0}24′0″E- 37^{0}24′0″E longitude. It is characterized by highly rugged topography, dendritic drainage pattern, and tropical to sub-tropical climate condition. Groundwater is precious resource for life and growth and development of country. Hence, reliance on the groundwater has increased greatly. The fractured and weathered volcanic rocks are the main water bearing unit in the catchment. From the existing borehole data, the higher values of discharge, hydraulic conductivity and transmissivity zones are mapped at or near fractured regions, accordingly, substantial increments in the groundwater withdrawals have occurred in almost every part of the country. One of most fundamental condition for the growth and development of nation is certainly to fulfill its urgent water needs hence, along with this are demanded good scientific and technical capabilities for the assessment and substantial development of the country for water resource potential particularly for the groundwater assessment of groundwater resource potential of the catchment is studied based on conventional hydrogeological techniques, by gathering and interpreting geological and hydrogeological data.

Hydro geologically study of the area has indicators that show as the groundwater potential and occurrence. The geological units like clay sediments, weathered and fractured basalt, and other quaternary sediments, and geological structures causes for different landforms and for primary and secondary permeability and porosity which are plays great role on the aquifer properties. The given data were collected from geological field activities to fulfill the gaps in hydro geological field observation data reports. The ground water also uses for many purposes in study area, such as for domestic, industrial and agriculture. There are so many problems related to ground water management in study area town such likes, Poor sanitation, not good hygiene condition, insufficient water supply due to lack of management and not good scientific and technical capabilities. To solved and given the addition of water supply scheme, addition of water source at the nearest to community services are required. The regional water resource office should provide financial and logistic support for this area.

KEYWORDS: Assessment, Groundwater, Occurrence, Permeability, Resources, Surface

CITATION OF THE ARTICLE

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I. INTRODUCTION

Background of the study area:

Water is the main source of life on Earth and is abundantly supplied by nature. This natural resource is used for irrigation, industries, domestic, agriculture, and plant growth. Although fresh water is one of the limited resources, its demand is increasing as a result of an increase in population growth and modern civilization all over the world. The resource is used for irrigation, industries, and domestic purpose. It is also one of major source, which contributed a lot to the world water demand. Ground water is precious and most widely distributed resource of earth and unlike any other mineral resource it gets in annual replenishment from meteoric precipitation. At the present one fifth of all water used in world is obtained from the ground resource (Fetter, 2001).Ground water plays important role in Ethiopia as a major source of water for domestic uses, industrial and Agricultural uses.

In order to use large scale development, it is essential to have a reliable estimate of groundwater potential (Sing,1985). The largest amount of water on Earth (97.2 %) is contained in the oceans and seas as a saline or salty water but only small amount of it (2.8 %) exist as fresh water on land. This fresh water found on land is distributed as ice caps and glaciers (76.43 %), groundwater and soil moisture (21.96 %), fresh-water lakes (0.32%), saline-lakes (0.29 %) and very small amount of it as streams channels (0.004 %)(Fetter, 2001). It requires less expense for purification and transport, occurs in places where there is scarce amount of surface water supply making it to be vital source for drinking, domestic and livestock use for population like in the study area.
The occurrence of ground water is not uniform because it depends on various environmental and geological factors (Alemayehu, 2006). Ground water used is also poorly monitored relative to surface water use. These reduce the information available to determine sustainable ground water extraction regimes. According to National Water Commission (2005) large scale metering of bores has only considered. Ground water is easily extracted through wells and how much can be extracted is depend on water level or how much storages available NWC (2005). Agriculture can flourish in some deserts but only wide water either pumped from ground us imported from other area (Fetter, 2001). To manage the resource in a more sustainable manner, knowing the spatial distribution and assessing of groundwater resource is of vital importance. This activity increases the chance of planning productive ground water development activities which is used for potable water supply and can also used for agricultural activities. Groundwater resource can be assessed using different methods. Among the methods, a geologic investigation begins with the collection, analysis, and hydrogeologic interpretation of existing topographic maps, aerial photographs, geologic maps and logs, and other pertinent records. In some places, the drainages may be fully controlled by the presence of minor and major structures like joints, faults and lineaments. Such zones are good and potential zones for groundwater exploration.

In Ethiopia ground water is available in sediments, sandstone, alluvial and karstic limestone (MOWR, 1998),the shortage of fresh drinking water for human and livestock population and for agriculture asses is known in lowland, in some highland areas of Ethiopia found essential to explore water resource for sustainable water supply and food self-sufficient(MOWR1998). Ground water management is the planned and coordinate management of a ground water basin with a goal of long term sustainability of resources. The management of surface and groundwater resource is more complicated than that of surface water supply on the basis of the mode of occurrence (Fetter, 2001). Ground water resource is one of the natural resource which is the determinant resource for every live on this earth. The main objective of the research, to identify the source of surface and ground water, to assess the resources and potential of the study area and to identify the problems related with technical aspects.

II. LOCATION OF STUDY AREA

2.1 Location and Accessibility

The study area, Wama Catchment, which is the major tributary of Upper Didessa, is bounded between 36^0 24′ 0″E to 37^0 24′ 0″E longitudes and $8^0$24′0″N to 09^0 0′ 0″N latitude, and is located in the East Wollega zone of Oromia region, Western Ethiopia. It is situated at about 281km west of Addis Ababa and it includes major parts of Nekemte town which is the capital city of East Wollega Zone. The area which has a total area of 3385.5km² is accessible through Addis Ababa → Ambo → Nekemte asphalt road. Weather and seasonal gravel roads which connects different town of woreda are also available in the catchment.

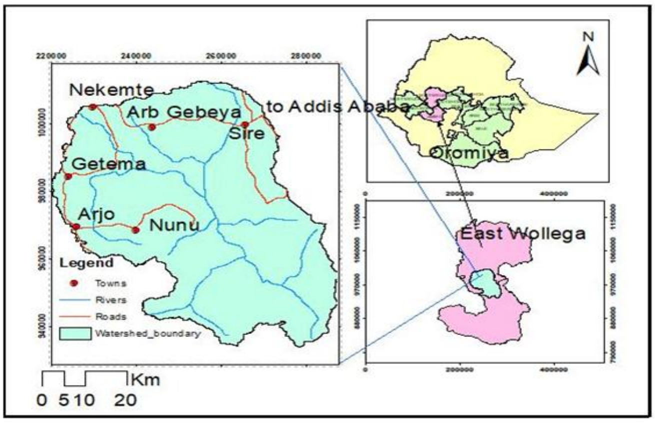


Figure 0.1 Location map of the study area

2.2 Physiographic setup

Surface elevation in the catchment varies from 1923 to 2180m (a.s.l). Higher areas are generally in the northern periphery of the catchment that gradually slopes southward forming plain at southern extreme (fig.1). The establishment of base elevation in the south has instigated a drainage system that in the north-south direction with dendritic drainage pattern.

2.3 Climate

Climate of Nekemte area is tropical highland monsoon. Rainfall distribution and pattern over the country is generally controlled by the movement of Inter Tropical Converge Zone (ITCZ)) with respect to equator (Lacaux et al., 1992). The Western region receives summer rainfall when ITCZ moves northward. Elevated rainfall amount is usually received during the months of June, July and August while dry condition persists during the rest of the year.

2.4 Drainage System

The catchments are characterized by spares flow down streams from the major fault which is at high elevation (3158m) and at low elevation (868m) found the area with flat topography and join the river where tributaries end up. The low density of streams may indicate that the bed rock is either highly resistant or highly permeable, it is characterized by parallel and dendrites drainage pattern. As shown in Figure-2.

2.5 Soil Type

The predominant soil type along the Nekemte road is well reddish to brown, clay and loam soil. Soil erosion is significant along the most parts of project road and due to up down of the land form. In addition, erosion cuts land along many sections of forms.

III. MATERIAL AND METHODS

Desk study: Prior to field work published and unpublished materials were collected and reviewed in order to get the detailed awareness on geology and hydrochemistry of the area. This includes water resources study reports, water points completion reports (borehole, hand dug wells, springs, pump test data, geophysical reports or any other literature regarding the catchment area and it' surrounding). It also includes the collection of hydro meteorological data, regional geologic map, digital elevation models (DEM), scanned topographic maps of the area with appropriate scale.

During field work: At this stage, water samples for chemical analysis were collected. In doing this, systematic sampling of representative water samples of different water sources (deep wells, shallow wells, hand dug wells, and springs) in the study area have been collected. During sampling, the sample bottles were carefully cleaned with distilled water and have been washed in the field by the water to be sampled. Sampling from some wells was carried out right on borehole using leakage but for others it is just near the well head before entering the reservoir. In the study area data have been collected from different source, which includes primary and secondary data to present the research and the method of data collection includes discussion with expert, beneficiary and field observation.

Methodology followed to asses ground water assessment and potential resources conducted with the community member to give an interview of the level community utilization, management and administration of ground water. Data and information about the beneficiary perception of water supply sustainability problems were collected use different method of data collection like structure questionnaires, discussion with beneficiary member of different water committee, technical staff member and personal observation were employed to produce primary data. Field observation was also one of the method by which primary data have been collected. It is used to understand, if there are some problem related with administrative and technical aspect that leads to the unfair distribution of ground water consumption for the beneficiary. In addition, it used to assess some ground water occurrence indicator to interpreter whether really, the professional are working for proper extraction of ground water.

Therefore, different data collected from different source by the researcher. In addition, the researcher discussed with water experts and investigation of local and regional geology of the area by observation and description of geologic structure and morphology. After the data have been collected from beneficiary, the researcher has summarized in the interpretation, compilations and organization of the result ground water resource management point view. The researchers are analysis and compute the information and field observation by comparing and contrasting the qualitative and quantitative research in percentage form.

IV. GEOLOGY OF THE STUDY AREA

4.1Regional geology

The area is situated in the Western Ethiopian plateau and underlain mainly by Eocene-Pleistocene (Solomon, 2000) volcanic rocks and small portion of Mesozoic sedimentary and metamorphic basement rocks. It is contained in the Abay basin, Upper Didessa Sub-basin, particularly the Wama river catchment. Geology of Western Ethiopia has complex tectonic history starting from Precambrian and Phanerozoic sedimentation to tertiary volcanic activity resulted in exposure of metamorphic, sedimentary and volcanic rocks. The Western basement terrain is considered to contain lithological components common to both the Arabian-Nubian shield (ANS) and Mozambique Belt (MB) (Kazmin et al., 1978, 1979). Recent studies have divide tectonic evolution of the Western Ethiopian shield into Gore-Gambella area which comprise Birbir, Baro and Geba domains (Ayalew, 1997) as well as Tulu Dimtu belt that comprises five domains from East to West; Didessa, Kemashi, Dengi, Sirkole and Daka domains (Allen and Tadesse, 2003).

The Didessa domain extends from approximately 5km East of Didessa River in Wollega area covering about 70km to 25km west of Gimbi town. Didessa domain is characterized by moderate grade gneiss, intruded by Neoproterozoic intrusive rocks like poly deformed gabbroic and granitoids bodies and post-kinematic mafic and felsic plutons (Allen and Tadesse, 2003). The western Precambrian basement is overlain either by Paleozoic-Mesozoic sandstone or tertiary volcanic product. Sandstone is supposed to be southwestern extension of central Ethiopian (Abbay) sedimentary succession (Geological Survey of Ethiopia, 2000). The tertiary volcanics covering western Ethiopia is commonly trap series which constitute majority of the Ethiopian plateaus. The Ethiopian volcanic plateau is divided into west and southeast plateau. However, the regional and wide E-W oriented rift transversal structure called Addis AbabaNekemte tectonic line (Abbate et al., 2015) or Yerer-Tulu Wollel Volcano Tectonic Lineament (YTVL) (Abebe et al., 1998) has divided the western plateau volcanics into Northwestern and Southwestern Plateau. The southwestern plateau, of which the study area is part, is characterized by thicker volcanic rock.

This volcanic sequenceis resting directly on the crystalline basement or rarely, on the Eocene basalts. The succession of this volcanic begins with a hundred meters of mildly alkaline basalts (Omo Basalts), capped by a thick unit, up to 1,000 m, of rhyolites, acidic tuffs, and subordinate. Jimma volcanic comprises trachyte basalts and rhyolites which covers most part of the southwestern Ethiopian plateau. The Wollega Basalts resting on the basement or on the tilted Omo Basalts and Jima Volcanites is consist of predominant columnar alkaline basalt flows interbedded, particularly in the upper portion, with acidic tuff and loose fluvial deposits. The sedimentary rocks of the catchment area are the southwestern extension of the West central Ethiopian sedimentary succession. These rocks are exposed around Beda Sire, Fungan Sire localities and Finca'a valley (Nekemte map sheet) (Solomon Gera and Mulugeta, 2000). It consists of thick lower sandstone succession that is overlain by thin remnants of transitional beds. The late Paleozoic and Mesozoic sediments are uncomfortably overlain by thick massive flood lavas, mainly of basalt; which is classified as Trap series by (Mohr, 1962). These rocks cover the northwestern plateau. The volcanic rocks in the catchment area are the Southern extension of these rocks. These volcanic rocks are generally post - Oligocene- Quaternary (Berhe,et al., 1987; Conticelliet,al, 1999) which have stratified nature, built up of various succession of flood basalts. Quaternary volcanic activities with the formation of lava flow, trachyte plugs and scorea cones are also recorded (Mengesha, et al., 1996).

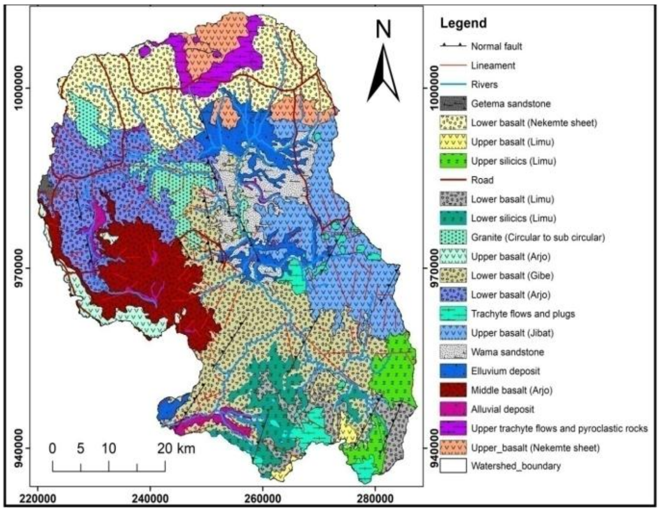


Figure 4.1 Geological map of the studyarea

4.2 Local Geology and Stratigraphy

The geology of the Wama catchment is constituted by the rocks ranging in age from Precambrian to recent time (GSE, 2014). They include metamorphic, sedimentary, igneous and recent deposit (Figure 3.1) and are described below. Even though it includes a variety of rocks, volcanic rocks are the most extensive lithology in the study area. Basic regional geology and field checking have indicated the occurrence of three major types of rocks in the catchment area. These are Precambrian crystalline basement rocks, Mesozoic sedimentary rocks, Tertiary volcanic rocks and associated plugs and Quaternary soils.

4.2.1 The Precambrian Basement Rock Granite (Circular to sub-circular)

The deformed granitoid are sub-circular to elliptical in shape and which is located about 5 km south of Chewaka settlement. It forms northwesterly elongated body of about 48 km and having moderate to high relief. Granite, which represents the dominant part of the Demeksagranitoid, is grayish to reddish pink, medium- to coarse-grained and in equigranular. This granitoid is situated in the central part of the area and it is pink to grayish pink in color. The total area coverage of this unit is 137.5 km². It covers about 4.06% of the study area.

4.2.2 Mesozoic Sedimentary Rock

The Mesozoic rocks of study area are comprised of continental clastic sediments represented by Getema Sediments and Wama Sandstones. In the vicinity of study area particularly around Gute and Sire (Solomon and Mulgeta, 2000) discussed the presence of both lower and upper sandstone that have thickness of 470 m and 300 m respectively. This unit consists of rock fragments containing mainly sandstone and siltstone of the Lower sandstone and laid directly on basement.

Around Gute and Sire it also unconformably underlain by the Paleozoic sandstone without clear unconformity (Solomon and Mulgeta, 2000). Getema sediments which covers about 8.5km2 (0.25%) of the area unconformably overlie the Precambrian rocks, and underlie the Tertiary volcanics, which attains a maximum thickness of 250m. It is dominantly sandstone with intercalations of siltstone, conglomerate, mudstone, claystone and shale. Good exposure of these rocks exposed along Aleltu stream and Getema-Ambelta road cut exposure. Another sandstone unit is Wama Sandstone named after Wama River, which is the major tributary of Didessa River along which sandstone is clearly exposed. Wama Sandstone is comprised of commonly red and pinkish red with minor greyish yellow and white sandstone with minor conglomeratic inter beds, which is attaining a maximum thickness of 100 m (GSE, 2014). It covers about 179.4km² (5.3%) of the study area. Regionally Getema sediments may be correlatable with the Enticho sandstone whereas Wama sandstone with the Adigrat Sandstone of Northern Ethiopia (Kazmin, 1975).

4.2.3 Tertiary Volcanic Rocks

Tertiary volcanic rocks cover nearly 83% of the catchment area. These rocks cover wide range of the catchment area. Northern, North eastern, Eastern; southeastern, south western and the southern part of the catchment is extensively covered by these rocks. There are seven mapping able units, which are categorized on the basis of stratigraphy and mode of occurrence.

Lower basalt (Tlb)

This unit consists of Lower basalt which described as (Tlb) with its respective localities in geologic map of the area. It is forms gentle slope and steep cliffs and covers wide portion of the catchment area which is estimated to be 1559.7 km² (46.07%) of the total mapped area and exposed in Western ,Northwestern, Northern and Southern direction of the catchment. This unit rests unconformably either on the basement or Mesozoic sedimentary successions (Solomon, 2000). It rests on Mesozoic sedimentary around Sire area. In the catchment, it is visible around Arjo, Limu, Jibat, and Gibe localities.

Middle basalt (Tamb)

This unit occupies a higher topography and characteristically forming flat top ridges and plateau. The flow attains an average thickness of 50 to 60 m, but thicker to the west, which attains a maximum thickness of 175 m around Meko area (Tadesse Alemu and Yonas Hageresalam, 2005). In the southwestern part of the catchment area, around Arjo with areal coverage of 282.35km² (8.34%), this unit is exposed. The top part of the flow is highly weathered and laterized. At places, especially on the Dega-Meko road soils measured in thickness up to 1 m are seen. The basalt is gray to grayish black and aphanitic to locally amygdaloidal.

Upper basalt (Tub)

This unit crop out as Northwest trending discontinuous dome-like ridges and hills, which locally formed cones and isolated peaks. This The rock is light gray to grayish black and varying in texture from aphanitic to phyric, but locally porphyritic. It is columnar and platy jointed. This unit covers small part of the Northern catchment area and it is exposed around Arjo, Limu, and Jibat. It covers a total area of 566.4km² (16.73%) in the catchment.

Trachyte flows and plugs

This rock unit is evenly distributed at southern, eastern, and central part of the study area by having the physical properties of subcircular to elongated and dome like shape. At Mote area, it shows highly weathered and slightly fractured and porphyritic properties, but around the road Mote to Bilo, massive trachyte flow forming dome shape. The flows are light gray to grayishwhite and pinkish gray. The borehole data shows that this unit have yield of 1l/s. The total area coverage of this unit is 85km² (2.5%). Depending on quantitative and qualitative properties, hydro geologicallyit is classified as low productive fracture aquifer.

Upper trachyte flow and pyroclastic rocks (Tup)

The trachyte and pyroclastic rocks of the upper volcanics cover 83km² (2.45%) of the total mapped area. It is exposed in the northern part of the study area as lenses on the ridge sides between the Lower and Upper basalts in many localities, such as Biloyi, Kara, and Jobira. (Solomon etal.,2000) described that the unit attains a maximum thickness of 500 maround Jobira area. Generally this unit consists of trachyte flow, pyroclastic rocks of various types such as ignimbrite, ash fall and tuff, volcanic breccias and lahar, and plagioclase phyric- basalt. The trachyte flow is light, medium grained, porphyritic and shows flow layering. Some minerals occur as micro-phenocrysts within cryptocrystalline and glassy matrix. The ignimbrite is light gray to greenish gray, medium grained and compact. It is composed of plagioclase, and rock fragments.

Lower silicics (Tlls)

This unit is represented by varying proportions of trachyte, rhyolite and pyroclastic rocks. Either it directly overlies the Gibe group or separating from the underlying Gibe group by deposition of Tertiary sediments (Limu and Boter Becho sediments). Itattains a maximum thickness of 350 m at Akote-Gilgel Gibe section and a minimum of 175 m at Limu Seka section (GSE, 2014). This unit covers an area of 132km² which is about 3.9% of the study area. It is exposed in the southern part of the area. It is generally pink to pinkish grey, fine- to medium-grained, weathered and fractured.

Upper silicics (Tlus)

The Upper silicics are comprised of dominantly trachyte with subordinate rhyolite and pyroclastics, which formed plateaus and flat top ridges. This unit covers about 102km² (3%) of the area and it occurs in the southeastern part of the study area. The thickness ranges from 80 to 100 m, but it attains a maximum thickness of 300 m at Akote-Gilgel Gibe section (GSE, 2014). The trachyte which represents the largest part of the unit is greyish green to greenish grey fresh colour and greyish brown to greyish white weathered color. It is represented by aphanitic and porphyritic varieties.

4.2.4 Quaternary sediments (Qs)

Alluvial Deposit

This unit distributed found in the area but dominantly exposed in the southern and south western part of the study area. From the borehole data and field observation the unit overlies highly productive lower basalt with an average yield of 6.63l/s and middle basalt which is moderate to highly fractured and weathered basalt. It shows reddish brown and black soil, sandy soil and silty soil. From the field inventoried data there is thick alluvial deposit around the so called village- Silk Amba. Topographically the unit is located at the flat gentle slope, dispersals vegetated and along many perennial rivers, especially Nageso and Wama river. This deposit covers a total area of 61 km².(1.8%). Considering the qualitative observation, this unit is classified under low productive inter granular aquifer.

Alluviums (Qel)

This unit is represented by red to reddish brown soils that are developed from the surrounding basaltic flows. This unit covers a total area of 189.6km² (5.6%). The exposure of this soil around Sholes area shows a thickness of 5 to 20 m thick with a general topographic setting of the area is flat undulating, but the spring emerges through thick soil at the deep gorge with a spring yield 0.2l/sec; considering the qualitative and quantitative data, this unit is classified under low productive inter granular aquifer.

4.3 Geologic structures

Structurally, Wama catchment is found in the vicinity of regionally deformed tectonic structure known as YererTulluWolel volcanic lineament (YTVL). The YTVL is an East–West trending regional structure with a length of 800 km and diameter of 80 km that partly crosses Abbay basin and certainly dividing western Ethiopian plateau into Northwestern and Southwestern. There are two major lineaments in the YTVL zone (Abebe et al., 1998): Didessa Lineament (DL) and Ambo-Butajira Lineament (ABL). These lineaments are deep faults and lineaments that cut across the YTVL and are fed by dykes and aligned volcanic plugs. Within this deformed zone, the lineament known as Ambo fault belt also starts from the western escarpment of the rift and extend further to Wollega (Mengesha et al., 1996).

The other prominent structures in the YTVL is Didessa lineament whose name seems derived from Didessa River, which is the outlet of Wama river, a river under investigation around which many manifestation of the lineament easily observed. Didessa lineament crosses the catchment from SE-NW direction. Some of the local lineaments have aligned parallel to this lineament. The orientation of lineament and spring in the catchment depict that lineament has considerable effect on groundwater. Since the lineament is a kind of deep fault structure, the water circulate at great depth and evolve into high TDS, Na^{2+}, HCO_3^- and SO_4^{2-}.This property of thermal spring indicates pronounced water-rock interaction supplemented by long and wide lineament. On the other hand, there is agreement between lineament and groundwater flow direction of the catchment. As observed from groundwater depth location in chapter 5, groundwater flow is toward the northwestern similar to lineament which shows the positive effect on regional groundwater flow.

Figure 4.2 Malaya Nunu columnar basalt

Another geologic structure, columnar joints are among the structures prevailed in the study area**.** The joints observed on volcanic rock out crops are prominent. They act as recharging conduit. There is a columnar joint on basaltic unit (Figure 3.2) around Malaya Nunu (GPS location of X-240117E and Y-970645N, at elevation of 2452m). These are the most widely prevailed structures, but because of vegetation cover they are observed at a few localities. Generally, they act as recharging conduit and the occurrence of many springs especially in steep area may be a result of these joints.

V. HYDROGEOLOGY OF THE STUDY AREA

5.1 General

Hydrogeology deals with occurrence, distribution, and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers). It encompasses the interrelation ship of geologic materials and processes with water (Fetter, 2001). The major hydro geologic units in the catchment area are volcanic rocks which are subjected to weathering, fracturing (and /or) local faulting processes and the hydro geologic properties of which modified by these processes. Being situated in the Ethiopian plateau the main hydrogeological units composing Wama catchment are volcanic rock that were subjected to varying degrees of weathering and fracturing. As volcanic rocks have a wide range of chemical, mineralogical, structural, and hydraulic properties, their aquifers also range from some of the most prolific to those utilized only for limited individual supply (Kresic, 2006).

In the study area, there is also basement rock (granite), mainly exposed around Arjo and Adare area. These rocks are intensively weathered in the upper part and affected by local fractures. From all the lithologic logs of these wells it can be seen that, two major secondary processes enhance the permeability of this unit to be classified as aquifer. Weathering affects the most upper part of the aquifer. The weathered column of this aquifer ranges from 48 m at Adare area. The weathering column is thicker at Adare well most likely because, the altitude is lower and temperature is higher to enhance chemical reaction there by intensifying weathering activity. The depth of this well is 151m. Drilling at this site was easy because it has thick succession of weathered and fractured column.

5.2 Available groundwater point Spring

A spring is a concentrated discharge of groundwater appearing at the ground surface as a current of flowing water (Todd, 1959). Springs occur in many forms and can be classified by means of their origin, rock structure, discharge, temperature and variability (Todd, 1959). It represents the out flowing of groundwater from the saturated zone as a result of hydraulic head difference between recharge zone and discharge zone under the driving force of gravity for the case of cold spring (thermal spring may be from convective upward flowing of heated ground water in the absence of gravity). Spring is a concentrated discharge of groundwater appearing at the ground surface as a current of flowing water (Todd, 1980).

The catchment is endowed with many perennial and intermittent springs. All springs in the study area are cold. People are using these cold springs for their every activity. Especially Rural inhabitants solely rely on spring for both domestic purpose and their livestock even sometimes for local small-scale irrigation (Burqa Wama) where the yield is high. All the spring shows a fluctuation in their discharge rate with time and space. Their temporal variation may be a response of aquifer to recharge rate between dry month and rainy month recall that spring is groundwater discharge, whereas spatial variability partly depends on the extent of an area (often aquifer) contributing recharge for spring and climatic condition mainly magnitude of rainfall as it is not smooth throughout the catchment. The springs in the catchment are a result of different geologic and geomorphic processes. Those which located on hill side and mountain foot are emerged as topographic break and some of the low land springs are originated from contact between highly weathered and less weathered lithology. But majority of them are structural spring emerged through fractured lithology.

Hand dug well

Hand dug well is known by local people as alternative source of water supply where groundwater is very shallow. Hand–dug wells in the study area are enormous in number and distributed almost in recharge areas of the catchment, indicating that it may not indicate the regional groundwater zone, but they tap shallow circulating groundwater. Especially in highland area, hand dug might be a part of perched aquifer which eventually flows over the edges of the impermeable bed. The seasonal fluctuation of the static water levels in most of the hand-dug wells is highly attributed to the direct recharge condition from precipitation in to the well which intern indicates the unconfined nature of the aquifers. Water of these wells are not dependable, for the reason that they commonly dry out during dry seasons and an aquifer is vulnerable to pollution.

Borehole

Deep and shallow boreholes are distributed in and around the study area. They are commonly drilled by governmental and non-governmental organizations, for the purpose of water supply to urban and rural communities. The available boreholes in the study area are used mainly for water supply purpose. It is the principal water point of hydrogeologic interest through which aquifer can be assessed. The distribution of borehole is uneven. It is highly found in densely occupied residential area of the catchment and mainly determined by hydrogeological characteristics of the geological units. The main aquifer formations of the boreholes are volcanics which are pyroclastic deposits, weathered and fractured basalts, ignimbrites (welded tuffs), unwelded tuffs, rhyolites and trachytes. Alluvial and lacustrine formations are also recognized.

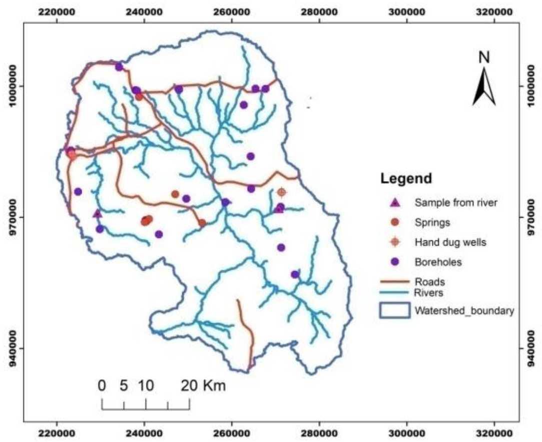


Figure 5.1 Distribution of boreholes, hand dug wells and springs in the Wama catchment.

5.3 Types of Aquifer

An aquifer is defined as a saturated a permeable geological unit that stores and transmits economic quantities of water to wells. The excellent aquifers are unconsolidated sands and gravels of alluvial deposits, but permeable sedimentary rocks such as sandstone and limestone, and highly fractured and/or weathered volcanic and crystalline rocks can also be classified as aquifers. There are three types of aquifers: confined, unconfined and leaky (GSE, 2014). A confined aquifer is an aquifer bounded above and below by an aquifuge; whereas an unconfined aquifer is a water table aquifer, and is bounded below by an aquifuge, but it is not restricted by any confining layer above. A leaky aquifer is also known as a semi-confined aquifer, whose upper and lower boundaries are aquitard, or one boundary is an aquitard and the other is an aquifuge. In order to get hydraulic characteristics, it is important to know an aquifer system. Because each aquifer type (confined, unconfined) has unique model that is appropriate to compute their hydraulic parameters. This means, the hydraulic characteristics which are assumed to represent the real aquifer system relies on the model applied which in turn depends on aquifer type. Thus, aquifer type identification is a basic step in evaluating aquifer characteristic. Identification of the aquifer system of the study area has been made by considering the following technique. The first approach is based on observation of lithologic logs of bore holes supported by well depth and general geological set up of the study area. This method utilizes aquifer location in the groundwater basin and static water level with respect to the position of water bearing formation.

As a second approach, fluctuation in discharge of springs and water level in hand dug wells are used. In the catchment area, it had been observed that discharges from springs increases during the rainy season falls with dry season. Likewise, the level of water in hand dug wells rise during rainy season and falls during dry months. These phenomena gives insight that portion of the aquifer is exposed to the surface and receives recharge directly through the unsaturated zone and thus classified as unconfined aquifer. These are shallow aquifers that over lies fractured aquifers. They comprise mixture of sand, gravel and soil. The depth goes from surface to about 25m. Spatially they are restricted to stream banks. They can easily tapped by hand dug wells and shallow drilled wells. In general, confined and unconfined aquifers are common type of aquifer in the catchment.

5.4 Hydraulic characteristics of aquifer

The main characteristics that define groundwater flow and storage are hydraulic properties (transmissivity, conductivity, yield, etc.). These properties are generally made through field measurements by means of pumping test. As it is a usual the pumping test duration is not smooth for all well and here it varies from 120 minute to 2880 minute. In almost all tests, steady sate or equilibrium is reached and data analysis is made using a suitable well-flow equations developed for such condition. Both Cooper-Jacob and Neuman analysis method were used for the interpretation of the data (GSE, 2104).

As an example, from well completion report of Bulbulo, the pumping record of well was analyzed for which the constant discharge test conducted without interruption for the total duration of 24hrs. The well discharged by a constant rate of 7l/s with a dynamic water level of 18.2m and 8.75m total drawdown. Under recovery test, water level was recovered over 71 percent within one hour. Among the important parameter to be analyzed is transmissivity, which is the measure of rate of flow under a unit hydraulic gradient through a cross-section of unit width over the whole saturated aquifer thickness. In quantitative terms, transmissivity is the product of hydraulic conductivity of the aquifer material and saturated aquifer thickness.

T = kb, where 'k' is hydraulic conductivity and 'b' is aquifer thickness.

But all the transmissivity of the studied well are derived from pump test data using aquifer test software to characterize the aquifer. Accordingly, Bulbulo well has transmissivity value of $34 m^2/day$ as obtained from constant test of Neuman curve fitting method for unconfined aquifer. Depending on this transmissivity value, hydraulic conductivity can be determined. Hydraulic conductivity determines the ease by which water can move through aquifers and is a function of both fluid and medium. Therefore determines the productivity of the aquifer.

Then, hydraulic conductivity (k) =T/b where, value of saturated aquifer thickness is fairly assumed to be the length of total screened section of the well (42m).

$$k = (34.2m^2/d)/ 42m = 0.81m/d.$$

This value is in agreement with the one obtained from the Neuman analysis test (0.808m/d). Another parameter to define aquifer is specific capacity of a well. The data used for the calculation of specific capacity are obtained from the constant discharge rate used during pumping test and the pseudo steady state drawdown obtained at the end of constant rate test. The specific capacity of a well depends both on the hydraulic characteristics of the aquifer and on the other features of the well like construction and pumping rate. The obtained value of specific capacity for different borehole ranges from 0.016-8.9 l/s (Annex 8).

SC = Q/S where, SC = specific capacity, Q = discharge rate (7l/s), S = drawdown

$$SC = \frac{7l/s}{8.75m} = 0.8\ l/s/m$$

This means 0.8 l/s can be pumped per one meter of drawdown (water level fall) in the well.

As observed from pump test analysis, the catchment aquifer shows wide range of variability in transmissivity and conductivity value. Both transmissivity and hydraulic conductivity is relatively high in the southern and extreme northern side than other side of the catchment. The conductivity and transmissivity value ranges from 0.003 – 17.28 m/d and 0.7 – 828 m^2/d respectively.

5.5 Aquifer Productivity

According to the report on hydrogeological and hydro chemical map of Arjo and Nekemte map sheet, the hydrogeological systems of the study area have been classified based on qualitative and quantitative methods. Classification and characterization of the aquifers based on qualitative approaches was based on dominant primary porosity, secondary fissured permeability and impermeable rock unit. But, to quantitatively characterize an aquifer with high degree of reliability, density of borehole data and their spatial distribution are the main requirement. In this work, despite the fact that the classification of the hydrostratigraphic units are made on the basis of transmissivity and yields and specific capacity, the boreholes data in the catchment are limited and most of them do not have complete and continuous pumping test data. Hence, in the area where data are not sufficiently available, field observations such as extent of weathering, fracturing, joint, distribution and magnitude of spring, topography and vegetation density were taken into consideration to accomplish the classification (EIGS, 2018). On the basis of this concept, the water holding media of the catchment were grouped into different aquifer unit.

Based on the qualitative and the very limited quantitative data (the yield of springs and boreholes) and geological description, classification of the various rock units with their areal extent within the map sheet area was defined as follows:

1. Extensive (438.6 km^2) and moderately productive (T = 1.1-10 m^2/d, q = 0.011-1 l/sm, Q = 0.51 - 5 l/s for wells and/or springs) or local or discontinuous but highly productive porous aquifers in which flow is mainly inter granular. This aquifer consists of Quaternary deposits of lacustrine sediment of unconsolidated sand and silt, pyroclastic deposits and Mesozoic sediments.

2. Extensive (2008.5 km^2) and moderately productive (T = 1.1-10 m^2/d, q = 0.011-1 l/sm, Q = 0.51 - 5 l/s) or locally highly productive fissured aquifers in which flow is mainly through a regularly developed system of fissures and joints of volcanic and sedimentary rocks. These aquifers are shown in light green and consist of a large part of tertiary volcanics (lower, middle and upper basalt).

3. Extensive (larger than 100 km^2) and moderately productive aquifers with mixed porous and fissured permeability (T = 1.1-10 m2/d, q = 0,011-1 l/sm, Q = 0.51 - 5 l/s for wells and/or springs). The aquifers consist of part of Jimma volcanics in the southern part of the map sheet where basalts are mixed with silicic rocks.

4) Extensive (larger than 100km^2) and low productive m/d, q = 0.0011-0.01 l/sm, Q = 0.051-0.5 l/s for wells and/or springs) aquifers in which flow is mainly developed in an irregular system of fissures and the weathered mantle of crystalline rock (intrusive and metamorphic rocks) with local and limited groundwater resources.

5) Aquitard (433 km^2) – minor aquifers with local and limited groundwater resources are represented by trachyte flows and plugs.

5.5.1 Extensive and Moderately productive fissured aquifer

The hydrostratigraphic units of this zone are highly weathered and fractured basalt and ignimbrite/trachyte. The basalt usually possess columnar joint and so highly susceptible to fracturing which in turn increases the potentiality of aquifer. Though fractured basalts and ignimbrites are the main constituent of this zone, scoria also encountered as water bearing formation in some borehole (Sire, Hadiya, etc.). The scoraceous nature of formations gives rise in water bearing characteristics together with high weathering and fracturing. Thus, productivity of this zone is favored by cumulative effect of high weathering and fracturing, columnar joint, paleo soil and inters lava flow between different lava successions. This basaltic unit might be a part of tertiary lower basalt exposed in part of plateau forming gentle slope and steep cliff.

Three volcanic units (Lower basalt, Middle and Upper basalt) are playing a great role as indispensable source of groundwater in the catchment. Unfortunately, Lower basalt dominate the elevated northern, southern and southwestern most extreme part of the catchment where annual rainfall is maximum. This basalt has considerable amount of primary porosity and so it easily subjected to secondary processes. As a result this unit has suffered weathering because of heavy rainfall and related intensive plant root that widens the joint. In some cases, it has a nature of multi-layer confined aquifer which attributed to its being affected by geologic processes at different depth. In fact, the degree of importance of the volcanic formation being an aquifer increased and gets better where it contains a secondary structure.From the borehole data an average yield of highly productive aquifer of lower basalt is 6.63 l/s, average yield of spring 0.75l/s.

The upper basalt on the other hand, dominates the northern and southeastern part of the area. Majority of this zone especially on southeastern part is characterized by thick succession of basalt and felsic rocks with basalt dominating the lower section. The felsic unit comprises ignimbrite, rhyolite, trachyte and pyroclastic material. According to Miller (1999) silicic lava such as rhyolite tend to be extruded as thick, dense flows and have low permeability except where they are fractured. Because of weathering, pyroclastic rock has formed a thick clay top soil. Even if thick topsoil enhances infiltration, this weathered material seen to reduce the opening of underlying formation as secondary filling rather than promoting recharge. Likewise, it is difficult for water to soak down through such clay mixed top soil. As a result, more water drained and leaves the area either as runoff or evaporation lowering the total recharge. This can be revealed from Kechema borehole (Table 5.1) where formation is dominated by clay and well yields only of 1.5 l/s as estimated by compressor flushing. But in an area where clay material is not a problem and secondary structure prevailed, upper volcanic also found to be essential aquifer with enough yield in the catchment and nearby catchment ((Hadiya and Toba (25 l/s)) respectively. Middle basalt which occupies a higher topography and characteristically forming flat top ridges and plateau is also found in this zone. The flow attains thicker to the west, which attains a maximum thickness of 175 m around Meko area (GSE, 2014). The top part of the flow is highly weathered and fractured.

Table 0.1 Representative lithological log of Kechema borehole

Depth (m)	Lithologic description
0 – 13.6	Cotton soil
13.6 – 27.3	Clay soil
27.3 – 31.8	Sticky clay soil
31.8 – 45.5	High sticky clay soil dominate pyroclastic
45.5 – 59.15	Slightly sticky clay soil
59.15 – 68.25	Slightly weathered clay dominated basalt
68.25 – 82	High to moderately weathered clay dominated basalt
82 – 86.43	Highly massive basalt
86.43 – 95	Highly fractured basalt

5.5.2 Extensive and moderately productive inter granular aquifer

This is aquifer associated with quaternary sediments in which the flow is inter granular. Quaternary sediments are mapped in the central part of the catchment area. It topographically situated on plain areas (topographic lows). It extensively found following the river.

Quaternary superficial deposits derived from down slope movements of weathered rock fragments and riverbank sediment occupying flat area are another distinct aquifer unit in this zone. This is the only unique formation in the catchment that behaves like inter-granular unconsolidated aquifer.

Such deposit are found in limited thickness and areal extent at the foot of ridges and mainly in flat laying areas of Wama plain and its tributaries. They composed of gravel, sand, silt and clay. Generally, they are only source of groundwater in Wama valley but their productivity is determined by abundance of coarser and clay material as well as sorting. This situation results in the heterogeneity of the aquifer and hence its hydraulic conductivity is dependent on the position within the geologic formation. No much borehole data is obtained for this unit. However, one well drilled in Daleti (Table 5.2) area close to Wama plain with depth of 150 m has aquifer thickness of 42.5 m and 1.68 m^2/dtransmissivity. Maximum drawdown of 83.27 m observed with only 2.4 l/s yield. These observed values are unsatisfactory with respect to aquifer made of such formation. The problem is that the area has low annual rainfall and high temperature that promote evapotranspiration. However, this is not only likely to be a factor. Therefore, this value probably attributed to either the error during pump test like partial penetration or the presence of intercalated clay and silt on the surface of recent alluvial deposits give rise to a limited direct recharge from rain. Generally, quaternary deposits are relatively permeable and productive. But, show great heterogeneity since their texture ranges from coarse gravel to clay and loose undifferentiated grains. According to Sen (1995), the aquifer potential of unconsolidated sediment ranges from moderate to high. In this case, depending on the result obtained from pump test the transmissivity and yield of this moderate zone range from (0.3 – 5.81) m^2/day and (0.5 – 7) l/s respectively.

Table 0.2 Representative lithologic log of Daleti borehole

Depth (m)	Lithologic description
0-13.8	Clay soil
13.8-52	Alluvial deposit
52-78.2	Highly weathered basalt
78.2-125	Scoria
125-150	Alluvial deposit

This zone is also represented by sandstone unit exposed around Wama lowland and Getema area. Sandstone is weathered at the top part while massive and fresh at the lower part. Wama sandstone shows medium to coarse grained texture and cross bedded sandstone with minor interbeds of conglomerate and conglomeratic sandstone (GSE, 2014).The sandstone has thickness up to 100m. Getema sandstone is known by its intercalation of siltstone, clay stone, shale and glacial deposits at the base of succession.

The upper part is massive, thick and bedded sandstone. Unfortunately, borehole data is not found for sandstone units. However, the sandstone formations are mostly massive and poorly sorted. The spring emerging from these units show low discharge and are seasonal, especially Getema sandstone. Few perennial springs which likely to emerge at contact between basalt and sandstone observed in Wama (Qaso spring) have good discharge. This partly associated with low topography of Wama as it is a part of discharge zone.

5.5.3 Extensive and Moderately Productive aquifers with mixed porous and fissured permeability

The aquifers consist of part of Jimmavolcanics (Upper and Lower Limu Silicics) in the southern part of the area. The mixed aquifers are developed in fissured silicic basalt and porous rock in the southern part of the study area where some Tertiary sediment also intercalate volcanic rocks on the plateau.

Fresh basalt and silicic rocks are usually considered as being low permeable lithological units; however, the presence of the porous volcanic material and even sediments in between lava flows forms a body that can accumulate a large volume of groundwater by draining the surrounding fissured aquifers and contribute to the yield of wells. These fissured and mixed aquifers of the plateau represent an important hydrogeological unit in the study area.

5.5.4 Low productive fissured (weathered) Mantle of crystalline rock

This aquifer is local, discontinuous fissured in which flow is mainly developed in an irregular system of fissures and weathered mantle of crystalline rock (granite) with local and limited groundwater resources. This unit is exposed around Adere area, which is the central part of the catchment area. From the drilled well near the central periphery of the catchment (Table 5.3), for a source of water supply for Adare rural community (GPS location of 253233mE, 968716mN), it can be seen that, two major secondary processes enhance the permeability of this unit to be classified as aquifer.

5.5 Aquitard

Minor aquifers with local and limited groundwater resources are represented by upper trachyte flows and pyroclastic rocks (GSE, 2014). Surface exposures of this deposit are found in the northern parts of the study area covering a total area of $83 km^2$.

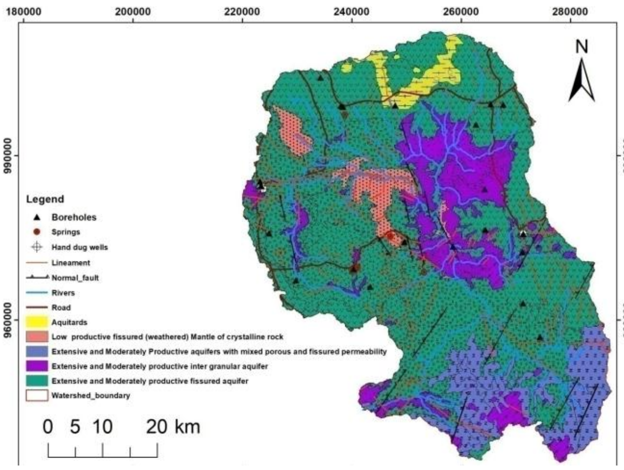


Figure 0.2 Hydrogeological map of the study area

5.6 Ground water flow direction and system

Groundwater flow direction is an imaginary path that particle of groundwater would flow as it flows through an aquifer. It helps in visualizing the flow nature of invisible subsurface groundwater movement.

Groundwater commonly flows from regions of recharge to regions of discharge in the direction of decreasing water-level altitudes and perpendicular to the water-level altitude contours (Fetter, 2001).However, there may be local flow deviation from a regional direction due to impact of structure like sediment bedding, foliations or some hidden structures like fault. Occasionally, Variation in the hydraulic conductivity of the different rocks can even cause local deviations to the general groundwater flow direction.

In preparing groundwater flow direction, water level measurements are taken from preexisting borehole records because well have no access for water level measurement currently since they are sealed. But, this may have paramount effect on the reliability of flow map. Because, water level measurements have taken at different time but temporal variation in groundwater level can also bring changes. According to John (2002) water level measurements should be measured within a few days of each other because the map represents a specific point in specific time. Another source of uncertainty is that, water level might be affected by penetration depth of well into aquifer as in some aquifer partial and in others fully penetrated. This all together with scarce distribution of borehole at important point in the catchment limited the preparation of actual map for groundwater flow direction.

5.6.1 Groundwater flow direction

Groundwater flow direction is primary controlled by topographical, geological and structural pattern of the area. However, degree of these effects on flow direction is different depending on the nature of a given catchment. In most cases, it is highly influenced by geology and topographic setup. However, in the area where geologic structure dominates groundwater flow is governed by structural alignment. Southern part of the catchment is characterized by SW-NE running dense lineament responsible for emergence of many stream. Hence, it is likely that lineaments are acting as groundwater conduit and also partly control the local flow system. However, groundwater flow of the catchment mainly follows gentle slope and the groundwater table is parallel to the topography.

As a result, the regional trend of groundwater flow is from the surrounding ridge and highland to the northwestern direction along which there exists a general Potentiometric head decline. Spatial distribution trend of water chemistry can also justify this flow direction. In addition to this, by means of field measurements of the water table or piezometric surface, representative contour maps can be drawn for the various types of aquifers within the hydrogeological basins (TenalemAyenew and TamiruAlemayehu, 2001). However, in this work because of no enough borehole data, there is no groundwater contour produced to show groundwater flow direction. Instead of this, the groundwater depth. In tracing the cross section from any part of the catchment to the Wama plain all shows gradual elevation decline toward the outlet. This indicates that groundwater flow exhibit topographic replica.

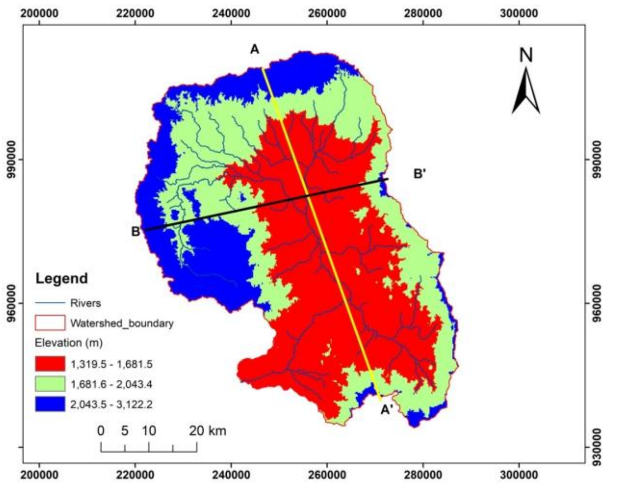
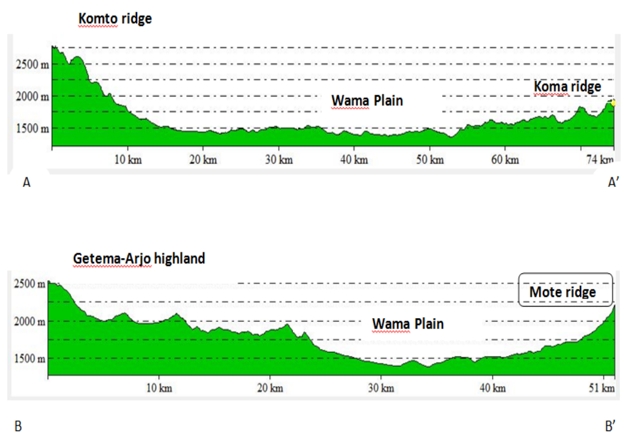


Figure 0.3 Map showing a line along which cross section AA' and BB' given below are plotted



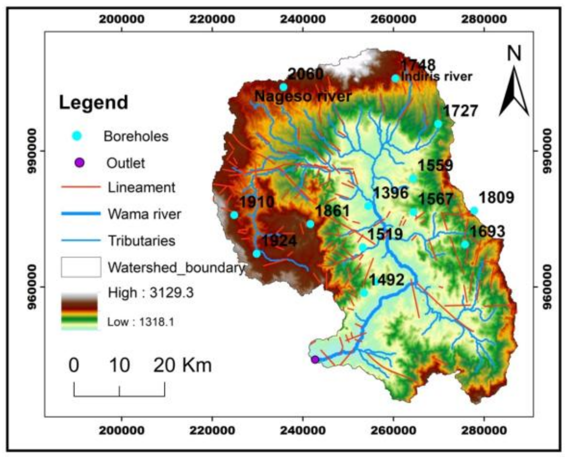


Figure 0.4 Digital elevation map with groundwater water level (in meter) from the sea level for existing boreholes in the study area

5.7 Recharge and discharge zone

Groundwater recharge is a downward flow of water reaching to the water table and forming an addition to the groundwater reservoir (i.e., an aquifer). Even though, the magnitude may differ, every catchment posses the following identifiable three different types of groundwater recharges (Tenalem Ayenew and Tamiru Alemayehu, 2001).

- The first one is direct groundwater recharge which comes from the rainfall. It is the ultimate groundwater recharge that we worry and should worry about.
- The second is Localized groundwater recharge which is associated with very local lateral flows of infiltrated water, ultimately joining the groundwater level (table) at some distance from the point of infiltration.
- The third is indirect recharge which is obtained from surface water bodies. This type of recharge can be originated either from natural (Eg. Rivers, streams, ponds, lakes, etc.), or man-made structures (eg. dams, irrigations, reservoirs, canals, etc).

The indirect recharge is common in arid and semi-arid areas (TenalemAyenew and TamiruAlemayehu, 2001). Groundwater recharge area can be defined as that portion of the drainage basin in which the net saturated flow of ground water is directed away from the ground surface and the water table usually lies at some depth (Freeze and Cherry, 1979). In the catchment, chain of ridge and hill which act as surface water divide are the main recharge zones. High velocity surface runoff and groundwater from these mountains area rush down the slope to the discharge area. In the catchment area, most of the northern and northwestern highlands (Komto and Getema-Arjo) and the eastern highlands (Sodu, Koma and Mote) feed the catchment from all directions (Figure 5.5). In the recharge zones, there is often deep unsaturated zone between the water table and the land surface. As the result, the opportunity to get water at surface is minimum unless at contact and intermountain depression.

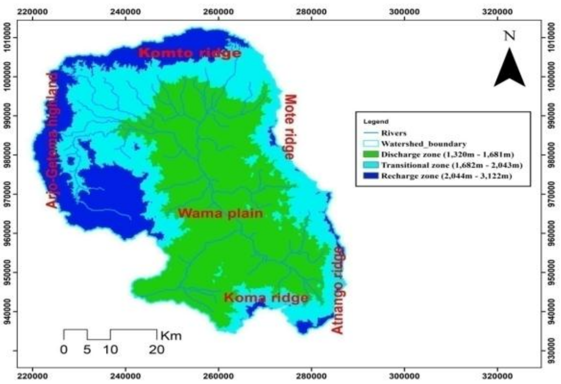


Figure 0.5 Recharge and discharge zones in inferred from elevation map

On the contrary, discharge areas can be defined as the movement of the net saturated flow of groundwater directed toward the ground surface and the water table usually lies at or very close to the surface (Freeze and Cherry, 1979). By general principle, topographically high areas are usually considered as recharge zone and topographically low areas can be considered as discharge zone. In most cases, the ground water discharge areas are indicated by the appearance of springs. Here in the catchment, a lot of springs emanate at the weathered and fractured parts of high ridge and high cliff of deep gorges. Another form of groundwater discharge is the capillary rise of water from shallow groundwater tables.

The rate of capillary rise depends on the depth to groundwater table and the type of soil or rock material. This is observed forming saturated mud at surface mainly before the onset of dry month. The groundwater discharge in this form is usually a local and temporal phenomenon. Thus, it may not essentially represent the regional groundwater discharge but give rough estimate of discharge condition. In discharge area, water table is found either close or at the land surface (Fetter, 2001). This is marked by many wetlands and saturated soil.

In the catchment, communities around Wama Boneya, Nunu, and Boke are using it for agricultural activities during dry season. Unlike the recharge area, the net saturated flow of groundwater is directed towards water table and the flow vector lines converge to each other in discharge (Figure 5.5). But, this convergence may not occur if the discharge zone is large. Some area but shows property of both recharge and discharge area and considered as transitional zone. Major part of Adare, Seka and Haro are few possible area of this zone.

Toth (1963) cited in Fetter (1994) showed the possibility of mapping recharge and discharge areas on the basis of field observation using the basic indicators such as topography, peizometric patterns, hydro chemical trends, environmental isotopes, and soil and land surface feature. Among these indicators, topographic elevation is the simplest (Freeze and Cherry, 1979) and peizometric measurements are the most direct. Below is the topographic map and groundwater level contour map based identification of recharge and discharge zones is used in this paper work.

VI. RESULT AND DISCUSSION

In the study area by the investigation of geological observation, distribution of geology by observation and description of geologic structure, researcher study ground water resource management development. The geology of the study area is generally covered by tertiary volcanic rocks such as upper volcanic rocks, lower volcanic rocks, hypabyssal rocks, dome and dykes. We have many indicators to show the area is comfortable for occurrence of ground water such as different geological structure joints, fracture, lineaments and different topography. In the study area, different discussion with water experts in the government organization and local community was made on the historical back ground of the ground water assessment and potential resource what it looks like. Through investigation of geology of the study area by observation and description of geologic structure, if would be investigating the nature of area. The main aquifers in the basin are identified to be volcanic rock of fractured and weathered basalt. The hydro-geologic characteristics of the catchment's aquifer materials vary widely because of the differing extent of weathering and fracturing distribution of the volcanic rocks. Generally depending on transmissivity and yielding capacity observed from pumping test data in conjunction with geological and hydro-metrological consideration, catchment is grouped into five potential zones. Fracture traces as manifested lineaments in land sat images are abundant in the catchment area. They have significant controls on drainage pattern, drainage density and ground water flow systems. Water flows from surrounding highland to the discharge areas following low hydraulic gradient and regional groundwater flow is generally toward the southwestern direction. The research took peoples from the households of this town to discuss, in order to gather about ground water management. According to the information obtained and actual observation, there are many aspects that reflects the existence of ground water management problem. This includes insufficient water supply due to the limited water supply schemes for this town, limited water consumption by individual person per day due to the limited amount of drinking water collect per day by one house hold and existed ground water source. Therefore, to avoid the above mentioned problem additional water supply schemes, additional water resource to the house of this community and in urban water supply quality are needed for the town. Existing water resources availability and scarcity Ground water is an important source of water supply in the study area. According to the information obtained from the discussion with respondents and field observation, ground water is the major and the most drinking water in the study area. Near about 65 % of the communities of the study area use ground water which is exposed to the surface in the form of bore hole methods. The remaining 35% of the community use surface water. During the dry season and technical problems, many peoples use river water, when the ground water source discontinuous its serve. In addition, as responds due to increasing people, the distribution source of drinking water can be drying of the ground water aquifer. Regarding with this problem scarcity the researcher concluded that another ground water resource which has high productive good aquifer needed for this town. The main use of ground water in the study area is for domestic purposes. According to the information obtained from the respondents, discussion and field observation, ground water that reaches the town from borehole used for domestic purposes.

Generally, ground water that obtained from bore well used only for domestic purposes and there are no industrial activities that need ground water use in the study area also no irrigation activities, that dependent on the bore wells reaches the town.

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