

GROUND WATER RESOURCE MANAGEMENT – A CASE STUDY OF NEKEMTE, OROMIA REGION, ETHIOPIA



Original Research Article

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ABSTRACT

Groundwater is precious resource for life and growth and development of country. Hence, reliance on the groundwater has increased greatly. 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.

This research was conducted in Nekemte area which is bounded in 36o 30' to 36o 40' longitude and 9o 05' to 9o 10' latitude of western Ethiopia, For the ground water resources and management data as there is limited information on groundwater storage distribution and management. The study area is comprising in different geological formation is mainly covered by tertiary volcanic rock such as upper volcanic rock (lower volcanic rocks, hypabyssal rock plug and domes syenite dome trachyte plug and phonolite plug. 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 Nekemte town, such as for domestic, industrial and agriculture. There are so many problems related to ground water management in Nekemte 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 town.

Keywords:

Assessment,
 Management,
 Nekemte,
 Occurrence,
 Potential,
 Substantial

I. INTRODUCTION

Background of the study area

Ground Water is important natural resource for living things to exist on the earth and it is a backbone of civilization. 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. Lack of professional and public awareness about the sustainable use of ground water resource made gaps in ground water management. Ground water management regimes may be expected to encompass a set of economic, regulatory and ethical levers that operated by markets regulatory or state in situations and user associations. Ground water acts as the primary buffer against the impact of climate variability and spatial variability in drought. Effective institutional approaches need to be aware of these socio-economic realities surrounding ground water use. In most situation ground water is a common property resource with extremely high use value. The country has enormous surface water and ground water resources. Very little has been Done in the field of development of the water resource particularly in area of ground water, ground water utilization has been limited to community water supply using shallow hand dug wells and unprotected springs. 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). 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 (MOWR 1998). 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 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 ground water, to assess the effects of management activities on ground water qualities and to identify the problems related with technical aspects.

II. DESCRIPTION OF STUDY AREA

Location of the study area

The study area is located at latitude of $10^{\circ} 0' 0''$ N and at longitude of $37^{\circ} 30' 0''$ E of Nekemte in East Wollega zone, Ethiopia. The study area is found at the distance of 334km from Addis Ababa to Nekemte town.

Topography

The topographic study has its own role in ground water occurrence and the direction of the flow of ground water, so that the topographic land mass in this study recharges the water received from the rainfall and causes ground water occurrence in this area. In other words, the topographic land forms cause the ground water occurrence flow from high topographic to low land topographic areas.

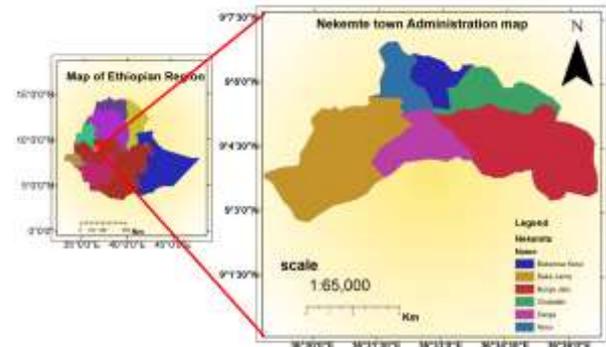


Figure-1 Location map study area

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.

Climate

The climate of the study area is comfortable for the live of persons and for different activities. The climatic condition of this study area is comfortable for raring of animals, for production of different area from June to August and between October and January respectively. The weather is cooled during the rain.

Physiographic and Vegetation

The catchment data can be subdivided into two physiographic landform, these are low land with elevation ranging from 1000m to 1500m. This low land area can be divided into Western and Eastern lowlands. The high land area with elevation ranging from 1500m to 3500m and this high land area characterized by mountains and mountain chains, (Solomon and Mulugeta, 2000). The type and amount of vegetation cover depend on physiographic and climatic conditions. The scattered thrown, bushes and savanna grass cover the low land areas, while the escarpment area is cover by thick and long trees like Wanda and Tad.

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.

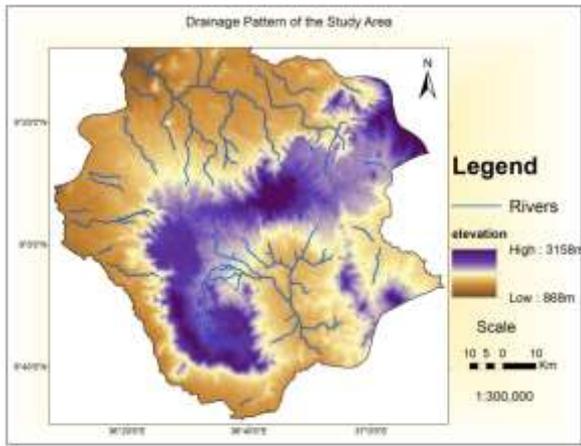


Figure-2 : system of study Area

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Geology of study area

Regional geological setting

The Metamorphic basement of rocks of Nekemte map sheet is a part of protozoic rocks of western Ethiopian shield which assumed to be southern extension of Arabian Nubian Shield (Kazmin, V.1979), and some other has studied the protozoic rocks of western Ethiopia. The Precambrian rocks of western Ethiopia studied and classified in to three N-S running zones. This is the western high grade gneiss, the central low grade volcanic sedimentary belt bound both the east and west by high grade belt. The low grade volcanic sedimentary belt bound both the east and west by high grade gneiss (Kazmin, V.1979).

Local geology and Stratigraphy

The basic regional mapping and field checking for compilation have indicated the occurrence of their major rocks in Nekemte shown in figure-3. Precambrian basement rocks from youngest to oldest include graphite schist, undifferentiating Meta volcanic sedimentary schist, quartz and gneiss. Paleozoic to Mesozoic rocks, these rocks unconformable over lay the Precambrian basement rocks identified. The Paleozoic sand stone, Mesozoic sand stone, silt and shale. Tertiary to quaternary volcanic includes four units these are lower volcanic, upper volcanic, hypo abyssal rocks, dykes plunge and domes.

The hypabyssal rocks include plugs, dome of trachyte, phonolite and syenite, delineate basaltic dykes; composition occur in various part of the study area. It indicated that they are intruded along weak zones, probably concealed fault. Dolerite is highly fractured and weathered rocks. Usually the fractures and joint are filled by calcite. The rock is dark green, medium grained and composed of 35% olivine, 30% pyroxene, and 20% plagioclase, 10% calciteamyydule and 5% quartz. Basaltic dykes are composed of pyroxene, olivine and plagioclase. It is fine to medium grained and locally porphyritic (Solomon G and Mulugeta, m 2000). Syenite dome covers small area of the study. It is composed of 35% orthoclase, 30% plagioclase, 25% hornblend,3% sphere, 3%biotite, 2%quartz, andacgirine augite. The rock is characterized by holo-crystalline texture. Phonolite plug unit covers small areas of the study area. This rock unit intrudes almost all the tertiary volcanic rocks.

This rock is light gray greenish to gray, weathers to reddish brown, massive and jointed .it varies gradually from medium grained to glassy texture upwards. Ti is composed of 35% sanidne, 25% nepheline, 10%opaque mineral and tromatite (Solomon G. and Mulugeta H.G, 2000).

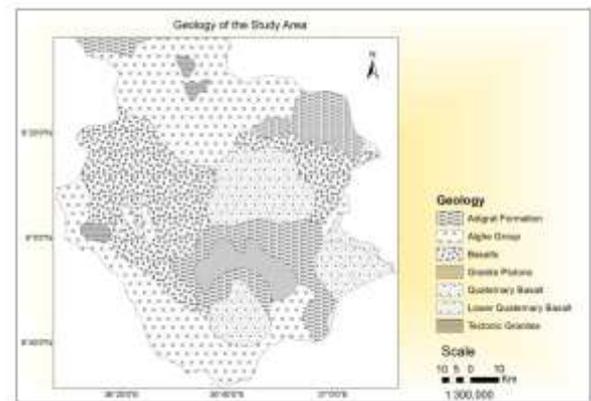


Figure-3: Geological map of study Area

Hydro geology

Ground water is part of natural hydrological cycle. When the rain falls on to the land surface some the water infiltrates more deeply, eventually accumulating above impermeable bed, saturating available for space and forming an underground reservoir. This water now called ground water and the rocks that store and transmit ground water are called aquifer (Macdonald 2005). Ground water occurs at different depth in varies geological unit of hydrogeological basin. All three classes of rocks (igneous, sedimentary, and metamorphic)can hold ground water at different scale depending up on pores space and features in the rocks. The rock properties determine how much ground water can be stored and how productive an aquifer is porosity of rocks related with the proportion of voids. When pores and feature are interconnected the rocks are said to be permeable and water can flow easily. The main features important for groundwater occurrence in crystalline rocks are weathered zones (regolith) and fractured zones. The weathered layer, also called regolith, developed on intact volcanic and sedimentary rocks is an important source of groundwater, for the rural and urban water supply in Studied area. Normally, the alluvium as well as the volcanic rock units in the study area lacks primary porosity which limit the capacity to preserve groundwater. As a result, both rock units have low permeability which inhabits movement of groundwater, were insignificant units in the research site. In volcanic rocks fractures, vesicles and interflow sediments are main features for groundwater occurrence. From these structures fractures are dominant one in volcanic terrain for groundwater in studied area. From the geological data recorded during the many of the drilled boreholes, the basalt which lacks primary porosity has high secondary porosity due to intense weathering and fracturing through which the rainfall percolates and mixing with the composition of rock outcrops. So, it is a good aquifer in the area and influences groundwater quality. The vesicular basalt has high primary and secondary porosity and hence high permeability for groundwater movement and reserve. It has high groundwater potential. Springs are an important source of hydrologic information. They occur because hydraulic head in the aquifer system intersects the land surface. By paying attention to their distribution, flow characteristics, and water qualities, much valuable information can be derived without drilling a single well. Impervious Rock Springs (fracture springs) are recorded in the area from gentle slope of Nekemte highland. They are found in massive basalt which is highly fractured and jointed, the water movement through fractures and springs from where these fractures intersect the land surface at low elevations.

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Due to the differences in mineralogy, texture and structure of volcanic rocks water bearing quality and potential also vary. Ground water recharge Ground water is defined as down ward flow of water reaching the water table following an addition of ground water. There are two type of recharge, direct recharge and indirect recharge. Direct recharge is the process by which water added to the ground water reservoir excess of soil moisture deficit and evapotranspiration by direct percolation to water table following run of and localization in joints, as surface water beaches in lying areas and ground water system. These include precipitation or direct recharge, river recharge; inter aquifer flows, irrigation losses and urban recharge. The topographic land forms always known by recharge area, so that the recharge area is mainly from precipitation or direct recharge and in small areas there is irrigation activities that can play role in ground water recharge. On the other ways different geological structure found on the study areas such as fractures and joints have great role in occurrence ground water is recharge.

Ground water recharge affected by different factors is given bellows:

- Land surface: -Topography, precipitation (magnitude, intensity, duration, special distribution) run off and ponding of water, cropping pattern, and evapotranspiration rate.
- Rivers: - Flowing into and leaving out of the study area, rivers gaining water from losing water to aquifer.
- Irrigation: - Nature of irrigation scheduling losses from cannels and water courses.
- Soil zones spatially and with depth, rooting depth of the soil and cracking of soil on drying out or swelling due to wetting.
- Unsaturated zone between soil and aquifer: Flow mechanism through unsaturated zone with different hydraulic conductivity.
- Aquifer: -Ability aquifer to accept water, variation aquifer conduit condition with time.

III. MATERIAL AND METHODS

Methods

In the study area data have been collected from different source, which includes primary and secondary data to present the research. The method of data collection includes discussion with expert, beneficiary and field observation.

Sampling techniques

Methodology followed to asses ground water resource management 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.

Data collecting procedure

The first task performed was gathering information from office of East Wollega water, Mineral and Energy, Resource department of East Wollega zone Nekemte and observation of ground water wells. It would take 5 days for information gathering from beneficiary, office and field observation. 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.

Method of data analysis

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. RESULT AND DISCUSSION

Major finding of study area

In the study area, different discussion with water experts in the town and local community was made on the historical back ground of the ground water resource management 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 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.

Ground water use

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.

Sustainability of water supply systems

For scheme to be sustainable good operation and maintenance must be fulfilled. In addition, the presence of community management and water committee is crucial for a scheme to be suitable for longer service. Generally, a scheme is sustainable if:

- Technical repairing done on the time.
- The department should be care takers are technical trained.
- Community management system should be developed.
- Make a water committee and generalized awareness program how to save the water.

Regarding with this issue as the information obtained from the responds of the study area, in this there is no repair on time, there is no well-trained staff care taker in this town. Based on the information obtained the above issue the researcher conclude that to solve this problem repair on time well trained staff care takers well arrange, community management in and well developed water committee is needed for the community this town.

Sanitation and hygiene condition

According to information gather from the respondents and obtained by the observation, the problem of sanitation and hygiene is not well known in Nekemte town. The exist problem concerning this condition is not hazardous as the information obtained.

V. CONCLUSION AND RECOMMENDATION

Conclusion

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. There are many aspects that show existence of ground water management related problem in Nekemte town such as, insufficient water supply, limited water consumption and technical problems.

Generally, to avoid existed problems in Nekemte town in ground water resource management, the additional water supply scheme that are another ground water source which have high productive, additional water source or point at the nearest community houses, and related problems with technical is rapid done needed the crucial ground communities of Nekemte town.

Recommendation

- In addition to the existed water supply schemes hand dug wells and bore wells, other water supply scheme should be added for the community of Nekemte town.
- Selection of ground water source or point to the nearest of the house of the community should be need for them.

- The regional water resource bureau all should provide financial and logistic supports for this study area in order to improve the problem exists in ground water resource management.
- The regional water resource bureau all gives attention to ground water management.

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