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Research Articles

The Military Organization and Strategies of the Patriots under the Leadership of Dejazmach Belay Zeleke

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Abstract

Ethiopian patriots protested the Italian occupation in different forms from 1936 to 1941. Dejazmach Belay Zeleke was one of the renowned patriot leaderswho could organize tens of thousands of patriots and carried out successful military campaigns against the Italians and their collaborators in some parts of Gojjam, Wollo and Showa. This study explored the military organization and strategies of the patriots under the leadership of Dej. Belay. Primary data were gathered through in-depth and key informant interviews with 17 people. Descriptive and interpretive methods were employed to analyse the data. Findings revealed that Belay ensured hierarchical chain of command in the military organization, and assigned chiefs who commanded the patriots in their respective districts. The patriots were organized into five military units as Dereq Tor were well experienced and senior warriors; Yemetreyes Zebegnoch (guards of the machine guns) and Zuriya Safari or Mezezo Tor (rear guards in charge of patrolling the court of Belay and surrounding areas.The Gamme tor or Angach acted as security guards, patrolled military fortifications and nearby villages and took part in military campaigns. The Kemanianishae - literally not less than the other – largely includes young boys organized as guerilla units. Belay organized the council of military advisors responsible to make decisions on military matters. Basically, the patriots' military operation was characterized by guerilla fighting and they practiced different military strategies including hit and run, sudden attack, espionage, intercepting and ambushing the enemy, changing sites frequently, encircling camps and strongholds. The military organization and strategies created cohesiveness among the patriots, reduced the magnitude of casualties and contributed to the success of the patriots resistance.

Key words: *Belay Zeleke, Military organization,Military strategy, Patriots,*

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1. Introduction

Belay was born in 1912 from Basha Zeleke Laqew of Lamchan (in Enemay woreda, East Gojjam Zone) and Woyzero Taytu Assene of Chaqata (in Wogdi woreda, South Wollo Zone). The Abay river separates Lamchan and its surroundings from Chaqata. The inhabitants of Chaqata and Lamchan had close relationships for centuries and shared common history, socio-cultural, economic and religious entitles that perpetuate this day. Belay grew up in Chaqata and Lamchan and spent his banditry life and the period of resistance in these localties. Belay continued his life as a *shfta* (bandit) following the assassination of his father *Basha* Zeleke Laqew.[1]

In Ethiopia the patriots resistance retains the attention of historians and it continues to be a research agenda. Pevious studies shade light on the history of patriots resistance, yet there are unknown or under researched issues that necessitate further investigation. Among others, Salome Gebre-Egziabher (1969)[2], Manyazewal Assafa (1970)[3], Yohannis Birhanu (1972)[4], Zelalem Assefa (1983)[5] and Seltene Seyoum (1999)[6] explored various aspects of the patriots resistance in Gojjam, Gondar and Wollega.

Salome (1969)[7]studied the patriots resistance in Ethiopia focusing on the roles of peasants, older people, priests and young boys; cooperation and rivalries among patriots, sources and shortage of food, and medication; and method of collecting information from the enemy. This study does not give wide coverage to the patriots military organization and strategy. Manyazewal Assafa (1970)[8] explored the patriots resistance in the provinces of Begemdir, Gojjam and Wollaga focusing on engagement of the patriots in military campaigns, sources of arms and food supply, and problems of communication and transportation. Manyazewal explains that in the study areas as part of the strategy areas the patriots stationed advanced guards to ambush the enemy lines.

In another development, YohannisBirhanu (1972)[9]did a thesis research on the patriots of Gojjam and discussed cross-cutting issues. This study highlights hit and run or ambushing as a military strategy widely practiced by the patriots of Gojjam led by Bitwoded Negash Bezabih, Bitwoded Mengesha Jembere, Ras Haylu Belew and Dejazmach Belay Zeleke. Zelalem Assefa's (1983)[10] biographical research explores the early life and growing of Dej. Belay'spower to prominence and his achievements from 1912 to 1945. In relation to the patriots military organization Zelalem noted*Yemetreyes Zebegnoch, Mezezo tor or zuriya*

safari, and Gamme or Angach as the patriots military units and highlights their tasks. The work of Seltene Seyoum (1999)[11] is comprehensive and informative and it presents detailed accounts of the patriots resistance in Gojjam 1936 to 1941. Comparatively this dissertation research elucidates structures of the patriots forces and techniques of fighting mainly guerrilla warfare.

Previous studies utilized primary and secondary sources, and some of the interviewees were eyewitnesses and had proximity with Dejazmach Belay Zeleke and other patiots. These academic works shared valuable knowledge to construct the patriots resistance under the leadership of Dej. Belay Zeleke. However, further studies are needed to enrich the history ofthe patriots the military organization and strategies. The current study presents detailed accounts of the patriots military organization and starategies under the leadership of Dej. Belay Zeleke using primary and secondary sources. This study has relevance to build up the body of knowledge how the patriots organized themselves into military units, duties, responsibilities and leadership in the military units, and the patriots military startegies.

In order to explore the patiots military organization and military strategies primary data were collected through in-depth and key informant interviews with 17 people who were selected purposively considering their knowledge related to the topic. The researcher conducted field work in Bichena, Lamchan, Debre Work, Yegossa, Dimma, Yeduha, Debre Markos (in East Gojjam Administrative Zone), Wogdi, Chaqata, Gota Maryam, Sabella (in South Wollo Administrative Zone) and Addis Ababa in different years. Open ended questions pertinent to the patriots military organization and strategies were prepared in Amharic. In addition articles, books, theses, dissertaions were used as secondary data sources, The data were organized, field notes and transcriptions were read, coded and categorized and analysed using descriptive and interpretive analysis.

2. Military Organization

In the five years of resistance movement against the Italians peasants constituted the basic unit of fighting force in many parts of the country. The patriots of Showa, Gondar, Gojjam and other regions led by chiefs organized at village and district levels and waged a stiff resistance.[12]Some of the patriots' leaders like Dej. Belay Zeleke who had a *shifta* (banditry) background that enabled them to get rich experience in military leadership, became successful in guerilla fighting.[13]Here is a brief transition from banditry to resistance fighter to avenge the "blood of Ethiopia" (in the words of Belay Zeleke) that is defeat the Italians and restore its

independence. Dej. Belay Zeleke started the resistance movement with 13 to 15 followers and many of them were his relatives.[14] Belay's personal character, military skills and quality of leadership contributed to rallying thousands of patriots to his side. Belay was ambitious, aggressive and energetic.[15] He was committed to achieve his goal and utilize existing opportunities towards that end. In order to strengthen his force Belay established close relationships with brigands who hid themselves in the bushes after having committed crimes.[16]

Leadership among the patriots was based on ability and experience. Authors Shibru and Sibhat Gebre-Egziabher confirmed that Belay was elected by the patriots on the basis of his ability.[17] Belay gained a reputation as an able military leader and he was well versed in military tactics. The British journalist Edmund Stevens expressed his appreciation of Belay as follows,

> Lij Belay Zeleke was the ablest soldier among the patriot leaders. He -was the only one with a professional understanding of military tactics, the only one who could impose regular military discipline on his column. He was the only irregular commander capable of moving his host from place to place in secrecy and silence.[18]

Greenfield strengthened the reflection of Edmund Stevens, and put Belay on the forefront among the patriot leaders who could build trust among the people and win support.[19]

Different sources suggested different figures regarding the number of patriots led by Dej. Belay Zeleke. According to the estimation of Kebede Tesema, in October 1941 the size of the army which had been under the command of Belay was greater than those of Bitwoded Negash Bezabih, Bitwoded Mengesha Jembere and Ras Haylu Belew. However, Kebede does not provide the specific number of the troops of each patriot's leader.[20] According to Nega Ayele "Belay started his resistance movement with 20 men. In 1941 the number of troops reached 30,000."[21] Zelalem Assefa pointed out that in April 1941 Belay marched to Debre Markos to welcome Emperor Haile Silassie and to show a victory parade and he had 40,000 troops.[22] Sibhat estimated that in 1941 the number of patriots under the command of Belay was more than 44,000 men.[23] Considering the figures suggested by the authors, it is possible to estimate that in 1940 and 1941 on the average the number of troops was estimated between 30,000 and 40, 000.

The growing size of troops and the need to coordinate the resistance movement necessitated the organization of the patriots under military units. Abera and Mockler elaborate that the

patriots were organized into three military units in accordance with seniority and military experiences of the patriots as *arbanna alaqa* (forces of the great chiefs), *gobaz alaqas* (a leader of the brave), and the group of *kemananishe* (literally meaningnot less than the other fighting groups and it included youngsters who were between 12 to 15 years old). This division was used also by other patriot leaders of Gojjamincluding Bitwoded Negash Bezabih, Bitwoded Mengesha Jembere and Ras Haylu Belew.[24]

There were different forms of organizational structures of the patriots forces. As cited in Seletene (1999, p.183)[25], Amdetseyon identified *Teklay Tor Aleqa* (General or Central Military Command), *Tor Aleqa*(Commander of the Patriots), *Kifle Tor Aleqa* (Sub-Division of the Patriots), *Gobez Aleqa* (Leader of the patriots at the village level in charge of mobilizinfg forces for military campaign), and *Tewagi Arbegna* (a patriot assigned to fight against the enemy). This form of hierarchical chain of command was common among the patriots fighting in different parts of Ethiopia including Showa, Gondar and Gojjam.

Yohannis (1972)[26]questioned existence of military structure among the patriots forces in Gojjam. However, the works of Zelalem (1983)[27], Mockler (1984)[28], Abera (1990)[29], Samson (1991)[30] and Seltene (1999)[31] come up substantive evidences and confirmed formation of indigenous-based military organizations and hierarchies to command the patriots.

2.1. Dereq Tor

Recent data obtained from oral informants revealed an organization of patriots into five military units comprising of *Dereq Tor*, *Yemetreyes Zebegnoch*, *Zuriya Safari* or *Mezezo Tor, Gamme/Angach, and Kemanianishae.* The patriots assigned in the *dereq tor*(it maybe described as a group of brave fighters that do not surrender to the enemy*)*and had better endurance to hostile environment, hunger and thirst compared with members of other military units. The *dereq tor* is the combination of two Amharic words "*dereq*" (dry) and "*tor*"(armed force). This military unit was recognized as *dereq tor*considering characteristics of the patriots who are eligible to join this military unit. Members of the *dereq tor*reached 500 and they were adults with extensive experiences in military campaigns. These patriots had endurance to hardships, hostile temperature, hunger, thirst and shocks. The *dereq tor*was under the direct command of Belay and it was mobilized to accomplish major military missions, and when patriots encountered strong confrontations from the enemy.[32]

Making decision to order the *dereq tor* to engage in military campaign was not an easy task. There must be strong justifications supported by evidences regarding the military strength of the enemy (in terms of number, armamentand composition of the army),geographical features of the area controlled by the enemy, duration of the campaign, availability of food and water, and the weather condition to order for the *dereq tor* to take part in the campaign. Dissemination of information about engagement of the *dereq tor* in the campaigns was a source of fear and anxiety to the enemy and it had psychological and military repercussions. Members of the *dereq tor* fought the battles of Dejen, Ayalfush and Wogdi and inspired patriots to fight gallantly and raised their military spirit.[33]

2.2. Yemetreyes Zebegnoch

Ensuring security in and around the residence of Belay was a major concern.Nearly 200 patriots were assigned to serve as *Yemetreyes zebegnoch* (guards armed with machine gun)and they had the responsibility tomaintain peace and order and to escort Belay. Dej. Ayalew Meshesha (Belay's maternal brother) was commander of *Yemetreyes zebegnoch*.[34]Fit. Zegeye Adela, Fit. Mitiku and Fit. Iwnetu were well known in operating machineguns in many battle fields and they provided technical assistance to members of *yemetryes zebegnoch* and other military units on how to operate machineguns. Zegeye Adela, and the two brothers Belew Tesema and Dori Tesema were well known in firing of a machine gun. These individuals played major roles in many battlefields. Fighting was the main task of the metreyes *zebegnoch*. They were dependent on the tribute collected from the people, mainly in kind.[35]

2.3. Mezezo tor or yeelfign zebegna

Among the patriots 300 people were assigned in the *mezezo tor or yeelfign zebegna*(special guards in the residence of Belay) to maintain peace and order near the residence of Belay. They were also considered as personal guards of Belay and other dignitaries and court attendants. The *mezezo* tor was also called *zuriya sefari*as it was stationed encircling Belay's residence. The*mezezo tor*was divided into two sub-units as the*ye-gira zebegna*(the left guard) and *ye-qegn zebegna* (the right guard) andeach group consisted of 150 men. *Ye-gira zebegna* was commanded by *Basha* Deneqew Woregna, and *Basha* Kassa Tgegne was commander of *ye-qegn zebegna*. Both the left and right guards patrolled villages in the vicinity of the residence of Belay and gates of Bokena and Yinfa, the headquarters of Belay.[36]The *mezezo tor* introduced rules that required people living around the residence of Belay to remain

indoor between the restricted timesin the night. For security reason the *mezezo tor* imposed curfew, and fired a gun as a signalto urge people to stay in their houses.A detachment of the *mezezo tor*patrolled villages regularly and they had the right to take measures against people who violated the rules.Patrollers may shoot a person who refused to stop and disclose himself at night.[37]

2.5. Gamme/Angach

The *Gamme* were very young. Those who could carry a gun (*angach*) were allowed to join this group. The *gamme* cut their hair in special style to distinguish themselves as the *gamme*, and the hair style was called *gammekurt*.The *gamme* shaved the centre of their head in a circular shape and left the other part to grow. Young people assigned under the *gamme* unit were large in number counted in thousands in different districts. Sometimes *gamme* and *angach* were used as titles. The *gamme* enjoyed warfare and knew about military tactics. They were under the command of Angach Adamu Nigatu.[38]

The *gamme*/*angach* unit was divided into two sub-groups as *tiliku* gamme/angach tore (senior *gamme*/*angach* military unit) and *tinishugamme*/*angach tore* (junior *gamme/angach* military unit). *Angach* Mengistie Melaku and *Lij* Shiferaw Gerbaw (Belay's cousin) were heads of the senior and junior *gamme/angache* respectively. Following the death of *Angach* Adamu, fighting against *Dej*. Chane Terefe, who was the rival of Belay, *Lij* Shiferaw Gerbaw was appointed as commander of the *gamme tor*.[39]Besides their engagement in military campaigns, the *gamme* provided services in the residences of Belay, district governors, officials and senior patriots. They acted as security guards, patrolled military bases and villages, escorted and checkedguests, served food and drinks, and accompanied guests.[40]

2.6. Kemanianishe

During the battle of Adowa in 1896 and the second Italo-Ethiopian war of 1936 to 1941, young boys were active participants in military campaigns as camp followers and fighting groups. Under the military organization of Belay Zeleke, there was a separate military unit which was recognized as *kemanianishe* largely embraced boys between the age of 12 and 15.[41]These boys were related to some of the senior and junior patriots. They were children, grandchildren, brothers, distant and close relatives or neighbors of the patriots themselves.The *kemanianishes* assisted senior patriots in carrying guns, cartridge belts, swords, shields, food, watching and feeding mules,donkeys and horses, and some of them participated in fighting wars against the enemy. Boyswho were physically strong and had

the capability to operate guns were proposed by senior patriots to join the *gamme*/*angachtor*. Senior patriots shared their experiences to *kemanianishes* on military matters.[42]

Table 1: Areas under the influence of Dejazmach Belay Zeleke

District	Chiefs	District	Chiefs
Inarj –Inawga	*Bitwoded* Tiruneh Sahilu later Ras Tamesgen Fenta	Dabay Tilatgin	*Dej*. Bekele Bogale, later Dej. Kassa Engidasew
Berrentta	*Dej*. Ijigu Zeleke	Derebie	*Dej*. Adimassu Alemu
Shabal	*Dej*. Ayele Adigeh, *Dej*. Gedamu Adigeh	Derra	*Dej*. Worqe Assene, later *Dej*. Imirru Abesha and *Dej*. Mengistu Tegegne
Inamay	*Dej*. Tadesse Laqew, later *Dej*. Ayele Tadesse	Gubaya	*Dej*. Chane Terefe, later *Fit*. Ashagrie Haylu
Siso Iji Inabsie	*Dej*. Dilnessa Yihun	Qinbuat	*Dej*. Chane Minalu
Nazireth	*Dej*. Ijigu Iwnatu	Wudmit	*Dej*. Gesesse Alemu , *Dej* Yihunie Haylu
Borena	*Dej*. Legesse Assene	Awabal	Dej.Chane Mazengia & Belay Mazengia
Ararra	*Dej*.Abebe Belew	Chaqata	*Dej*. Yilma Nigussie
Aneded	*Dej*. Shiferaw Adigeh		

Although these were overlapping roles shared among the five military units, each unit had specified tasks. Fighting and ensuring security were common tasks that each member in different military units was expected to execute. At the district level chiefs created military units and organized patriots under the categories of senior patriots, the *gamme tor*, and *kemananishe, and* there were patriots who renderedservices as the *dereq tor* and *mezezo tor*. There was a hierarchical chain of command among patriots down to the village level.

Belay appointed chiefs as commanders of the patriots in their respective districts.Belay was able to win the support of the people in east Gojjam (Enemay, Inarj –Inawga, Siso Iji Inabsie, Berenta, Shebel, Nazireth, Arara, Aneded, Derebie, Gubaya, Debay Tilat Gin, Awabel, Kinbuat, Borebor, Tilat Gin, Dejjen and Wudmit), part of south Wollo (Chaqata and Borena), and part of north Showa (pocketterritories in Derra bordering Shebel along gorges of the Abay river). Chiefs started patriotic movement as *yegobez aleqa*, and became the voice of the local people, influential and popular. Chiefs had dual tasks of administering districts and commanding the patriots. Table 1 shows list of districts which

were under the influence of Belay and the names of chiefs. [43]

Chiefs mobilized the patriots under their command during military campaigns. Some of the campaigns were ordered by *Dej*. Belay, but others were undertaken on the chiefs own initiative especially in their districts. Belay organized a Council of War which was composed of chiefs, commanders of the *dereq tormetreyes zebegnoch*, *mezezo tor*, the *gamme tor*, and influential personalities. The Council discussed on military campaigns, how to strengthen the patriots' struggle, military strategies, weapons and logistics, the need to strengthen mutual help, and exchange information.[44]

Table 2: Members of the Council of War

Dej. Belay Zeleke	*Dej*. Chane Terefe	*Dej*. Chane Minalu
Bitwoded Tiruneh Sahilu	*Fit*. Ashagrie Haylu	*Dej*. Wubetu Trfe
Ras Temesgen Fenta	*Dej*. Gesesse Alemu	*Dej*. Yihunie Hayle
Dej. Ijigu Zeleke	*Lij* Siferaw Gerbaw	*Dej*. Ayalew Adigeh
Angach Adamu Nigatu	*Basha* Kassa Tgegne	*Angach* Mengistie Melaku
Basha Deneqew Woregna	*Dej*.Chane Mazengia	*Dej*. Yihunie Haylu
Dej. Ayele Adigeh	*Dej*.Abebe Belew	*Dej*. Beyene Bishaw
Dej. Gedamu Adigeh	*Dej*. Yilma Nigussie	*Dej*. Mengistu Tegegne
Dej. Tadesse Laqew	*Dej*. Worqe Assene	*Fit*. Temesgen Haylu
Dej. Ayele Tadesse	*Dej*. Imirru Abesha	*Fit*. Bekele Wassie
Dej. Dilnessa Yihun	*Dej*. Mengistu Tegegne	*Fit*. Haylu Galiya
Dej. Ijigu Iwnatu	*Dej*. Fenta Senbete	*Fit*. Teshale Alemu
Dej. Bekele Bogale,	*Dej*. Guanche Adela	*Fit*. Abetu Tesfaye
Dej.Kassa Engidasew	*Dej*. Ferede Adela	Fit. Tesema Laqew
Dej. Legesse Assene	*Ras* Tesema Nigussie	*Bejirond* Abate Adigeh
Dej. Adimassu Alemu	*Dej*. Belay Mazangia	*Lij* Degu Adigeh
Lij. Mekonnen Kassa	*Dej*. Ayalew Meshesha	*Dej*. Shiferaw Adigeh

Most of the patriots armed themselves with modern and traditional weapons that they had. After the military campaigns many patriots returned to their villages to farm plots of lands, and when the need arose they joined chiefs for military duties.[45]Fundamentally, people joined patriot leaders to free their country from Italian occupation. The desire to get rifles, military titles and to collect booty motivated some people to join Belay and local chiefs. Even those who had guns wanted to have another which were considered as the best quality by the standard of the time. The quality of firearms had an impact on the degree of gaining respect among friends and local community.[46]Pankhurst discussed the psychological impacts of firearms in the Ethiopian society.[47]

The practice of looting contributed to increase the number of patriots. Looting was the source of food and firearms. Belay encouraged looting and plundering to weaken the *bandas*, and to have more firearms to strengthen patriots' military might.[48] There were other sources of supply of firearms. The victories that patriots achieved in the various battlefields were the main source of arms.Belay carried out a series of military campaigns and won victories and collected much booty. As the number of campaigns increased the quality and quantity of firearms captured by the patriots increased. It was in 1937, that for the first time Belay's followers captured 62 *wochefo* (wetterly) and *minishir* (Manlicher)*wujigra (*Wijitra or fusil Gras*) dimotfor* (Lee metford), *mauzar* (mauser), *nasmasar* (a rifle which has a brass shoulder-strap) and *sinadir* (Schneider hunting rifle) from the bandas. [49]In the same year Belay and his followers captured four or five rifles each following their victory over the *banda* at the Battle of Abarra in January .[50]

Capturing weapons or other materials from the enemy was a sign of bravery and animportant criterion to get military titles and an award from Belay. In this case the patriots were ready to hand over the booty to local military chiefs. When patriots received guns as an award it was usual to swear in the name of Belay and Saint George to show their loyalty.[51]Belay distributed the available guns and bullets to unarmed patriots or to those who were equipped with spears, shields and sticks after they were trined in operating guns. [52]

Arms were purchased mainly from the *bandas*, Darra and Chaqeta were important trading centers for firearms and bullets. The process of buying and selling firearms and bullets was conducted in the form of bartering and in cash. There was variation in the prices of rifles depend on their quality. The price of one Beljig (Belgium's rifle) was equivalent to 40 Maria Theresa Thalers or one mule,one *achir minishir* cost 50-60 MT, 10 *yealbin tiyit* (bullet for Albanian made rifle) were sold for 1MT; and 30 *yebelijigtiyit* (bullets for Belgium's rifle) were sold for one MT.[53]

Firearms were also obtained in the form of gift. In March 1941 Emperor Hayle Silassie sent 300 rifles to Belay from Omedla.[54]There was limited number of machine guns and field glasses owned by the patriots. *Dej*. Belay Zeleke, *Ras*Temesgen Fenta, *Dej*. Mengistu Tegegne, *Dej* Ejigu Zeleke had field glasses.[55]Belay was not able to arm the entire army with guns. For instance, when Belay and his followers launched a surprise attack on the *banda* on January 14, 1937 in Abarra with 60 men only 30 were armed.[56]The problem of shortage of

arms continued to exist until the close of the liberation struggle. In 1940 when the news of the return of the Emperor was heralded a large number of people including the *banda*started to join the patriots and that it became impossible to arm them.[57]

Formal military training was not given to the patriots. The young patriots learned how to fight by watching and listening to the advices of senior patriots. However, sometimes, they were given orientation on how to attack the enemy and defend themselves.[58] The captive *bandas* taught the patriots how to handle machine guns, hand grenades and other weapons and how to exchange greetings as trained soldiers. They also taught the patriots military drill imitating after the Italians, but it was given up after a while considering it as irrelevant.[59]In 1938, 13 *banda*deserted the Italians and joined the forces of Belay at Yinfa and taught many patriots how to use machine guns. Occasionally, some of the patriots exchanged military salutes with *Dej*. Belay. Beshir and other *banda*fought on the side of the patriots in several military campaigns.[60]

Patriots improved their knowledge and skills of operating rifles, machine-guns and implementing military strategies through mutual learning. Senior patriots including *Dej*. Belay gave instructions and briefings to inexperienced patriots on military issues and on how to open and assemblerifles, machine guns, hand grenades and pistols, fire rifles, shoot targets, ambush and disguise from the enemy.[61]

During rest time and on holidays Belaywatched patriots exercising and practicing target shooting, usually skull of a cow or an ox,running, riding a horse in the open field of Yinfa. *Angach* Wasse and Abate Worya from Enebse Worya were famous runners among the patriots; *Fitawrari* Ayalew Tefera and Biazin Niguse from Yedaguat were winners in horse riding. Champions of shooting, running and horse riding were awarded rifles, bullets, horses and money, and were respected by the patriots.[62]

As far as provision of food is concerned, in time of military expeditions patriots used to eat bread, roasted grain and dried meat prepared in their homes; people also served them with foods and drinks. The largest proportion of the army was composed of peasants and practiced both agricultural and military activities at the same time.[63]

The Italians appointed Ethiopians who collaborated with them as local governors regardless of their background. They were given honorary titles such as *ras, dejazmach, fitawrari* and

*grazmach.*Titles were given even to the butchers, tailors, waiters, cooks, drivers and gardners.[64]Belay granted military titles to the patriots as *ras, bitwoded, afengus, dejazmach, fitawrari, qegnazmach* and*girazmach*[65]to counteract the Italians attempt to increase the number of the *bandas* by offering honorary titles. In other words it was a preemptive measureto discourage the inclination of patriots from jining the Italians; to upstage the Italians by projecting an image that Belay had an able military leaders with lofty military titles; to strengthen their morale to fight the enemy and to make them obedient to Belay.[66]Belay had no desire to award himself with the highest military titles. He reasoned that his mother had already given him the name Belay meaning above all. But many of the patriots called him *leul* Belay, and the *bandas* called him *atse begulbetu*(majesty by his own strength).[67]

In addition, Belay created incentives and a spirit of competition among his followers. A patriot who killed an Italian soldier or captured weapon from the enemy was given the privilege of drinking tej in the special vessels which were called *genbaw, ye wodaj mescha, deboch and sale* Belay.Patriots with such achievements were also allowed to seat near Belay Zeleke when there was a banquet, and the guests who were invited to the banquet would welcome them warmly standing from their seats after they performed their valor traditionally called f*ukera* meaning a war dance.Patriots who captured enemies enjoyed more prestige. [68]

3. Military Strategy

The patriots did not rush to the battle fields spontaneously, rather they explored their potentials and tried to get informed about the existing situations on the Italians side through *yewust arbegnoch* (Ethiopians who had contact with the Italians and the *bandas* but they assisted the patriots underground) and the *qabi* (ቃቤ*Qabi* is an Amharic word used to describe patriots who were assigned to spy the Italians and the *bandas*). The Council of War, the chiefs and their followers considered the arms and logistics, size of the army, topography and weather condition of the battlefield as inputs to plan feasible strategies. There were debates over the proposed strategy before reaching consensus on the proposed strategies. The strategies were designed to reduce casualties on the side of patriots and to resist and defeat the enemy. [69]

The patriots used several strategies in the campaign against the Italians and the *bandas*. Guerilla warfare was a common strategy widely used by Ethiopian patriots.[70]Dejaches Mengesha, Negash, Lej Haylu Belew were popular leaders chosen by the people. Another

reason that contributed to the the continuity of the struggle was the guerrilla warfare the patriots adopted as a method of struggle against the enemy. The patriot chiefs Abebe Aregay of Showa, Belay Zeleke of Gojjam and Wubneh Tesema of Armachoho, who all adopted guerrilla warfare, are particular examples.

Yohannis BIrhanu and Nega Ayele explained that the form of fighting in Gojjam was characterized by guerilla warfare that involved hit and run tactics. The patriots controlled strategic places, attacked the enemy and advanced forward or retreated depending onthe strength and weakness of the enemy.[71]The patriots ambushed the enemy in the jungles and valleys, and they used mountains and caves as strongholds. The enemy was unable to destroy the patriots' strongholds in Somma, Filaw and Bokena which were inaccessible and demanded huge sacrifices.[72]

Deploying a group of patriots along the Italians lines to intercept and ambush them [73] and diverting attention of the enemy through disseminating misleading information about location of the patriots were important strategies employed by the patriots. The patriots moved elsewhere rapidly after they fired from a certain point to mislead the enemyin order to attack it when it moves into the intended target.[74]Belay**did** not stay in the same place for a long period of time.[75]

Salome Gebre-Egziabher has emphasized the contribution of information gathering as part and parcel of military strategy utilized by the Ethiopian patriots.[76]Actions taken by the patriots against the enemy were supported by information gathered by spies known as Qabi in Amharic.The *qabi*disguised themselves and approached the *bandas*, Italians and women cooks as if they were their supporters and observed day-to-day activities. The *qabis*focused on Debre Markos, Dejjen, Bichena, Debre Worq, Derra and Wogdi where there were Italian camps, Italians and *bandas* as well. The *qabi* infiltrated the enemy and establihed contact with the *yewustarbegnoch* and worked together to dig out information about the enemy and communicate it to *Dej*. Belay and the chiefs. The *qabi* disseminated fake information among the *bandas* and the Italians about the patriots that might have negative implications to the enemy and positive outcomes to the patriots. Fake information influenced the enemy to make wrong decisions.[77]

Sometimes, the number of patriots who participated in the campaign was decided based on the strength and size of the enemy. Belay deployed his troops systematically to save time and

energy and to take quick military actions. If thecampaign was in Inebse patriots would be mobilized from surrounding areas e.g. Enarj Enawga. Chiefs of neighbouring districts supported each other to boost their strength.[78]The *qabi* gave misleading information to the spies of the Italians. For example when Belay planned to attack the enemy which was stationed at Debre Worq in August 1940. spies of the enemy were informed that the campaign was directed towards Dejjen. They misinformed the enemy about the date of the launching of the fighting.[79]

Belay thought that stationing a large number of patriots in the same place might have the risk of vulnerability to enemy attack. Patriots were dispersed in different sites to watch for movement of the enemy. For security reasons the patriots used the roads which were not frequented by the enemy, and launched an attack from different directions to split and exhaust the enemy. Belay and other chiefs arranged contingents and logistics to reinforce troops.[80]

It was a common practice that Belay and other chiefs fired the first bullet to the sky as a signal to alert the patriots to start fighting. [81]The patriots had respect for their leaders,they accepted orders and put them into actions.[82]The patriots used codes (in words) to indicate their affiliation to Belay and other commander/s of the campaign. The code may be changed,so every person should update himself. For instance, the patriots used this code in a certain campaign: To which group do you belong to? Belay Zeleke! What did he say? Kill the enemy! (የየትኛዉቡድን/ጭፍራህ! የበላይዘለቀ! በላይምንአለ? ጠላትንግደልአለ!)[83]

4. Conclusion

During the period of resistance 1936-1941, mainly voluntary peasants from different walks of life and age categories formed the nucleus of patriot forces under the leadership of Dejazmach Belay Zeleke and his chiefs assigned in different localties. Organizing the patriots (considering their military experiences, age and type of weapons they used) under the military units of the *Derek Tor*, *Yemetreyes Zebegnoch*, *Zuriya Safari* or M*ezezo Tor, Gamme Tor or Angach, and Kemanianishae* is a major achievement. The patriots assigned in each military unit had defined roles and responsibilities, however, whenever necessary every patriot was expected to take part in military campaigns. Indigenous forms of military organization served as anchor institutions to hold patriots together and ensure continuity of the resistance movement. The patriots military organization had functional structures linking

the patriots at the village and district levels to facilitate chain of command to deploy forces and to fight against the enemy. The patriots used diverse military strategies to attack the enemy including guerrilla fighting, hit and run, sudden attack, intercepting, blocking roads, infiltrating in to the enemy camps, espionage and misleading the enemy. There was flexibility and the practice of blending different strategies that fit the existing contexts leading to success.The patriots put stiff resistance against the enemy, this was attributed partly to the formation of military organization, implementation of feasible military strategies, and existence of good leadership, mutual respect and devotion among the patriots.

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5. Yohannis
6. Zelalem
7. Salome
8. Manyazewal
9. Yohannis
10. Zelalem
11. Seltene
12. Salome; Seltene

13. Seltene; Yohannis
14. Sibhat Gebre –Egziabher, Jagnaw Balay Zalaqa, in *Yekatit,* Hamle 1972 EC (July 1980)pp. 10-13.

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Mockler

25. Seltene
26. Yohannis
27. Zelalem
28. Mockler
29. Abera
30. Samson
31. Seltene
32. Informants: Tesemma Laqew, Kassa Tegegne, Kebede Fenta and Mammo Kefale
33. Kassa Tegegne, Kebede Fenta and Mammo Kefale
34. Samson; Zelalem

Informants: Kassa, Tesema

35. Ketintawit Ethiopia Jegnoch Arbegnoch Mahiber Office; Samson

Informants: Kassa, Kebede, Tareqegn Melesse

36. Informants: Kassa, Kebede, Gedamu Beyene,
37. Informants: Kassa, Mammo, Kebede
38. Samson; Zelalem

Informants: Kassa, Mammo, Tesemma

39. Informants: Kassa, Mammo
40. Informants: Tesema, Ayalew Desta, Mammo, Kebede, Kassa
41. Informants: Mammo, Kebede, Kassa
42. Informants: Kebede, Mammo
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Manuscript – Biography of Fitawrari Tesema Laqew 28/04/1982 E.C.) Informant: Menber

44. Abba Kostir, Ketintawit Ethiopia Jegnoch Arbegnoch Mahiber Office No h 329 Kibur Dej. Belay Zeleke; p.1

Manuscript – Biography of Fitawrari Tesema Laqew 28/04/1982 E.C.)

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Informant: Teshale

51. Informants: Ayalew, Kassa, Mammo, Kebede
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53. Informants: Tesema, Kebede, Mammo
54. Informants: Ayalew, Tesema
55. Informant: Kebede
56. Manyazewal

Informants: Teshale

57. Manyazewal

58. Salome

59.Salome

Informants: Ayalew, Kassa

60. Informants: Kebede, Mammo, Tesema

61. Informants: Members of Yeshebel Berenta woreda patriots association, Mammo, Menber, Kebede

62. Kebede

63. Manyazewal; Aberra

Informants:Kebede, Ayalew, Admasse,Endalew, Libanos,

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67. Mockler; Kebede

68. Abera; Zelalem

Informants: Zenebe Hayle, Admasse Wasse.

69. Informants: Tesemma, Mammo, Kebede, Menber

70. Sbacchi

71. Yohannis; Nega

72. Samson; Zelalem

Informants: Menber, Mammo

73. Manyazewa

74. Salome

75. Aberra

76. Salome

77. Informants: Abate, Alamirew, Mammo, Tesema, Kebede

78. Informants: Mammo, Kebede, Ayalew

79. Informants: Kebede, Mammo, Alamirew

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Manuscript – Biography of Fitawrari Tesema Laqew 28/04/1982 E.C. (Obtained from the family.)

Appendix 1.

List of informants

Name	**Remark**
Abate Endalew (Ato), Age 92	Interviewed in Dimma in August 2013. Joined the patriots in his childhood, under the service of Belay.
Admase Wase (Ato), Age 70	Aug. 6&24/1990. Bichena, He was a patriot under Belay
Alamirew (Ato) Age 92	Interviewed in Zekort, Geday Iyasu (Yeduha-Berenta) in August 2013. Well known patriot, under the service of Belay.
Ayalew Desta (Ato), Age 75	July 26/1990, Yeqefet Abbo (Bichena). Under the service of Belay.
Chanyalew Kassa (Dr.), 45	Addis Ababa, April 15/1990. He was well informed about the patriots.
Eshetu Ewnetu (Kegngeta), 73	Bichena, July 23/1990. Attended church education. Knowledgeable about Belay's military organization
Gedamu Beyene (Blatta) Age 77	Agam Borebor, July 14/1990. Under the service of Belay
Kassa Tegegne (Basha), Age 80	Gabarma, August 5&6, well known patriot, member of yemetreyes zebegnoch and leader of yeqegn zebegna
Kebede Fenta (Ato), 90	Lemichen, June 2009. Had close relationship with Belay since his childhood. A patriot and eye witness.
Libanos (Merigeta), 77	Debre Markos, June 27/2013. Attended church education. Knowledgeable about patriots struggle.
Mammo Kefale (Abba), 90	Bichena, Mar.20-22/20133; July 21/2018. Under the service of Belay since childhood.
Menber (Ato), 50	Bichena, August/2013. Secretary of Patriots Association. Well informed about patriots struggle.
Tarekegn Melesse (Ato), 74	Yashabab (in bichena), August 5. Angach of Belay
Tesema Laqew (Fit.), 76	Bichena, August 6&20/1990, July 18/1990. Belay's uncle, known patriot and an eyewitness, had reach knowledge.
Teshale Alemu (Fit), 83	Bichena, July 29/1990. Belay's cousin, known patriot, grew up with Belay. Eye witness about patriots struggle
Yeshebel Berenta woreda yEthiopia abat arbegnoch mahiber abalat. Yeduha, August 2013. they were 50 and older, informed about patriots struggle, Their parents and relatives were under the service of Belay.	
Zenebe Hayle (Ato), 38	Bichena, July 25/1990. His father was member of yemetreyes zebegnoch.

Determinants of Household Water Supply Sustainability in an Emerging Town in Northwest Ethiopia

Fekadu Workneh[1] and Mehretie Belay[2]

Abstract

Accessing useable freshwater appears to be the main worry of urban citizens in Ethiopia today. The possible reasons for the problem are not yet duly addressed in scientific literatures. In this paper we analyzed the determinants of household water supply and sustainability in a rural town named Agew-Gimjabeht, Ethiopia. We captured data through questionnaires, interviews, discussions and observations. Data were analyzed using descriptive statistics and the binary logistic regression model. We found that many households (≥68%) lack adequate water supply to satisfy their family needs. The daily household per capita water was 42.13 liters. The per capita water (9.93 liter per person per day/ l $p^{-1}d^{-1}$) found less than the universally recommended 20 l $p^{-1}d^{-1}$threshold. Age, house type, micro-relief, rate of urbanization and management capacity significantly influenced households' freshwater sustainability in the town. It is recommended that urban governments design better urban management schemes and capacities to minimize water shortages.

Keywords: Water supply; Sustainability determinants; Rural towns; Northwest Ethiopia.

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1. Introduction

1.1 Freshwater Sources and Supplies

Freshwater is an indispensable resource for the survival of life on the planet Earth. It is the basis and foundation of all living organisms and equally important for sustainable socioeconomic development (UN-WATER, 2018). Potable freshwater required for household consumption is priceless and cannot be replaced by another Earth resource (Koehler, 2008). But, its amount in the human settled areas of the Planet Earth is limited. Because greater than two-third (≈69%) of the useable freshwater on Earth is frozen in the glaciers and polar ice caps (Hudart and Stot, 2010).

Earlier in the past, the widespread view of people on freshwater was consistent to an infinite enormous wealth (Jethoo and Poonia, 2011). But, freshwater is the only renewable non-living resource; depleting and finite equally. Some scientists argue that it is something similar to the top soil exhibiting both living and non-living components. However, contrasting to minerals and other water resources, freshwater is firmly unified with the biosphere. Hence, its extreme loss in the biosphere can drastically cause biodiversity and ecological health collapse (Koehler, 2008). Based on Koehler (2008) essay, three major kinds of freshwater (deposits, funds and flows) each differing by way of the inherent restoration capability is distinguished. Ground based freshwater stocks (deposits) easily deplete with excessive use and slightly regenerate or cannot be restored at the span of human lifetime. The aquifers and lakes (freshwater funds) reduce provisionally with use; yet replenish naturally provided that they are not irrevocably damaged. The flow freshwater resources in the springs, rivers and streams are fundamentally inexhaustible. But, these waters can be easily altered with excessive and improper utilization and withdrawals. So, as a depleting resource, freshwater, which is very fundamental to life after oxygen, is getting progressively scarcer and less accessible to human use all over the Globe (Koehler, 2008).

Useable freshwater is an essential drinking good to satisfy human thirsty. But, its relevance is not limited to get satisfaction. It is the center for food production, personal hygiene and to sustain biodiversity and ecosystem functions. In addition, it plays major role in poverty reduction via the use of irrigation and fishery. It can generally be considered as a strategic wealth forming the basic framework of socioeconomic development and human civilization (Koehler, 2008; Wiek and Larson, 2012). However, proper freshwater use activities are

violated by poor access, inadequate delivery, low quality and quantity. When availability, accessibility and proper utilization of fresh-water are violated the continued existence of humanity is endangered. For instance, when freshwater and hygiene get lesser and lesser in an area, fatal infections easily come-up from polluted water and spoiled food items then cause severe sickness and grave deaths (Sobsey *et al*., 2008; Tesfaye, 2012). Abebe (2014) argues that insufficient access to potable freshwater supply is exacerbating sanitation and hygiene problems and the incidence of poverty in many developing countries. Shortage of adequate and clean potable freshwater thus jeopardizes food security, human nutrition and health in the developing areas of Africa and Asia (Koehler, 2008). The shortage can trigger conflict among users at village or diverse community levels (Ostrom, 1990; Gleitsmann *et al*., 2007). Availability of ample freshwater supply of adequate quality for human use and environmental health is thus essential for the long-term progress and stability of any country (Roy *et al*., 2005).

World population was estimated 6.9 billion in 2010, and projected to reach 9.15 billion by 2050 (Alexandratos and Bruinsma, 2012). By the mentioned time (in 2050), the worldwide freshwater demand is anticipated to rise by 55%, primarily owing to the rising demands of the increasing population, agricultural expansion, rising manufacturing industry, growing power production and household consumption. According to UNDP (2006), 1,700 meter cube water per person per year ($m^3\ p^{-1}\ yr^{-1}$) is required for meeting such human basic and socioeconomic demands. Taking this threshold as a standard, there is in fact sufficient freshwater reserves at the Global level though the distribution is uneven. But, water shortage occurs due to the uneven freshwater distribution and as a result of inadequate access and poor quality. Coupled with the uneven distribution of the Earth's freshwater, over use of both surface and underground water for agriculture alters the availability required for coming generations. Improper freshwater use practices with erection of excessive irrigation dams on upstream areas increasingly lower freshwater availability and endanger terrestrial and aquatic ecosystems. The occasion alters the sustainability of the local biological diversity and ecological functions. This finally violates the hydrological system in downstream areas (Koehler, 2008).

Ten years ago, Sobsey *et al*. (2008) remarked that around 1.1 billion people throughout the world were forced to use risky water from underground and open sources due to shortage of clean drinking water. Recent sources remarked as well over 2 billion people suffer from

severe water stress globally (Mwangi, 2014; UN, 2017; Bain *et al*., 2018). Other additional sources also indicate large numbers of countries are reaching frightening stages of freshwater shortage and scarcity. For instance, countries in the middle-east, sub-Saharan Africa (SSA) and South Asia suffer from severe water shortage and stress. In SSA, the water-stressed countries are experiencing extreme population growth rates; but diminishing rates of per capita water (UNDP, 2006). Less developed areas such as Ethiopia suffer from the scarcity of safe potable freshwater for home consumption and environmental purposes due to rapid population growth rates; despite having numerous rivers and lakes (Degefu *et al*., 2015). The freshwater supplies in these countries are expected to be scarcer and scarcer in the coming decades owing to the rapidly increasing populations, growing demands, wetland alterations and climatic changes (Wintgens *et al.*, 2008; Wiek and Larson, 2012).

Cities and towns are areas where development prospects and challenges are often confronting. They are places of higher population agglomeration. In the Current decade, around 54% of world's population is living in urban areas and it is projected to reach 66% by year 2050 (UN, 2014). These urban people in 2050 are expected to emerge in developing countries (UNWWDR, 2015). However, these rapid population changes in the cities and towns are weakly equipped with urban infrastructure and freshwater schemes (Berore, 2016). The weak urban infrastructure perhaps remains unfavorable to deliver sustainable and adequate freshwater supply to households in many countries. Rival demands among various sections of the community also intricate the freshwater allotment and delivery practices. The user community participation during planning and policy formulation on freshwater development is also very low in a number of countries (Fita, 2011; Laurent *et al.*, 2012; UNWWDR, 2015). The concern of freshwater supply, access and sustainability is thus nowadays emerging to be one among the many challenges of urban areas; particularly in the developing countries.

People living in cities and towns can access household freshwater from springs, bore-holes, streams, rivers, ponds, lakes, hand-dug wells and trapped rainfalls. The water from these sources can be made available for household consumption through fetching using human and animal labour, from private standing pipes or from public taps (Kithinji, 2015). Yet, potable freshwater supply for household consumption from reliable source is rare. Due to this households are forced to collect it from defective sources. Accessing it from unreliable sources is possible only through paying higher prices; and often unsustainable, inadequate and unsafe. Freshwater from such unreliable sources are frequently contaminated by urban wastes;

thus expose urban dwellers to diverse illnesses and diseases (Bahri, 2012; Otti and Ezenwaji, 2019).

The task of accessing useable water to urban residents thus requires active planning; good governance; user community participation and suitable infrastructural schemes (Adams *et al.,* 2018). The process involves the production and storing of the water at the sources; conveying it to the treatment plants and reservoirs and then distributing it to consumers via the use of pipelines. Deficiencies associated to these procedures significantly influence the urban freshwater access efforts and processes. Scarcity of adequate water sources, ill-equipped technical support services, repeated power interruptions, inequitable water allocation dealings, poor water storage habits, weak user participation, financial constraints and absence of good governance also greatly impact urban water access functions (Tesfaye, 2012; Ashenafi, 2014; Godebo, 2015).

1.2 Sustainable Freshwater Supply

Sustainable freshwater supply refers to clean and affordable freshwater supply available to all persons with no discrimination on a continuous basis to satisfy their basic needs (drinking, food preparation, bathing, cloth washing and related household sanitations) (Gleick, 1996). According to World Health Organization (WHO, 2003) standards, the minimum basic water requirement is 20 liters per person per day (l p^{-1} d^{-1}); although there are no clear compromises among the scientists. Gleick (1996) recommended 50 liters of fresh water p^{-1} d^{-1} to satisfy the mentioned basic needs. He proposed 3 l p^{-1} d^{-1} for survival (for drinking) in normal temperate climatic settings. He then suggested an increased threshold of ≈ 5 l p^{-1} d^{-1} with consideration of both temperate and tropical climatic conditions. He recommends 20 l p^{-1} d^{-1} for sanitation. For bathing, he suggested ≈70 l p^{-1} d^{-1} (a range of 45-100 l p^{-1} d^{-1}) in developed countries and 15 l p^{-1} d^{-1} (or between 15-25 l p^{-1} d^{-1}) for developing regions. Average amount of freshwater required for food preparation in Gleick (1996) report is 10 l p^{-1} d^{-1} to achieve basic requirement or (≈10-20 l p^{-1} d^{-1}) to meet regional levels.

Sustainability of the potable freshwater supply and use can be achieved by 'protecting the water environment'. This can be made through involving stakeholders such as user communities, governmental and Non-Governmental Organizations (NGOs) and the private sectors (Tadesse *et al.*, 2013). Sustainability can also be retained by addressing equity between rival uses; current and upcoming demands, and between human and other needs

(Armstrong, 2006; Adams and Smiley, 2018). In other words freshwater supply, use and sustainability can be viewed as the result of the interactions between socioeconomic and environmental variables. It must consider both the local and Global water potential plus the demands of the coming generations (Del Borghi *et al.*, 2010). However, sustainability of future freshwater use is complicated by increasing current demands and limited supplies (Roy *et al*., 2005). Rapid population growth rates, insufficient infrastructures and faster rate of urbanization are other factors affecting the sustainability of potable freshwater supply in poor communities. Absence of good governance and unsustainable development greatly impact the quality, access and sustainability of freshwater supplies.

Household freshwater supply access and use in Ethiopia is one of the lowest in the world. For instance, the per capita freshwater use ($l\ p^{-1}d^{-1}$) in 1990 was only 13.3 for the country (Gleick, 1996). This 13.3 $l\ p^{-1}d^{-1}$ is below the minimum absolute freshwater (20 $l\ p^{-1}\ d^{-1}$) recommended by the WHO (2003) for basic human needs. In 2014, only 55% of the households all over the country were getting access to improved potable freshwater supply. This is almost higher compared to the only 25.6% households' access to water in the year 2000. Nonetheless, access to pipe water is still very low; only 33% in 2014 (UN, 2015). For Amhara Region where the current study site is located, the potable household freshwater coverage is not exceeding 60%; meaning, 40% of the households do not have access to clean potable freshwater supply (Shimelash, 2013).

There are several studies on household water access and supply in different parts of Ethiopia. To cite some, the paper by Ashenafi (2014) explored the urban water supply and use in Asayta town, northeastern part of Ethiopia. Similarly, a research conducted by Abebe (2014) assessed the urban household water supply in Gimbichu town, southern part of Ethiopia. Berore (2016) evaluated the Welkite town water supply system, in the Gurahge Zone, Ethiopia. The paper of Gebre (2016) also examined the causes and impacts of water shortage on urban households in Burayyu town, central Ethiopia. All these studies described the water access and supply systems in the different towns of Ethiopia. This study mainly differs from the mentioned studies in that it focuses on describing the determinants of household freshwater supply sustainability in an emerging rural town named Agew-Gimjabeht, in the northwestern highlands of Ethiopia.

2. Research Methods and Materials

2.1 Description of the Study Area

The study area, Agew-Gimjabet town is found in Awi Zone, in the northwestern highlands of Ethiopia. It is located 420 kms northwest of Addis Ababa at $10^0$51' N and $36^0$54' E (Figure 1). The town covers 627 ha land at an altitude of 2320 m asl on a basaltic plateau in Ankesha-Gugusa Woreda (District). The entire size of the domicile woreda measures 1029.24 km^2 area between 1800-2900 m asl elevation ranges. The main climate is *Woina Dega* (sub-tropical). The average yearly temperature and rainfall values range between 15-20^{0}C and 1000-2000 mm, respectively. Three discrete rainfall periods (summer, autumn and spring) are experienced in the area. Summers are of high rainfall spells whilst autumns and springs are characterized with modest and slight rainfall events, respectively (ANGWFEDO, 2017).

The name Agew-Gimjabeht has been known as a rural church village (Gimjabeht-Mariam) since 1673 with the establishment of the Saint Marry Church by Atsie Yohannes I (Tsadiku Yohannes, 1667-1682 AD). Recently, the size of the village expanded and got the status of town and has served as a district administrative and market-service center during the past 35 years. The town now is inhabited by 17,898 people (8,488 males and 9,410 females) in two Urban Kebele Administrations (UKAs)[2]. Afan Oromo, Amharic, Awigna, Guraghegna and Tigriegna are spoken by different number of people. Christianity and Islam are followed by the town dwellers (ANGWFEDO, 2017). Schools, health centers and financial institutions are among the main public institutions found in the town.

Suburban - residential, market (commercial), administration, social amenity, transport terminal, agricultural, sport and recreational areas are the major land uses in the town. Mixed agriculture is practiced by considerable number of the people living in the town to augment livelihood gaps. Small-scale enterprises are major occupations for many people. Small-scale business (shopping and hotel services), milling, bakery, lumbering, brick-making, retail shopping of different commodities including grain selling and electronics are important occupations of the people.

[2] UKAs are lower urban administration units

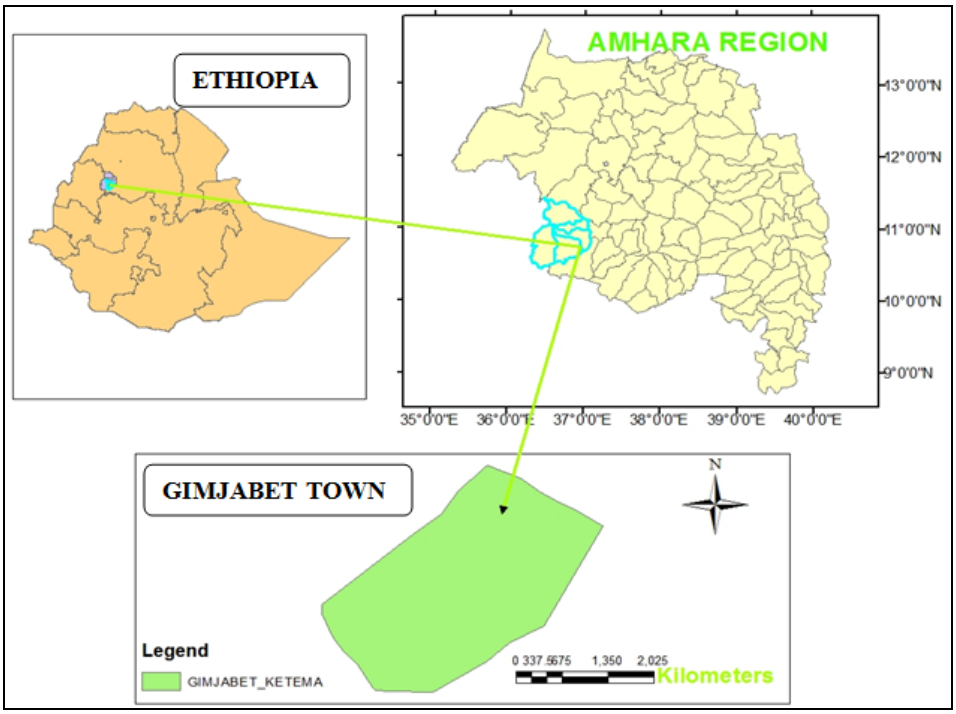

Figure 1. Map of the study area (Adapted from Ethio-GIS, 2007 data).

2.2 The Research Method and Data

2.2.1 Research design

The study used the concurrent triangulation mixed method model which involves concomitant gathering and analysis of quantitative and qualitative data. The approach employed manifold information sources and techniques to generate both numerical and qualitative information using several perspectives such as questionnaires, in-depth interviews, focus group discussions (FGDs) and field observations. These approaches and methods help to verify the information and to reach at accurate conclusions.

2.2.2 Sampling and data generation

The study urban area; Agew-Gimjabeth town, is restructured into two UKAs for the reason of governance. Scarcity of access to potable freshwater is a pervasive constraint of the households in the two UKAs. Hence, both were considered in the study. A total of 357 sample representative households were identified from 3321 households using systematic random sampling technique for the questionnaire survey. Yamane (1967) sample size determination procedure was followed to reach at the 357 sample population. Because this method offers large number of samples compared to other models, it was used to determine the sample

households in this paper. Following deciding the size of the sample population, 204 and 153 household respondents were identified from 01 and 02 UKAs, respectively using the proportional-to-size allocation method through systematic selection procedure. Sixteen knowledgeable household heads (four women and four men in each UKA) for FGDs and six elders (one woman and two men in each UKA) were also purposively selected for additional in-depth qualitative data gathering on households' perspectives, behaviours, attitudes and experiences.

Following identification of the study samples, both close and open-format questions pertaining demographic, biophysical, socioeconomic, water supply access, use and sustainability issues were designed for numerical data generation. The questions were first prepared in English and then translated into the local language Amharic to ease the barrier of communication. Then, preliminary surveys were undertaken from 20 residents met at random occasions so as to check the relevance and validity of the questions. After that, the questionnaires were improved by deleting irrelevant concepts and adding new ones observed important during the pretest. Finally, the questions were distributed to the 357 sample households for final data gathering. During the survey, three university graduate interviewers were recruited, trained and assigned to assist respondents who cannot read and write. The questionnaires were filled from the beginning of March to the end of May 2018 under close supervision of the lead researcher.

Simultaneously, the in-depth interviews and FGDs were facilitated by the lead researcher. Pre-designed guiding questions were used during the in-depth interviews and FGDs. Detailed field notes were also compiled in the due process. Field observations were undertaken before, after and during the questionnaire survey time by walking across the different corners of the town. This has provided the opportunity to visualize the actual state of affairs at the field about the prevalent water sources, the walking distances between water points and the dwelling houses, the existing water utilization conditions and about freshwater supply and sustainability issues. Additional background data were gathered from books, office archives, governmental and non-governmental reports, research articles and internet sources.

2.2.3 Methods of data analysis

Data analysis is one of the important elements of research study help to covert the raw survey data into a meaningful information. Accordingly, the data captured through different ways in this study were analyzed using quantitative and qualitative techniques. The quantitative data

captured from the questionnaire survey were first edited, coded and encoded into the Statistical Package of the Social Sciences (SPSS Version - 20) and then explored using descriptive statistics and the binary logistic regeression model. The descriptive statistical measures were mainly employed to describe the amount of freshwater collected and consumed by the households.

The binary logistic regression model was employed to appraise the factors affecting household freshwater supply sustainability in the study town. The fitness of the model to the data was evaluated using the Pearson's Chi-square, Hosmer-Lemeshow goodness-of-fit statistics (Hosmer and Lemeshow, 1989) and the classification table of the sample cases. Multicolinearity among the continuous variables was tested by using the Variance Inflation Factor (VIF). The colinearity effects among the dummy variables were also checked through the Contingency Coefficients (CC). In most regression literatures, VIF >10 and level of tolerance nearer to zero (0) imply prevalence of high multicolinearity among continuous predictor factors. Similarly, CC >0.75 is the sign of existence of relevant multicolinearity impact among dummy/categorical factors (Gujarati, 2004). Hence, the multicolinearity effect among the predictor variables used in the linear multiple regression model was checked in these ways. The dependent variable used in the binary logit model was the perceived sustainability of household potable freshwater supply; i.e. a dummy variable one (1) if sustainable and zero (0) otherwise. Fifteen predictor variables (Table 1) selected based on the diverse literatures cited in the introduction part above are regressed to evaluate their influence on the criterion variable mentioned.

Table 1. Definition of explanatory variables used in the regression modeling

Explanatory variables	Description	Direction of influence
Sex	Dummy	±
Age (Years)	Continuous	+
Family size (№ household members)	Continuous	+
Formal education attendance	Dummy	+
Income in Ethiopian Birr (ETB)	Continuous	+
Employment	Categorical	+
House type	Categorical	+
Pipe connection	Dummy	+
Distance of water point from home (meters)	Categorical	-
Water service cost (ETB)	Categorical	-
Topography	Ordinal	±
Power fluctuation	Dummy	-
Season	Dummy	±
Management capacity	Ordinal	±
Rate of urban expansion	Ordinal	±

The qualitative information obtained from in-depth interviews, FGDs and field observation were concurrently analyzed to augment the quantitative results at each section of the data analysis.

3. Results and Discussion

3.1 Demographic and Socioeconomic Characteristics of the Studied Households

A total of 357 households were assessed to capture adequate information in this urban household freshwater supply sustainability study. About 51% of the households were managed by women while the rest 49% were led by men. Over 83% of the studied household heads were married (coupled) whilst 15.7% were non-married (single). On the other side, almost 92% of them have passed through formal education and only 8% were not formally educated. Many of them (63%) were workers in government offices and some others (37%) were engaged in non-governmental businesses such as trading, milling, shopping, carpentry and small-scale enterprises (Table 2).

The total number of people sheltered in the mentioned households counted 1515 and the average was 4.24 p^{-1} h^{-1}. The maximum family size for the considered households was recorded eight; yet the minimum was one implying that there are heads without children. The mean age of the family unit leaders described was 34.5 years.

Table 2. Basic information on household characteristics (N=357)

Household related variables	Category	№	%
Sex	Female	181	51
	Male	176	49
Marital status	Coupled	301	84
	Single	56	16
Formal education attendance	Yes	328	92
	No	29	8
Employment in government offices	Yes	225	63
	No	132	37
Home ownership	Own	298	83
	Rented	59	17
Pipe water connection access	Yes	243	68
	No	114	32
Access to sufficient & sustainable potable freshwater	Yes	112	31.4
	No	245	68.6
Facing water interruption	Yes	337	94
	No	20	6

The youngest head was 20 years old whereas the eldest was aged 60 years. The mean monthly income of the surveyed households reached Ethiopian Birr (ETB 3472.49). But, there appears a big gap between the lowest (ETB 200) and the highest (ETB 130,000) monthly incomes (Table 3). The total amount of freshwater collected and used by the 1515 households was 15040 liters per day (l d^{-1}) which is equivalent to 42.13 liters per household per day (l h^{-1} d^{-1}); or 9.93 l p^{-1} d^{-1}. The above reported evidences indicate that the per capita water used by households is too small and differing across the different household groups.

Table 3. Basic information on households' demography, income and freshwater use **(N=357)**

Variables	Total	Minimum	Maximum	Mean	Standard Deviation
Age of the head (years)	-----	20	60	34.53	7.82
Family size (№)	1515	1	8	4.24	1.45
Household income (ETB)	-----	200	13000	3472.49	1944.32
Water use (l $h^{-1}d^{-1}$)	-----	20	80	42.13	17.80
Water use (l p^{-1} d^{-1})	-----	-----	-----	9.93	-----
Total water use per day	15040	--------	-----	-----	-----

Source: Computed from the household survey data (March - May, 2018)

3.2 Households' Perception on Freshwater Supply and Sustainability

The UN declaration on the rights to water (UNDP, 2006) notes that all persons are entitled to get access to adequate, clean, and reasonably affordable freshwater supply for personal and family service. Sustainable household freshwater supply in this paper thus refers to clean and affordable water supply availability to all the households studied with no discrimination on a continuous basis to satisfy family basic needs (drinking, food preparation, bathing, cloth washing and related household sanitations). With this understanding, the surveyed households were asked to tell whether they get sufficient water for their domestic uses. Surprisingly, over 68% of them replied that they have no adequate access to sustainable potable freshwater supply. Only 31.4% of the households confirm that they have the opportunity to get such water (Table 2). Table 3 indicates that the per capita water collected by the studied households is $\leq$10 l p^{-1} d^{-1}. This water satisfies minimum threshold required for only food preparation (10 l p^{-1} d^{-1}) proposed in Gleick (1996). It is much lower than the 50 l p^{-1} d^{-1} average suggested by this author. It is even less by half from the lowest requirement (20 l p^{-1} d^{-1}) set by WHO (2003).

Referring Table 4, many households (68.3%) reported that they access the water they need from private standpipes and 68% (Table 2) indicated that they have their own pipeline connections at their homes. Yet, 32% of the households indicated that they didn't have their

own pipeline connections at their homes due to financial problems; corrupted bureaucracy in the water office; spare part shortages; and because living in rented houses as learned from FGDs. Some 17% of such households reported living in rented houses against to 63% living in their own constructed homes (Table 2). Yet, living in ones' own constructed homes or having a pipeline connection appeared not guarantying sustainable freshwater supply. For instance 94% of the households (Table 4) complain that the piped freshwater does not regularly reach their standpipes due to frequent interruptions and limited amounts (supplies) at the sources and reservoirs. About 71% of the households reported that they get water once in two or three days. Other 12.6% and 10.6% respondents complain that they get it once in a week or once in four to five days, respectively. Only few users (<6%) replied that they get water every day from their standpipes.

Households perceive different factors cause frequent water irregularities. Over 76% of them indicated irregularity of the water supply system occurs due to electric power interruptions (Table 5). More than 66% respondents confirmed high rate of urbanization led to reduced water volumes reaching the standpipes. Over 17% perceived the rough micro-relief influences the amount of water reaching their standpipes. Another 45.7% households revealed the water reaching their standpipes vary with the change in seasons. Greater than 83% respondents also reported water management at home and outside home is very weak. Key informants and FGD participants remarked that there is corruption and lack of equity in water distribution in the town. According to these people the water supply in the town frequently interrupts because of weak management and corrupted water technical staff.

Table 4. Households' freshwater information (N=357)

Information type	Responses	№	%
Potable freshwater sources (Multiple responses)	Springs	62	17.4
	Rivers/streams	5	1.4
	Hand-dug well	45	12.6
	Rainwater	16	4.5
	Public tap	37	10.4
	Private tap	244	68.3
Distance of water point from home (in meters)	<200	252	70.6
	201-400	59	16.5
	401-600	21	5.9
	>601	25	7.0
Availability of pipe water in a week (Multiple responses)	Daily	21	6
	Once in 2-3 days	253	71
	Once in 4-5 days	38	11
	Once in a week	45	13
Water cost per month (ETB) for 1 m^3 water	≤6	349	97.8
	>6	8	2.2

Few households (<3%) remarked that they pay >ETB 6 per month on average for their water gauges (Table 4). A considerable number of households (some 7%) reported also travelling > 600 meters to reach at water points.

Due to the above reasons, many households are forced to use water collected from unsafe sources. Over 17% of the households indicated they collect it from springs. Some others (12.6%) reported that they access it from hand-dug wells. Over 10% of the residents get it from public standpipes (locally named *Bono*). A considerable number of households (4.5%) revealed that they collect and use rainwater. Few households (1.4%) collect it from nearby rivers and streams (Table 4).

The aforementioned evidences normally confirm that the people in Agew-Gimjabeht town access potable freshwater from two main sources (i.e. from piped and non-piped sources). Piped water is often clean, safe and easily collected. But, it is not apparent and reliable for all the residents. Consequently, many people in the town are forced to use non-clean water from unsafe sources such as hand-dug wells, open springs, streams and rivers and from public standpipes, or else, purchase it from private standpipe water owners at higher prices so as to satisfy their household water requirements. Similar cases were reported for many towns in Ethiopia (e.g. Delesho, 2006; Abebe, 2014; Ashenafi, 2014).

Table 5. Household freshwater sustainability influencing factors (N=357)

Influencing factors (multiple response items)	% of respondents
Power interruption	76.47
High rate of urbanization	66.11
Seasonal change	45.66
Rough micro-topography	17.93
Weak management capacity	83.75

3.3 Determinants of Household Freshwater Sustainability

This section of the paper attempts to identify what factors control the freshwater supply and sustainability in Agew-Gimjabeht town with the binary logistic regression model. During running the model data fitness was checked from the Pearson's Chi-square and the Hosmer-Lemeshow goodness-of-fit statistics. Consequently, the Model-χ^2=210.713, P=0.000 (Table 6)

indicating a fairly better fitting model at 15 degrees of freedom. The Hosmer-Lemeshow test also indicated a fitting model (χ^2 = 13.875; P=0.085, df: 8). The classification table of the sample cases also showed 86% overall percentage with similar 86% correct prediction for both households who felt and not felt freshwater supply and sustainability constraints. The VIF among the continuous variables and CC among the dummy/categorical variables indicated having no multicolinearity problems (observed < 10 & 0.75, respectively).

In the final model, ten variables (sex, family size, education, employment, power fluctuation, and distance from the water point, season, monthly water service cost, pipeline connection and monthly household income) discovered statistically non-significant in predicting the supply and sustainability of potable freshwater in the study area. Other five factors (age of the household leader, house type, rate of urbanization, micro-relief of the area and water management capacity) showed significant response in predicting the supply and sustainability of household freshwater in Agew-Gimjabeht town (Table 6).

Table 6. Binary logistic regression results

Variable	B	S.E.	Wald	Sig.	Exp(B)
Sex of the household head	0.512	0.369	1.929	0.165	1.669
Family size (№ of household members)	0.009	0.156	0.003	0.955	1.009
Age of the head in years	0.063	0.028	4.967	0.026	1.065
Formal education attendance	0.919	0.691	1.769	0.184	2.506
Employment in government institutions	0.462	0.400	1.334	0.248	1.587
Power interruptions	0.662	0.488	1.843	0.175	1.939
Distance to water points (meters)	0.116	0.203	0.328	0.567	1.123
House type	-1.024	0.450	5.173	0.023	0.359
Rate of urban expansion	-5.296	0.795	44.379	0.000	0.005
Type of season	0.395	0.342	1.332	0.249	1.484
Monthly water service cost (ETB)	-0.054	1.185	0.002	0.963	0.947
Type of micro-topography	-2.187	0.449	23.765	0.000	0.112
Water management capacity	4.649	0.818	32.284	0.000	104.441
Pipeline connection	0.236	0.380	0.388	0.533	1.267
Monthly household income (ETB)	0.000	0.000	0.574	0.449	1.000
Constant	-6.492	1.968	10.881	0.001	0.002
Model-χ^2	210.713				
-2 Log likelihood ratio	233.430				
Nagelkerke R^2	0.626				
Hosmer & Lemeshow test	χ^2=13.87			P= 0.085	DF=8
Correctly predicted for Yes responses	86				
Correctly predicted for No responses	86				
Over all prediction	86				

Age: Age of the household head was assumed to influence household freshwater access and sustainability with the view that aged people can have better socioeconomic opportunities that have been retained through the long period of life experience. Fortunately, age appeared appreciably increasing the potential of households' capacity of accessing sufficient and continuous freshwater supply in the study area (significant at P<0.05). When the age of the household leader reaches the level of adulthood his potential to access resources required by the family grows and the water reaching the family increases by about 1.07 levels (Table 6).

Table 6. Determinants of household water supply and sustainability

***House ownership*:** House type where the respondents live can determine the amount and type of freshwater collected by people. This is because people living in their own homes have the potential to access their own piped water connections and can get pure water supply from their private standpipes. With this view house ownership was hypothesized to positively influence household sustainable water access and supply for it initiates households to build their own pipeline connections. Unexpectedly, after running the model, the regression output indicated a significant but negative influence of this variable on household freshwater sustainability. Under normal circumstances, living in one's own house appeared significantly decreasing households' capability of accessing sufficient and continuous freshwater supply by about 36% (significant at P<0.05; Table 6). A study by Getachew (2015) in Tora town offered dissimilar results. This part hence requires additional investigation.

***Rate of urbanization*:** Urbanization presents new prospects for enhanced access and management of freshwater for both sanitation and drinking. Conversely, problems are magnified in urban centers and now exceeding our capability of setting new solutions (Khatri and Vairavamoorthy, 2007). Increased populations and new technologies are entailing strong pressure on freshwater resources in many towns and Cities. They often influence freshwater access, supply and quality through increased freshwater requirements and by extended effluence problems (Guppy and Anderson, 2017). Therefore, it has both a deterring and enhancing effect on household water sustainability. In this study, the rate of urbanization entailed negative significant effect on household freshwater sustainability at P =0.000 level. It is observed decreasing household freshwater sustainability by about 0.005 times (Table 6). This in general reveals that the rate of urbanization statistically influences household freshwater sustainability in the studied town.

***Micro-topography*:** Micro-topography of the freshwater source location plus the type of terrain of the standpipe area can determine the continuous supply and amount of freshwater reaching the users. The nature of terrain influences the movement, continuity, timing and amount of freshwater delivery at any one particular area through its micro-gradients. So, it is believed to affect the sustainability of the access and supply of the freshwater to the households. Hence in this paper, it is found significantly determining the sustainability of the household water supply (P=0.000). The effect is negative; deterring the water supply sustainability by about 0.11 times (Table 6).

***Water management capacity*:** Improved water management approaches can enhance the supply, use and sustainability of freshwater resources at home and elsewhere in the surrounding environment. Integration among the different sections of the population and institutions; proper planning, decision-making, and appropriate coordination can also contribute to these endeavors. Planned management exercises broadly ascertain the basis for integrated approaches to guarantee the achievement of the planned goals and solve freshwater related problems (Shimelash, 2013). With similar intention, freshwater management capacity of the households at home and outside home was anticipated to positively influence household freshwater sustainability in the study urban area. As expected, it was found significantly and strongly increasing household freshwater sustainability by about 104.44 times with a P-value of 0.000 levels (Table 6).

4. Conclusions

This study evaluated the factors influencing the supply and sustainability of freshwater in a rural town named Agew-Gimjabeht in the northwestern highlands of Ethiopia. Data used in the study were gathered from questionnaire surveys, FGDs, in-depth interviews and field observations from March to May 2018. The results revealed that households access water from public and private standpipes, springs, streams, hand-dug wells and rainfalls. However, the per capita water collected and consumed by households in the town was found ≤ 10 l p^{-1} d^{-1} i.e. less than the universally accepted absolute minimum threshold (which is 20 l p^{-1} d^{-1}). Over 68% of the studied households reported that they do not get sufficient and sustainable water because of limited supplies at the sources; frequent power interruptions; and weak management systems. Freshwater supply sustainability in the town was discovered significantly influenced by age of the household heads, house types, rate of urbanization,

micro-relief of the area and water management capacity at home and outside home. Evidences in general proved that the level of the existing freshwater supply system in the town cannot meet the required optimum standards with regard to coverage, reliability, accessibility and sustainability.

Provision of sustainable freshwater supply systems fitting the growing urban demands is suggested to minimize the existing freshwater sustainability problems. All governments and public agencies in urban areas thus ought to develop sustainable freshwater supply schemes; uninterrupted power systems; equitable use of water resources; and respect the universal water right of citizens.

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Students' Perception on Causes and Consequences of Climate Change in Public Universities of Ethiopia

Arega Bazezew[1], Mulugeta Neka[1] and Meherte Belay[1]

Abstract

Climate change is impacting socioeconomic and biophysical environments at both Global and local scales. This paper presents the results of the assessment study of student perception on the information sources, occurrences, causes, impacts and solutions of climate change in the public universities of Ethiopia. A questionnaire survey was conducted on a total of 357 university students attending undergraduate and postgraduate courses to generate the required data. The data gathered in this way was analyzed using descriptive and inferential statistics. The results indicated that over 57% of the students get climate change information from different sources. The main climate change information sources identified by the students include television, radio, friends, internet, government reports and school teachers. Among these, teachers are the major (82%) of the studied students. Over 60% of the students reported that they do not have sufficient knowledge about climate change. Giving special concern to climate change information, obeying the laws of nature, limited interference in nature, developing awareness among the public and adopting safe industrial environments are suggested solutions to minimize the hazards of climate change. It is suggested that state agencies should design ways to deliver climate information to the wider public so as to develop awareness on the causes and consequences of climate change among the public. Local agencies and land users need also to adhere with the natural laws and adapt proper interferences in the local natural environment.

Keywords: Climate variability, Information sources, Causes, Consequences, Solutions, Ethiopia

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1. Introduction

Climate change is happening and will continue in the future; regardless of what investments in mitigation measures are made (Mertz *et al.,* 2009). This is evidenced by the fact that the Earth's temperature has changed considerably over the past millions of years (Robert *et al.,* 2011). Currently, this change is rapidly emerging and the world is facing a greater challenge of accelerated human-induced climate change than ever before (Klein *et al*., 2003; Aklilu and Dereje, 2010). Destruction of forests, carbon dioxide emissions, emissions from transport and emissions from power stations are major contributors to climate change (Lorraine, 2005). The tragedy is that those countries who contributed little to the causes of greenhouse gas emissions are the ones most affected by climate related shocks. This made climate change to be the most illustrious environmental issue since the late 20th century (Muhammad, 2013). The same author further pointed that climate change is primarily driven by greenhouse gas (GHG) emitting from human activities, such as the burning of fossil fuels and the accumulation of some dangerous gasses in the atmosphere. It was believed that human activity has caused the Earth's temperature to rise higher than it has been since civilization developed about 10,000 years ago. This is largely the result of changes in GHG-emitting that increased substantially following the Industrial Revolution. Hence, human behavior is changing the climate, and humans are in turn impacted by climate change **(**Lorraine, 2005). Put differently, the consistency of observed significant changes in physical and biological systems and observed significant warming across the globe very likely cannot be explained entirely by natural variability (IPCC, 2007).

Public perceptions on climate change and its risks are critical in achieving low carbon emission environment. However, research conducted over the past 3 to 4 years for example, in America and the United Kingdom evidenced that concern on climate change has declined dramatically (Spence *et al*., 2011). Particularly those located in the geographically south are more concerned about climate change and these countries do not have the resources and capability to deal with these impacts. Zaki (2011) noted that perception of climate change is highest in developed parts of the world compared to developing countries. However, country-by-country response showed that 31% in the USA perceived that climate change is a very serious agenda against 85% in Bangladesh and 75% in Kenya (Zaki, 2011). With evidences, the same author also noted that 13% respondents from USA and 63% from Vietnam and 53% from Kenya gave high priority to the issue of climate change. This is in line to the premises of Bast (2010) who argued that developed parts of the world such as USA believe that global

warming is dominantly the result of natural causes than human beings- they are climate change denials.

There are studies in relation to students' perceptions on climate change/variability across the world. Pitpitunge (2013) for example, assessed high school natural science students' perception related to aspects of climate change in the Philippines. The same author further confirmed that students are deficient on the causes and impacts of climate change knowledge in the Philippines. Deepak (2014) studied the perception of postgraduate students on the Mass Media related to creation of awareness over climate change in Agartala, India. Caranto and Pipitunge (2015) demonstrated the climate change awareness of 230 students registered for specialized science courses into two public high schools in the province of Pampanga, the Philippines. Christensen and Knezek (2015) analyzed middle school (Grade 5-8) 1576 students' beliefs and intentions towards the environment with a focus on climate change in the USA. Flores (2017) assessed the feelings of high school students towards climate change in Mexico City. Boon (2010) made a comparison study over the knowledge and understanding of climate change between secondary school students and pre-service teachers in Australia. Cornforth (2011) examined the variation of concern on climate change with level of knowledge focusing on young, adult and elder participants in New Zealand. Studies on climate change show that students have lack of perceptions on ozone layer depletion and global warming, on climate and weather.

More importantly, Alan (2013) made a study on students' perceptions on climate change in Hong Kong, Christensen (2015) in USA, Boon (2010) in Australia, Deepak (2014) in India, Arnold (2013) in Philippines, Viscusi and Zeckhauser, (2006) in USA, Lorraine (2005) in England. However, students' perceptions on climate change in Africa in general and Ethiopia in particular are overlooked. Besides, this study has attempted to compare different universities across the Amhara National Regional State that could sufficiently represent the country- Ethiopia. This is because university students are coming from different regional states of Ethiopia. This particular comparison is the focus of this study. More importantly, climate change perception is dynamic that needs up - to - date and reliable information. Hence, this study tries to fill these gaps and add knowledge to the existing literature. To be more specific, university students are key factors in making future generations, in making decisions about mitigation and amelioration strategies, as well as potential leaders in changing the lives of the wider community. Hence, understanding how much university students

perceive climate variability, which is a serious problem across the world, could help to inform policy makers about the issues.

The general objective of the study is to assess university students' perceptions on climate variability in the Amhara National Regional State of Ethiopia. The specific objectives include to:

(i) Assess students perceptions about climate variability

(ii) Assess sources of information on climate variability

(iii) Identify potential indicators of climate variability perceived by the students

2.2. Research Methodology

2.2.1. Research Design

Growing number of studies have examined that perceptions of climate change could be assessed using in-depth methodologies such as focus groups, semi-structured interviews, surveys using experimental study designs and case studies (Johanna and Susanne, 2011). These enhance the power in understanding people's thought processes, barriers, and what might serve to motivate people to act on climate change. Such kinds of studies reveal differences in individual understandings, perceptions and levels of engagement among fresh and senior university students. As the subjects of this study are university students attending undergraduate and postgraduate courses, a quantitative cross-sectional survey design was employed here expecting the students can easily provide the required information about their perception on climate information sources, and on causes and consequences of climate change and variability.

2.2.2. Sampling techniques

Multi-stage sampling techniques were used to select the respondents to fill the questionnaire. Amhara Region universities were selected using purposive sampling techniques. This is due to their accessibility and familiarity of the principal investigators. Besides, students are coming from different parts of the country; hence, representation could not be a problem. There are eight universities in the region. Using simple random sampling techniques four universities (Bahir Dar, Gondar, Debremarkose and Deberberhan) were selected for the study. Considering availability of time and financial resources, a total of 357 students attending classes in 2017/2018 were included in the study. The subject of the study was students from Geography and Environmental studies. Of these students, 307 were enrolled for their first

degree and 50 for their second degrees. The majority of the students (137) were third year, 119 first years, and the rest 101 were second year.

2.2.3. Data Collection techniques

Survey questionnaire: A mix of close and open-format questions expected to capture students' climate change perceptions were developed and filled by the 357 students. The questions covered students' perceptions about climate variability/change, the causes of climate change, and indicators of climate variability and sources of climate change/variability information. The enumerators and supervisors were first trained by the principal investigator on how to present and explain each question to the respondents. Besides, they were trained to inform some ethical issues that should be kept confidential to the participants before the actual interview. The principal investigator, four enumerators and four supervisors conducted the survey. The principal investigator and the supervisors monitored and checked the way questionnaires were filled for further data analysis.

2.2.4. Data analysis

The data captured in the questionnaire survey were edited, coded and entered into the statistical package of the social sciences (SPSS- Version-22) and analyzed using the descriptive and inferential statistics. For descriptive statistics tables, frequencies and percentages were employed for analysis. Inferential statistics such as Chi-square test and ordered logit model were used.

Ordinal logistic regression model

Ordinal logistic regression model is used to predict the odds of having lower or higher value for the dependent variable (y) based on the values of the predictor (x) variables. In this model, the dependent variable is categorical variable (accumulation of greenhouse gas in the atmosphere with four ordered categories: 1 = strongly agree, 2 = agree, 3= disagree, 4 = strongly disagree (a reference category). The independent variables include poor waste management, deforestation, agricultural expansion, volcanic eruption and air pollution with four ordered categories: (1 = strongly agree, 2 = agree, 3= disagree, and 4 = strongly disagree (a reference category)). Unlike the linear regression, ordinal regression focuses on odds ratio (OR) by taking the exponent of the estimates: exp (estimates). The OR is interpreted as for every one-unit increase in x; y increases/decreases of the (OR). The model is specified as… $\ln\left(\frac{prob\,(event)}{(1-prob\,(event))}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_k X_k$. This can be specified as $\beta 0 + \beta_1$ (poor waste

management) + β_2 (deforestation) + β_3 (agricultural expansion) + β_4 (volcanic eruption) + β_5 (air pollution).

Checking the Fitness of the Model (Testing Parallel Lines)

When an ordinal regression is fitted, it is assumed that the relationships between the independent variables and the logits are the same for all the logits. This means that the results are a set of parallel lines or planes—one for each category of the outcome variable. You can check this assumption by allowing the coefficients to vary, estimating them, and then testing whether they are all equal. In the test of parallel lines, the column called **sig** shows the **p-value** for the test of the parallel lines assumption. If the p-value is greater than 0.05, the test is non-significant and the assumption is not violated to run the regression model and hence the model is fitted.

Goodness-of-fit measures

From the observed and expected frequencies, it is possible to compute the usual Pearson and Deviance goodness-of-fit measures. If the model fits well, the observed and expected cell counts are similar, the value of each statistic is small, and the observed significance level is large. Then null hypothesis could be rejected if the observed significance level for the goodness of- fit statistics is small. It is believed that good models have large observed significance levels (greater than 0.05).

Assumptions

1. Dependent variable should be measured at the ordinal level or likert type of variables
2. Independent variables are measured at continuous, ordinal or categorical variables
3. There should not be multicollineraity, because it leads the problem of which variable contributes to the explanation of dependent variable.
4. Assumptions of proportional odds which means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable

3. Results and Discussion

3.1. Background of the Studied Population

The studied populations were from first and second generation Universities in northwest Ethiopia with majorities from Bahir-Dar University. As shown in Figure 1, about 60% of postgraduate students in Bahir Dar University filled the questionnaire. Relatively larger

number of undergraduate students in Debre-Tabor University responded to the questionnaire. Under graduate students in the selected universities were proportional in filling the questionnaire. However, small number of postgraduate students in Debre-Tabore University filled the questionnaire.

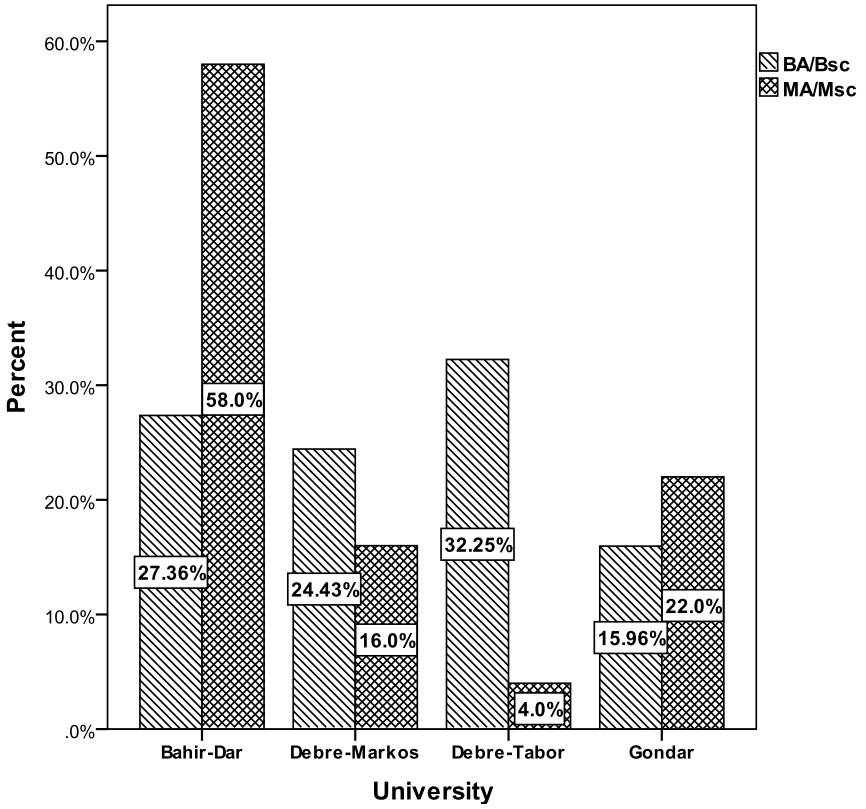

Figure 1. Name of university and degree sought

As shown in Table 1, a total of 357 students (of which 72% were male and 28% female) with gender ratio of 7.4:2.6 were studied. About 86% of these students were attending their BA classes and the rest 14% were registered for MA degree. One-third (33.3%) were first year; 28.3% second year and 38.4% third year students. The origins of over 58% of the respondents were from Amhara Region and 24.4% were from Gambela (Table 1). As shown from the Table 1, the mean age of respondents was 22 years with a standard deviation of 4.389 and a minimum 18 years and a maximum of 68 years. The majority of the respondents (over 96%) have an age between 18 and 28 years. Likewise a study made by Buggy and McGlynn (2014) evidenced that the majority of university students (90%) in Tanzania range between 19 and 30 years of age with a gender ratio of 7:3 male: female distribution.

Table 1. Background information on students studied (N=357)

Information type		**N^0**	**%**
Sex	Male	256	71.7
	Female	101	28.3
Degree sought	BA/Bsc	307	86.0
	MA/Msc	50	14.0
Year of study	First	119	33.3
	Second	101	28.3
	Third	137	38.4
Place of origin	Addis Ababa	38	10.6
	Amhara	209	58.5
	Banishangul	17	4.8
	Gambella	87	24.4
	Oromiya	1	0.3
	Somali	5	1.4

Age	**Frequency**	**Percent**	**Cumulative Percent**
18-28	344	96.4	96.4
29-38	7	2.0	98.3
39-48	3	.8	99.2
49-58	2	.6	99.7
59-68	1	.3	100.0
Total	357	100.0	

3.2. Sources of Climate Information

Examination of students' opinions about climate change shed light on their scientific literacy for climate and related issues. As can be seen in Table 2, the main climate change information sources for the majority (83.3%) of the students studied are school teachers. Over 79.3%, 78.2% and 76.8% of the students reported that their climate change information sources are Radio, Internet and television, respectively.

Table 2. Perceived climate change information sources

Sources of information	Responses		Percent of Cases
	N	Percent	
TV	271	15.0%	76.8%
Radio	280	15.5%	79.3%
Friends	223	12.3%	63.2%
Books/magazines	257	14.2%	72.8%
Internet	276	15.3%	78.2%
Government reports	206	11.4%	58.4%
Teachers	294	16.3%	83.3%
Total	1807	100.0%	511.9%

These figures were low with findings of Emmanuel and Kofi (2016) such that TV (42%), print media (24%), and text books and teachers (34%) as a major sources climate information.

3.3. Students Perception on Climate Change

The studied students were asked their sufficient knowledge on climate change so as to evaluate the overall understanding of the students on the perils of climate change. This is due to the fact that the more respondents know about climate related issues, the stronger their concern related to climate change (Skalik, 2015). Accordingly, about 60% of the studied students replied that they do not have sufficient knowledge on the issue. This indicates that there is still a doubt and blurred perception on the issue among the students. This is almost consistent with the report of Pitputinge (2013) in the Philippines who indicated that secondary school students are deficient on the causes and impacts of climate change knowledge. Likewise, a study made by Boon (2010) in Australia pointed that students have blurred information about greenhouse gas and global warming. Agozie-Ezeudu *et al*. (2016) a study made in Nigeria senior secondary schools also reached similar results.

Contrary to the above report, about 85% of the studied students indicated that they have knowledge on Global warming. Around 84% believe that there is climate change in Ethiopia and 89.8% reported the occurrence of weather change in their local area. Majority of the students (75.4%) feel that temperature in Ethiopia is getting warmer and warmer. Over 90% of the students perceive that there is rainfall fluctuation in Ethiopia and 53.7% reported that it frequently occurs during the harvesting season. More than half of the students (52.4%) indicated rainfall has decreased during the last ten years (Table 3).

Table 3. Occurrences, causes and consequences of climate change

Options	Responses		Percent of Cases
	N	Percent	
Weather change occurs in your local area	318	9.6	89.8
Rainfall fluctuation occurs in Ethiopia	322	9.8	91.0
There is climate change in Ethiopia	296	9.0	83.6
Climate change is a real problem in Ethiopia	259	7.9	73.2
Climate change reduces crop production	321	9.7	90.7
Climate change affects Ethiopian economy	321	9.7	90.7
Knowledge on the causes of Global warming	301	9.1	85.0
Global warming affects our way of life	313	9.5	88.4
Rainfall has decreased for the last ten years	184	5.6	52.0
Rainfall occurs during the harvesting seasons	190	5.8	53.7
Temperature has changed for the last ten years	205	6.2	57.9
Temperature is getting warmer in Ethiopia	267	8.1	75.4
Total	3297	100	931.4

3.4. Causes of Climate Change

Climate change and/ global warming are important areas of interest around the world and still under discussion. Every day, our world is affected more by disturbing climate change. Air pollution, global warming, climate change, greenhouse effect, acid rain, and ozone layer depletion constitute some of the major environmental problems in every parts of the world (Seyide *et al*., 2016). Past climate change literatures indicate the causes of climate change are diverse and complex, ranging from natural to anthropogenic issues. Considering this, a five level likert measurement scale (Table 4) was developed to evaluate the perception of students on diverse issues expected to cause climate change risks. Based on that 47.9% and 41.5% of the students correspondingly agree and strongly agree on climate change is human induced. Skalik (2015) on the other hand, indicated that half of the university students studied underestimated the scientific certainty that climate change is caused by humans.

Table 4. Perceived causes of climate change

Perceived causes		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Climate change is human induced	N^0	148	171	26	5	7
	%	41.5	47.9	7.3	1.4	2.0
Deforestation	N^0	244	88	13	11	1
	%	68.3	24.6	3.6	3.1	0.3
Overpopulation	N^0	187	135	20	10	5
	%	52.4	37.8	5.6	2.8	1.4
Agricultural expansion	N^0	142	162	40	8	5
	%	39.8	45.4	11.2	2.2	1.4
Urbanization	N^0	144	157	37	14	5
	%	40.3	44.0	10.4	3.9	1.4
Air pollution	N^0	169	138	34	13	3
	%	47.3	38.7	9.5	3.6	0.8
Poor waste management	N^0	143	136	54	14	10
	%	40.1	38.1	15.1	3.9	2.8
Ozone depletion	N^0	149	133	52	16	7
	%	41.7	37.3	14.6	4.5	2.0
Emission from different sources	N^0	141	164	39	11	2
(vehicles, industries)	%	39.5	45.9	10.9	3.1	0.6
Climate change is nature induced	N^0	100	146	73	26	12
	%	28.0	40.9	20.4	7.3	3.4
Volcanic eruption	N^0	115	125	82	25	10
	%	32.2	35.0	23.0	7.0	2.8
God/nature	N^0	84	91	102	55	25
	%	23.5	25.5	28.6	15.4	7.0

Associated to anthropogenic causes of climate change, 68.3%, 52.4%, 39.8%, and 40.3%, of the students, respectively strongly agree it is due to deforestation, overpopulation, agricultural expansion, and urbanization. The result also showed that 40.9% and 28% of the students respectively agree and strongly agree with the premise of climate change as nature induced. Considerable numbers of students 7.3% and 20.4% correspondingly disagrees and strongly disagree on this conclusion. Seyide *et al*. (2016) indicated that students had low level knowledge and perception about environmental problems such as air pollution, greenhouse effect, global warming, acid rain, and depletion of ozone layer although they took a course related to global environmental problems in the high schools and universities. Ho (2009) indicated that "Pollution" most often referred to emissions from factories, vehicles, and houses, as well as garbage, waste, and littering were causes of climate change according to students' perception.

As shown in Figure 2, there are variations between age of respondents and perception on causes of climate change. In all the cases, there is a tendency of percieving the causes of climate change in between the age group 39 and 48.

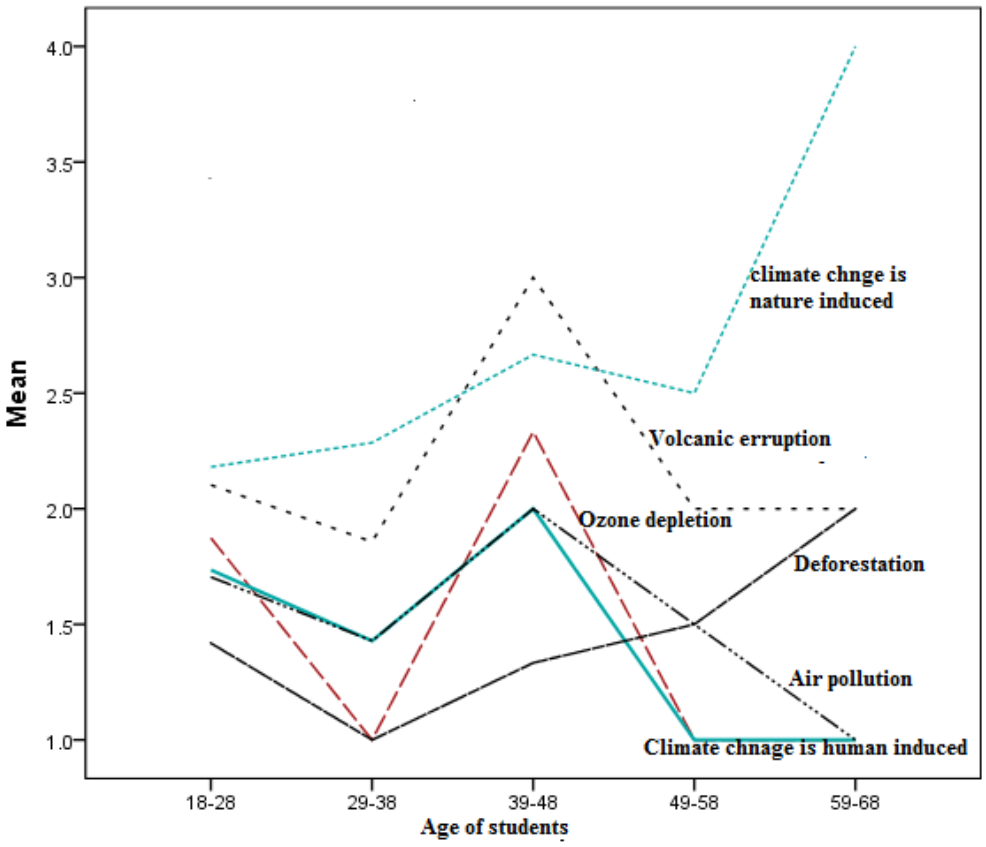

Figure 2. Perceived causes of climate change by age of respondents

However, there is a strict difference between the two options such as climate change is nature induced and cliamte change is human induced. Accordingly, older students percived that the causes of climate change is nature induced while more young students percieved the causes of climate chnage as human induced. The Chi-Square test indicates that there is significant association in perception between age of respondents and the causes of climate change at $P < 0.01$.

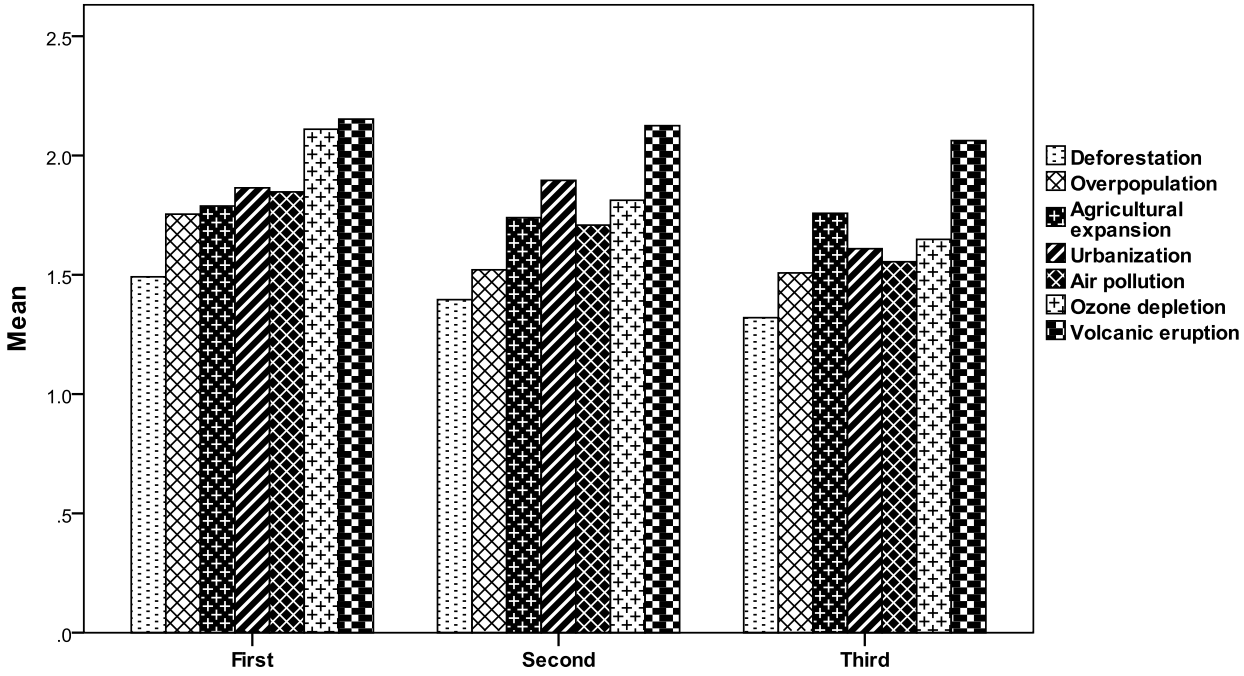

Figure 3. Perceived causes of climate change by year of education

As shown in Figure 3, there is no significnat dfferences between year of education and causes of climate change. In all years of eduction volcanic erruption rated the highest followed by ozone depeletion. Urbanization was the third rank as a cause of climate change. However, deforestation as a cause of climate change is the least percieved by all years of students. In genral the tendency to percive the causes of climate change dercreses with respect to their years of stay in the university. Emmanuel and Kofi (2016) also reached similar results and found out that senior students' involvement in climate change awareness creation is low compared to junior students.

As shown in Figure 4, perception on the causes of climate change based on sex does not show significant variations. However, there is a tendency of slight increment on male perception than female students' perception on the causes of climate change. Volcanic eruption as a cause of climate change is ranked first in both students. Ozone depletion is the third cause for climate change while ozone depletion is for male students. The Chi Square test indicates that

there is no significant association in perception between the male and female students on the causes of climate change at P > 0.05. Agozie-Ezeudu *et al.* (2016) also evidenced that there is no significant different between the male and female students mean score on climate change awareness and attitude.

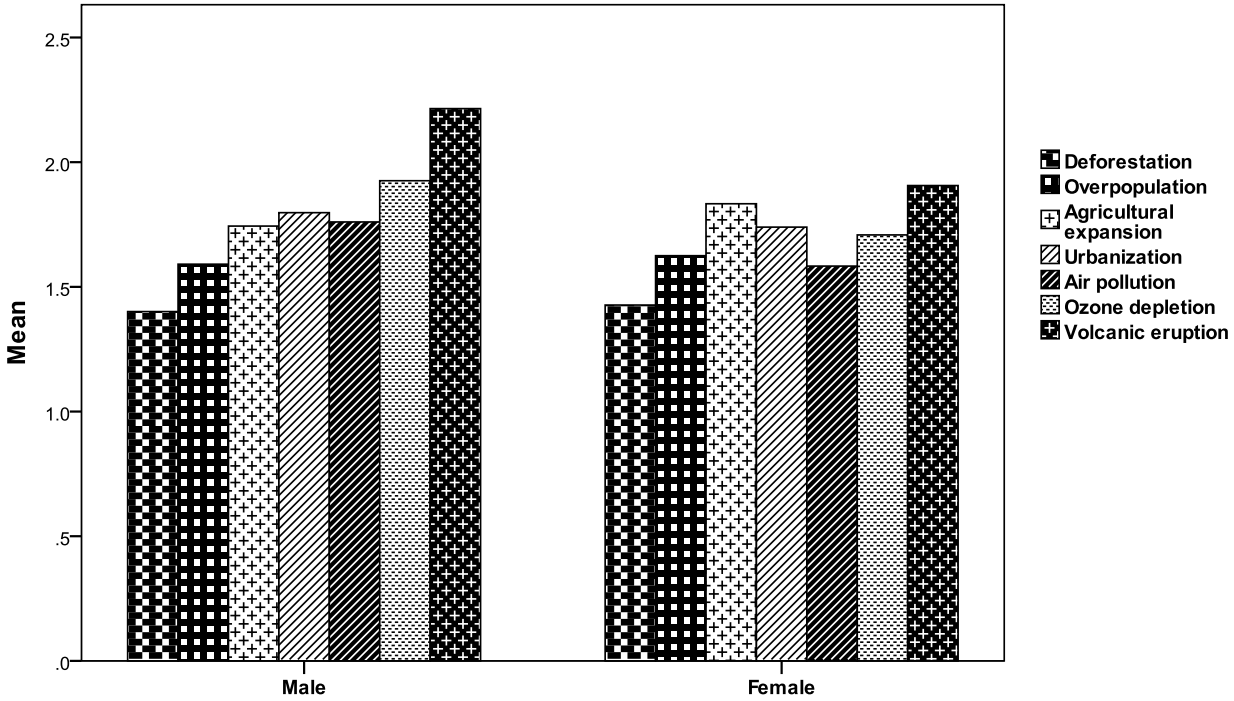

Figure 4. Perceived causes of climate change by sex of respondents

From the preliminary results it is clear that the university students have reasonable perceptions on what the principal causes of climate change are and what anthropogenic activity is contributing to climate change (urban expansion, agricultural expansion, urbanization and deforestation). However, students showed a low understanding of the natural factors (28% strongly agree) that influence climate change. In this regard, Buggy and McGlynn (2014) pointed that in several studies globally, there is a decline in the level of knowledge of university students related to climate change. In combating this decline at various levels of education should be undertaken in order to ensure that the next generation of adults is fully aware of the causes and consequences of climate change (Buggy and McGlynn, 2014).

3.5. Consequences of Global Warming Vis-à-Vis Climate Change

As shown in Table 5, loss of plant and animal species (52.4%), the decline of available water (45.1%) and decline of agricultural yield (48.7%) of the students reported to strongly agree with the consequences of global warming. The results also showed that 44.5%, 55.2%, 39.2%, 44.3%, and 40.6% students correspondingly strongly agree that rainfall comes early or lately,

drought has increased, heat is getting more intense, health hazards have increased and greenhouse gas concentrations are increased in the atmosphere (Table 5). In relation to the results, Oreskes and Conway (2008) supplemented that anthropogenic theory and climate simulations models suggest that global warming might lead to an increase in either the frequency or intensity of extreme weather events such as hurricanes, heat waves, storms and droughts. Khandekar *et al.* (2005) indicate that global warming leads to the increasing mean temperature of the earth, associated with extreme weather events such as melting of the polar ice caps, and the related phenomenon of rising global sea levels. All these result in famine, starvation, hunger, population displacement/migration and political chaos which many developing countries are experiencing.

Table 5 Perceived consequences of global warming

Perceived consequences		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Loss of plant & animal species	N^0	187	140	20	9	1
	%	52.4	39.2	5.6	2.5	0.3
Decreased available water	N^0	161	161	25	9	1
	%	45.1	45.1	7.0	2.5	0.3
Decline of soil	N^0	177	126	42	9	3
fertility/productivity	%	49.6	35.3	11.8	2.5	0.8
Declined agricultural yield	N^0	174	142	30	11	-
	%	48.7	39.8	8.4	3.1	-
Rainfall come early or lately	N^0	159	147	36	10	5
	%	44.5	41.2	10.1	2.8	1.4
Increased drought	N^0	197	119	22	17	2
	%	55.2	33.3	6.2	4.8	0.6
Heat is more intense	N^0	140	156	45	13	3
	%	39.2	43.7	12.6	3.6	0.8
Increased health hazards	N^0	158	151	26	17	5
	%	44.3	42.3	7.3	4.8	1.4
Accumulation of green house	N^0	145	161	26	16	9
gases in air	%	40.6	45.1	7.3	4.5	2.5

From the discussions, it can be concluded that the links between the causes and consequences of global warming are highly contested (Sylvén *et al*., 2008). Lee *et al.* (2007) indicated the perceptions of students related to the consequences of climate change in terms of glaciers melting, sea levels rising, and species extinction. Ho (2009) also mentions students perception on the consequences of climate change as polar ice melting, that it would have a negative impact on animal populations (not including humans), that it would result in increased temperatures, and also result in increased flooding or sea level rises.

In general, climate change associated with global warming is a debatable issue among politicians, academicians and scientific society. All sides of the debate agree that there is global warming with empirical evidence (IPCC, 2007; Strauc and Guest, 2016; Meredith, 2012). For example, flooding, sea level rise, melting of ice and species extensions and other extreme events are caused by global warming (Oreskes and Conway, 2008; Khandekar *et al*., 2005).

4.6. Perceived Solutions of Climate Change

Both adapting to unavoidable climate change and mitigating future greenhouse gas emissions are required to manage the risks of extreme weather at present. Since limiting the amount of CO_2 in the atmosphere limits the influence of climate change on people's life. Hence, a number of climate change coping and adapting solutions and strategies ranging from anticipatory and reactive measures have been proposed and used since the past many decades. Nevertheless, many of the measures and strategies have been observed not to trim-down the impact to the desired level.

Perceiving this constraint, the current study presents perceived solutions of climate change impacts expecting that they can be used in future climate change coping strategies. For this a five level likert measurement scale was designed to identify possible climate change solutions (see Table 6). Accordingly, 43.7% of the students strongly agree to provide special focus on getting climate change news. About 50% also agree on this measure against 4.5% and 0.6% corresponding students who disagree and strongly disagree on the proposed solution. A few students (1.4%) failed to decide on this solution. Climate change information can improve people awareness on the occurrence, causes and impacts of climate. The proposed strategy is thus believed to yield significant contribution in the fight against climate change. Over 42% of the studied students indicated that they agree and strongly agree developing people's awareness is the best solution although 9% and 2% of the students correspondingly replied disagree and strongly disagree on this measure (Table 6). In relation to this, Nkoana *et al.* (2016) mentioned that awareness about climate change impacts is also a critical determinant of human response and adaptation, as communities first have to be aware about the impacts of climate change to be able to adapt. Nkoana *et al*. (2016) further noted that the level of awareness influences communities' ability to adapt to climate change. The lack of climate change awareness can lead to complacency increasing people's vulnerability to climate change and climate variability in the near and far future. Huber and Gulledge (2011)

differently indicate that since climate change is already underway, some impacts are unavoidable and society must adapt to them. In order to be effective, adaptation actions must be commensurate with the magnitude of the risk. Adger *et al.* (2008) cited in Nkoana *et al.* (2016) similarly informed that climate change awareness is a precursor of climate change adaptation and local communities should be aware of climate change in order to adapt to it. The solutions to climate change according to students perception indicated by Ho (2009) were reduce waste, call for increased support and action from governments, and increase energy efficiency and use of car pools.

Table 6. Perceived solutions for climate change

Perceived solutions		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Giving special attention to climate change news	N^0	156	178	16	2	5
	%	43.7	49.9	4.5	0.6	1.4
People must obey the laws of nature	N^0	124	167	42	16	8
	%	34.7	46.8	11.8	4.5	2.2
Less interfere with nature	N^0	80	125	108	30	14
	%	22.4	35.0	30.3	8.4	3.8
Developing peoples' awareness	N^0	164	151	32	7	3
	%	45.9	42.3	9.0	2.0	0.8
Establishing safe industrial environment	N^0	163	126	49	14	5
	%	45.7	35.3	13.7	3.9	1.4

4.7. Factors that Determine Ozone Depletion

The assumptions noted were thoroughly considered and no significant violations observed. The test of parallel lines showed that the p-value of the general model is greater than 0.05 (X^2 (24) = 0.560). This showed that the test is non-significant and the assumption is not violated. However, the results of the Pearson Chi square goodness-of-fit is < 0.01 (X^2 (420) = 1180.451, p = 0.000). This showed that the null hypothesis is rejected violating the assumptions. However, the Deviance goodness of fit is not significant with p value greater than 0.05. The Nagelkerke pseudo R square showed that the independent variables explained 58.2% of the total variations of the dependent variable (ozone depletion).

From the observed significance levels as shown in Table7, it was learnt that poor waste management systems, deforestation, agricultural expansion, volcanic eruption and air pollution have relations with ozone depletion in the atmosphere and reject the null hypothesis

of zero assumptions. Besides, the Wald test showed that there is a strong relationship between ozone depletion in the atmosphere and predictor variables. Respondents ratings strongly agree to poor waste management systems as a cause of ozone depletion in the atmosphere are more likely to assign higher value than those who rated as strongly disagree (reference category) with the odds ratio of 5.296, while other variables in the model are held constant. It is also significant at $p < 0.001$. Likewise, respondents who rated agree to volcanic eruption, is more likely to assign higher value than who rated strongly disagree with the odds ratio of 5.243, controlling for poor waste management, deforestation, agricultural expansion and air pollution. However, those rated disagree is less likely to increase ozone depletion in the atmosphere held other variables constant. In general, volcanic eruption has positive relationship with ozone depletion in the atmosphere. This means that as volcanic eruption increases it is more likely to increase ozone depletion in the atmosphere, which is significant at $P < 0.001$ held other variables constant.

The model also revealed that overpopulation has strong relationship to ozone depletion in the atmosphere and highly significant at $p < 0.001$. A unit increase of strongly agree to overpopulation as compared to strongly disagree (reference category) increases the odds ratio by 2.403, while other variables in the model are held constant. Likewise, those who rated agree to overpopulation is more likely to increase ozone depletion in the atmosphere with the odds ratio of 2.661, held other variables constant. As shown in Table 7, air pollution has positive relationship with ozone depletion in the atmosphere. However, those rated disagree is not significant which is greater than 0.05. This showed that a unit increase of those rated strongly agree to air pollution as a cause of ozone depletion in the atmosphere increases the odds ratio by 44.701 held other variables constant.

The result of the model also revealed that volcanic eruption and ozone depletion in the atmosphere have strong relationship and statistically significant at $p < 0.001$. Those who rated strongly agree to volcanic eruption as compared to strongly disagree is more likely to increase ozone depletion with the odds ratio of 5.296 being other variables constant in the model. However, those rated disagree to volcanic eruption is less likely to increase ozone depletion with the odds of 0.294 being other variables are adjusted for.

Table 7. Ordinal logistic regression results

	Variables description	Estimate	Std.error	Wald	Sig.	Exp(B)
Threshold	[ozone = 1]	2.239	2.027	36.461	.000***	9.38
	[ozone = 2]	4.847	2.001	55.076	.000***	127.35
	[ozone = 3]	5.809	1.984	63.521	.000***	330.299
Location	[Volcanic=1]	1.666	0.574	21.589	.000***	5.296
	[Volcanic=2]	1.657	0.544	9.260	.002***	5.243
	[Volcanic=3]	-1.224	0.535	5.231	.022*	0.294
	[Volcanic=4]	0[a]	.	.	.	
	[waste management=1]	1.179	0.867	13.437	.000***	3.251
	[waste management =2]	2.525	0.854	8.751	.003***	12.490
	[waste management =3]	-1.919	0.871	4.858	.028*	0.146
	[waste management =4]	0[a]	.	.	.	
	[Air pollution=1]	3.805	0.801	22.562	.000***	44.701
	[Air pollution=2]	1.978	0.773	6.557	.010**	7.228
	[Air pollution=3]	-0.689	0.788	0.764	.382	0.502
	[Air pollution=4]	0[a]	.	.	.	
	[agri expansion=1]	1.455	1.785	13.074	.000***	4.284
	[agri expansion=2]	1.045	1.779	11.543	.001***	2.843
	[agri expansion=3]	0.655	1.794	13.769	.000***	1.925
	[agri expansion=4]	0[a]	.	.	.	
	[Deforestation=1]	1.895	0.589	10.360	.001***	6.652
	[Deforestation=2]	0.915	0.604	2.295	.130	2.496
	[Deforestation=3]	-1.162	0.659	3.114	.078	0.312
	[Deforestation=4]	0[a]	.	.	.	

Note that *** = significant at 0.001, **= significant at 0.01, * = significant at .05

5. Conclusions and the Way Forward

This study was intended to evaluate perception of students on the information sources, occurrence, causes, impacts and solutions of climate change in public universities of the Amhara Region of Ethiopia. A questionnaire survey was conducted on a total of 357 university students attending undergraduate and postgraduate courses to generate the required data. The data gathered in this way were analyzed using descriptive statistics (in percentiles) and inferential statistics. The results indicate that over 57% of the students get climate change

information from different sources. The main climate change information sources identified by the students include television, radio, friends, books/research journals, internet, government reports and school teachers. Teachers are main information sources for over 82% of the studied students. The results revealed that majority of the students do not have awareness about climate change. Students are selected from the department of Geography and Environmental studies. Climate courses are given at different levels; however, students' conceptualization is low indicating that the curriculum prepared for teaching or teachers performance failed to change the behavior of students. Giving special concern to climate change information, obeying the laws of nature, limited interference in nature, developing awareness among the public and adopting safe industrial environments are suggested solutions to minimize the hazards of climate change. It is suggested that state agencies have to design ways to deliver climate information to the wider public so as to develop awareness on the causes and consequences of climate change among the public in general and students in particular. Local agencies and land users need also to adhere with the natural laws and adapt proper interferences in the local natural environment.

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A Participatory Assessment of Soil Erosion and Farm Management Practices in Northwest Ethiopia

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Abstract

Soil erosion is a widespread problem on cultivated fields in northwest Ethiopia. Plot level survey studies of soil erosion and conservation are few and far fewer have involved farmers in their assessments of the erosion process and farmers' conservation efforts. This paper presents the outcome of a farmer-participatory research conducted at two rural communities, Dubi and Gayta, in Dangila woreda (district), in the northwestern highlands of Ethiopia. The study estimated the extent of soil erosion from tree root exposure measurements and identified farmers' soil and water conservation (SWC) practices by categorizing the farmers into three income groups: poor, medium and rich households. Data were collected from 31 plots between May and October 2010. Descriptive statistics and analysis of variance (ANOVA) were used to analyze the data. The results indicate that average rates of soil erosion to be about 1.26 mm yr^{-1}, but rates varied from 1.94 mm yr^{-1} on seriously affected sites to 0.21 mm yr^{-1} on the relatively less affected areas. The farmers used contour farming, traditional ditches, grass and tree planting for SWC purposes. The study concludes that as the extent of soil erosion is highly variable spatially, plot and location specific SWC measures that are designed by considering farmers' indigenous knowledge will be required to control soil loss in the study area. This study demonstrates that participatory plot level tree root exposure assessment provides useful information for soil and water conservation planning.

Keywords: Soil erosion; Farmer participation; Tree root exposure; Conservation; Ethiopia.

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1. Introduction

In Ethiopia, agriculture is the main source of livelihood, employment, and foreign exchange earnings. It supports the livelihood of about 90% of the poor and generates 90% of the national export trade and greater than 40% of the Gross Domestic Product (Diao, 2010). But, the agricultural sector in Ethiopia is confronted with diverse environmental problems. Land degradation in the form of soil erosion causes a severe damage on crop lands, particularly in the highlands. The steep terrain, erosive rains, improper use of land and water, rapid population growth and dependence on fragmented subsistence farming are major causes of the ongoing land degradation (Gebreyesus and Kirubel, 2009). According to Constable (1984), some 1.9 billion tonnes of soil are removed each year from the Ethiopian highlands. Most of this loss was estimated to occur from cultivated fields where the soil rate was estimated at 100 t ha^{-1} yr^{-1}. Other studies have indicated much lower rates of soil loss. For instance, Woldeamlak and Sterk (2003) indicated soil loss rates ranging between 18-79 t ha^{-1} yr^{-1} from two micro-watersheds in northwestern highlands, and Nyssen *et al*. (2007) reported 57.3 t ha^{-1} yr^{-1} average sheet and rill erosion in Tigray, northern Ethiopia. All studies of soil erosion in Ethiopia, however, agree that the rate of soil erosion is high and constitutes an important problem to sustainable agriculture.

Even though soil erosion is a serious environmental and economic problem in Ethiopia, available studies on soil erosion measurement or estimation are quite few, and many are watershed or plot scales to 'represent the diverse environments of the country' (Woldeamlak and Sterk 2003). Herweg (1992) noted that the model of test plots is questionable, because they are confined to limited areas that might not represent wide spatial segments. Similarly, Stocking and Murnaghan (2001) state that experimental plots and quantitative models are 'researcher-centered' and vague to farmers in less developed countries to easily assess the level of erosion on farm plots. Woldeamlak and Sterk (2003) also note that plot and watershed level measurements do not show the extent of eroded soil from individual farm fields due to gaps in scale of measurement and applied methodologies.

Stocking and Murnaghan (2001) argue that participatory survey methodologies instead integrate local farmer experiences with scientific methods and provide opportunity for smallholders to easily estimate soil erosion from their farm plots and thus are 'farmer-centered' designs. Consideration of farmers' experiences, knowledge and views can provide essential inputs to the success of conservation interventions. The approach can even provide researchers the chance to learn from farmers how they realize and control soil erosion (Stocking and Murnaghan, 2001). For instance, Yifru and Taye (2011) have observed farmers classifying soils based on fertility and designing their farming practices using their indigenous know-how in southeastern Ethiopia. Similarly, Okoba and Sterk (2006) identified eleven erosion indicators through the use of farmers' indigenous knowledge and participation in Kenya.

One method of the participatory approaches is field survey of tree root exposures (Stocking and Murnaghan, 2001). Tree root exposure shows the removal of top soil covering the root part of a tree due to sheet or rill erosion. As trees are frequent and familiar biological features, the condition can be easily perceived and measured by farmers using simple tools like a ruler. This may also develop clear and practical awareness on the part of participant farmers. Tree root exposure measurements and computations do not require complex techniques and models. They are simple, cheap and flexible to explore with both semi-quantitative and qualitative methods. However, the methodology has some limitations. During tillage operations exposed roots are covered with soil and make identification difficult. Weed heaps collected at the base of some trees also make difficult to notice root exposures. Nevertheless, owing to the less cost and time required, the ease of measurements and computations, there is a possibility to consider it as one appropriate method to assess soil erosion. The aim of this paper was to assess the extent of soil erosion using tree root exposure measurements and examine farmers' SWC practices in the northwestern part of Ethiopia.

2. Materials and Methods

2.1. Site Description

The study was carried out in two Rural *Kebele* Adminstrations (RKAs, the lowest government levels in Ethiopia's administrative structure) named Gayta and Dubi in Dangila woreda (district), northwest Ethiopia (Figure 1). The two RKAs cover 2332 and

2358 ha, respectively, and experience slight differences in altitude and local climatic conditions. Slope gradients extend from < 1 to 50% in Gayta and to 45% in Dubi. The two RKAs are part of the northwestern highlands with elevations varying between 2100 m to 2300 m asl in Gayta and 1850 to 2255 m asl in Dubi. The local relief of both areas is broken by small streams and gullies that often fill with rainwater during the rainy season. The climate is moist *Weina-Dega (*sub-tropical) with a mean annual temperature of 17^0C and annual rainfall of 1578 mm as measured at Dangila town ($11^0$16'00"N and $36^0$50'00"E).

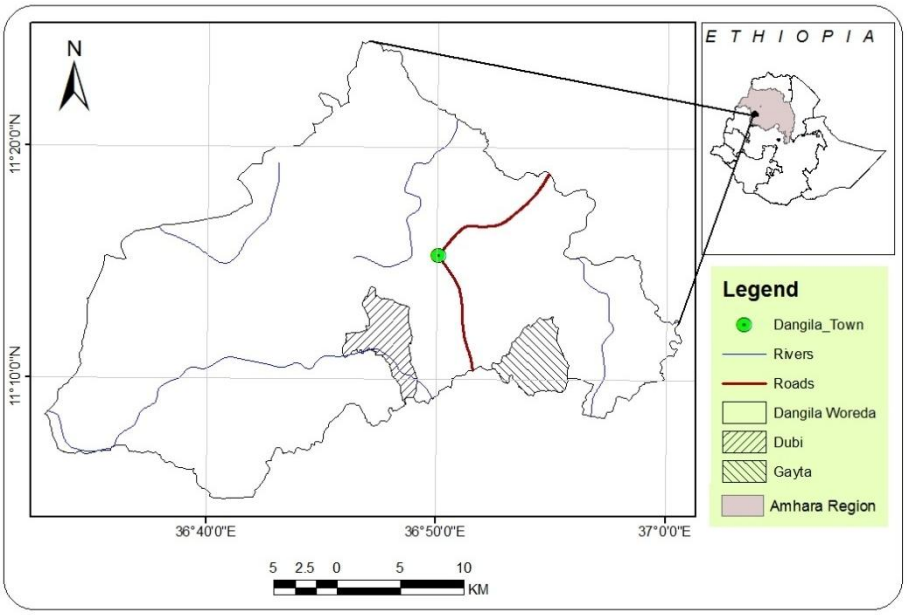

Figure 1. Location map of the study RKAs

Based on colour, the local people identify three soil types: *Forefor* (red colour), *Mezega* (black) and *Bunama* (grey-brown) as dominating the areas. The red soils (which belong to the Nitosols group) commonly occur on hilly and sloping parts in about half of both study sites. They exhibit a clay-loam texture and are most intensively cultivated but also most seriously eroded. The black soils (Vertisols group) are more prevalent in Dubi and often cover low lying landscapes. The grey-brown soils (Luvisols group) frequently occupy the pediments. Croton (*Croton macrostachyus*), Acacia (*Acacia lahai*), Eucalyptus (*Eucalyptus camaldulensis*), Cordia (*Cordia africana*), Albizia (*Albizia gummifera*), Terminalia (*Terminalia brownie*) and Justicia (*Justicia schimperiana*) form the dominant vegetation types in the areas. Crop-livestock mixed subsistence farming is the basic source of livelihood of the people in both sites. Crops and community grazing fields occupy large areas while forests comprise small proportions. Tef (*Eragrostis tef*) in Gayta and maize

(*Zea mays*) in Dubi are leading crops in area coverage and quantity of output. Vegetables and fruits are important crops cultivated using traditional irrigation around homesteads.

2.2. Data and Methods

2.2.1. Study framework

Erosion assessment by measuring tree root exposures has been conducted by many researchers in different countries. To mention some, Dunne *et al.* (1979) used the method and estimated average soil erosion rates at 8 mm yr^{-1} on basement rocks and 14.7 mm yr^{-1} on the lava plateaus in Kenya. Bodoque *et al*. (2005) applied the method in their study in Central Spain and estimated mean erosion rates at 1.7-2.6 mm yr^{-1} in one of their study sites (Senda Schmidt) and 1.1-1.8 mm yr^{-1} in another site (Monterrubio). They used dendro-chronological analysis to determine the age of the trees they used as references. But, Stocking and Murnaghan (2001) noted that tree-ring dating is not usually accurate because tree-rings are not annually created all the time, particularly in the tropics and subtropics. Trails and trekking grounds were main focus areas of Bodoque *et al*. (2005) study, while grazing fields were the focus areas of the study by Dunne *et al*. (1979). This study differs from these two studies in that it focuses on farm plots and it involved farmers in the survey process. Also, the ages of measured trees were determined by consulting the owners who have planted them. Thus, it was designed based on the 'farmer-perspective' model suggested in Stocking and Murnaghan (2001). The approach involved farmer participation in identification, measurement, mapping and ranking of affected areas. The steps of the participatory assessment process in general follow the sequence shown in Figure 2 below.

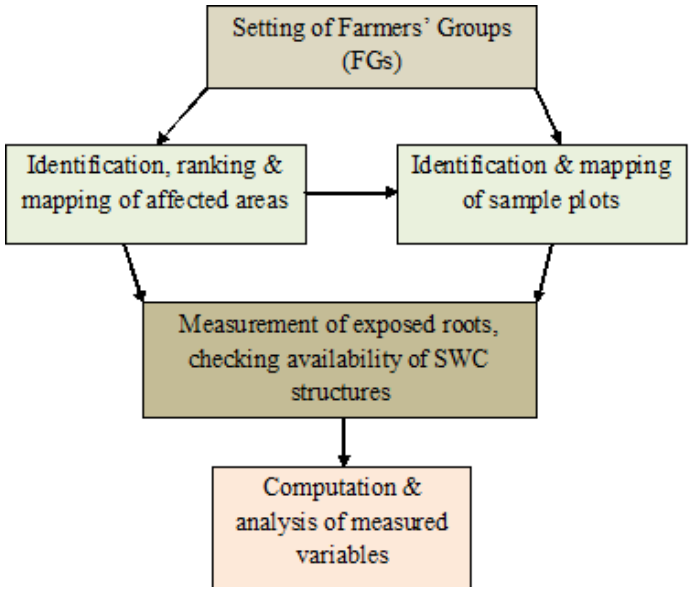

Figure 2. The participatory assessment process

2.2.2. Procedures of sample determination

The study was based on participatory field observation, formal and informal discussions with the local farmers and plot level field measurements. For this, first two Farmers' Groups (FGs), each containing six members, were set up in each study RKA. These FGs discussed, with facilitation by the lead author, on the problems of soil erosion and SWC practices and identified four villages in their respective RKAs as severely affected, moderately affected, slightly affected and non-affected areas, which were then ranked into four soil loss severity classes (Table 1) and mapped by the FGs and the researcher (Figure 3). For each site, presence of tree root exposures, gullies, rock-outcrops, soil colour and soil depth were assessed by a joint transect walk of the researcher and FG members.

Table 1. Estimated area, soil type and erosion severity rank of the eight villages in the two study areas

RKAs & Villages	Area (ha)	Major Soil type (colour)	Average soil depth (cm)	Soil texture	Erosion severity rank
Gayta					
Ashina	415	Red	55	Coarse	2
Giorgis	672	Brown	113	Loamy	3
Gishen	623	Light red	29	Very coarse	1
Selassie	622	Black	154+	clayey	4
Dubi					
Village One	541	Black	166+	clayey	4
Village Two	466	Red	58	Coarse	2
Village Three	901	Light red	27	Very coarse	1
Village Four	450	Brown	103	Loamy	3

Soil depth was measured from gully cuts and by digging using local tools. Soil texture was determined by finger-feel method in situ. The four soil erosion severity classes are the following:

i) Seriously affected: steeplands dominated by light-red sandy soils, affected by deep and wide gullies, exposed tree roots and rock outcrops. The soil depth is less than 50 cm.

ii) Moderately affected: steeplands, dominantly covered with reddish soils locally named *forefor*. The area contains gullies and soil depth is 50-100 cm.

iii) Slightly affected: gently sloping lands where soil erosion is low. The major soil is grey-brown having a depth of 100-150 cm.

iv) Non-affected: level lands where soil erosion is very low. The soil is much deeper and dominantly black in colour. Gullies are more or less absent; no concentrated water flow except in the perennial large gullies crossing community grazing fields originating from highly degraded upslope areas.

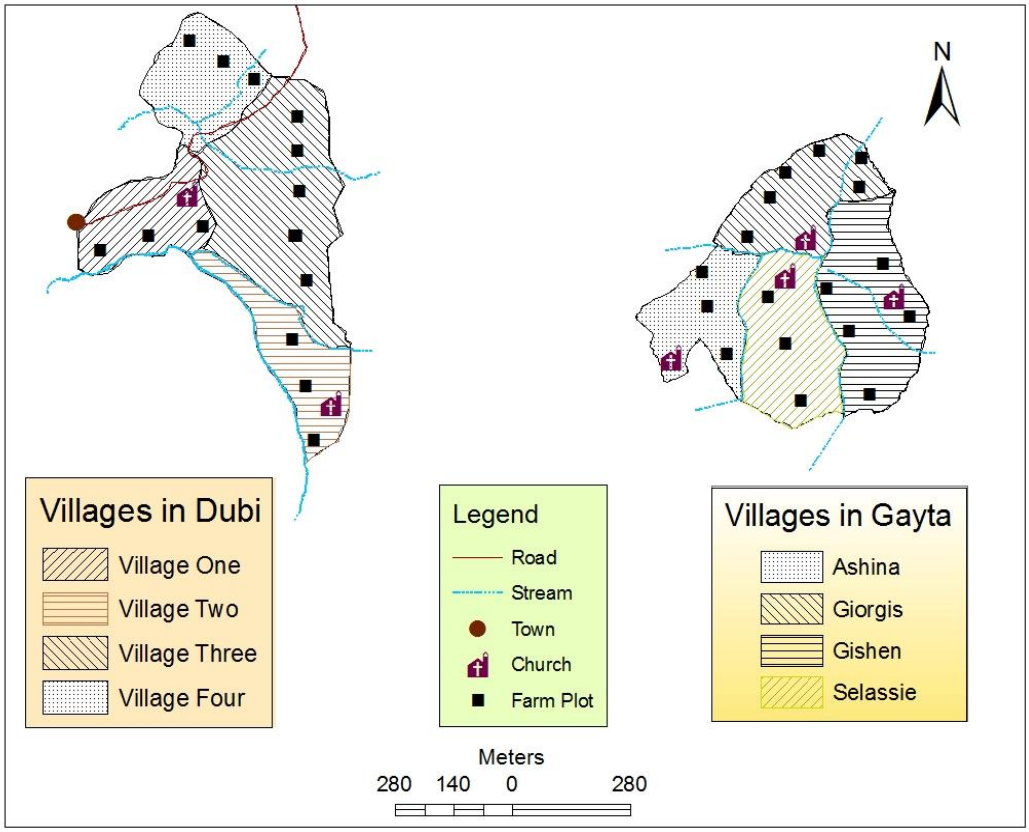

Figure 3. Sketch map prepared by FGs and the researcher, May 2010.

Following mapping and ranking, 31 plots (17 in Gayta and 14 in Dubi) were selected on purpose to represent three broadly defined household income (wealth) groups (HIGs), namely poor, medium and rich households as stratified by the FGs by using landholding

sizes, oxen ownership and annual food production[3]. Based on this, 22 plots were from the poor and medium farmers (11 from each) and the rest (9 plots) were from the rich farmers (Table 2).

Table 2. Number of assessed farms and measured trees by village and HIGs*

Study sites & villages	N^0 of assessed farms				N^0 of measured trees			
	P	M	R	T	P	M	R	T
Gayta								
Ashina	1	1	1	3	3	2	3	8
Giorgis	2	2	2	6	5	7	7	19
Gishen	2	2	1	5	5	8	2	15
Selassie	1	1	1	3	5	4	3	12
Dubi								
Village One	1	1	1	3	5	5	3	13
Village Two	1	1	1	3	3	5	4	12
Village Three	2	2	1	5	8	6	5	19
Village Four	1	1	1	3	3	5	2	10
Total	11	11	9	31	37	42	29	108

*Refers to P: Poor, M: Medium, R: Rich, T: Total

2.2.3. Data acquisition

Assessment of tree root exposures was conducted in the presence of plot owners and FGs. A detailed observation of the surrounding biophysical environment of the farms was made before measurement of exposed roots. The size of sampled fields and age of the target trees were first recorded by consulting plot holders. Local slope gradients were determined using clinometers. Soil types and their depths, and availability of any erosion control practices were recorded through observation and field measurements.

Next to recording of the surrounding geographical features, a close observation was made on tree root morphology to detect any changes in color, texture and structure of the tree stem based on methods cited in Dunne *et al.* (1979). Then heights (length from the upper part of the root to the present ground level) of exposed roots were measured using ruler

[3]Poor: households owning <1 ha of land, do not own any or have only one ox and do not produce sufficient food for themselves annually. Medium: households who own 1-2 ha of land, two or three oxen and produce sufficient food for one year. Rich: households with >2 ha of land, own more than three oxen and produce surplus annually.

following methods suggested in Stocking and Murnaghan (2001). Based on the measurements, data were gathered from 108 trees of different species, namely, croton (*Croton macrostachyus*), acacia (*Acacia lahai*), eucalyptus (*Eucalyptus camaldulensis*), albizia (*Albizia gummifera*), terminalia (*Terminalia brownie*) and sesbania (*Sesbania sesban*) from May to October 2010. The minimum number of trees observed per plot was two and the maximum was five. On average, about three trees far apart at least 8 to 10 meters were assessed from each plot. The size of each measured plot was about 0.25 ha. Of the total 108 measured trees, 37, 42 and 29 belonged to poor, medium and rich households, respectively (Table 2).

2.2.4. Data analysis

Average rates of annual soil loss were computed for each tree by dividing the measured exposed root height to its respective age as suggested by Stocking and Murnaghan (2001). This has provided the estimate of lost soil in terms of millimeters per annum for each measured tree. Average erosion rate for all trees was then calculated by adding the values of all measured trees and dividing the sum to their total number. A one-way ANOVA was employed to examine the mean difference in erosion, root exposure and tree age among the 31 farm plots. A two-way ANOVA was used to see the mean difference in soil loss among the study sites, slope categories, soil types and farm fields of the different HIGs.

3. Results and Discussion

3.1. Erosion Assessment

Table 3 presents summary statistics about tree age, root exposure and soil loss for the measured farms. Average exposed root height and mean tree age were 20.7 mm and 16.6 years, respectively. Exposed root height ranged from 2 mm to 61 mm, while tree age varied between 3 and 38 years. From these measurements, on average 1.26 mm of soil depth or 16 tonnes of soil per hectare has been lost annually (Table 4). This rate is less than the maximum tolerable erosion (which is 18 t ha^{-1} yr^{-1}) but over the minimum rate (i.e. 2 t ha^{-1} yr^{-1}) cited in Gebreyesus and Kirubel (2009). The figure is much higher if compared to the 6 t ha^{-1} yr^{-1} tolerance erosion rate predicted by Hurni (1983) for areas located 2000-2500 m asl in the Simen Mountains of Ethiopia. Conversely, it is much lower when compared with the average erosion rates estimated in northwest Ethiopia, 18-79 t ha^{-1} yr^{-1} in Woldeamlak and Sterk (2003) and 93 t ha^{-1} yr^{-1} in Woldeamlak and Ermias

(2009) in the Chemoga watershed as well as 27 t ha^{-1} yr^{-1} in Tibebu *et al*. (2010) near Lake Tana. But, it can be taken as modest in the context of a moderate erosion rate of 16-50 t ha^{-1} yr^{-1} mentioned in Lakew *et al*. (2000) for the western zones of Amhara region, Ethiopia. Soil loss rates ranged from 0.12 mm to 2.8 mm yr^{-1} and significantly differed across the measured fields as shown by the results of the one-way ANOVA (Table 3).

Table 3. Summary statistics of tree age, root exposure and soil loss

	Variables		
Statistics	Tree age (years)	Root exposure (mm)	Soil loss (mm yr^{-1})
N	108	108	108
Mean	16.56	20.72	1.26
Standard deviation	6.71	14.59	0.71
Minimum	3.00	2.00	0.12
Maximum	38.00	61.00	2.80
Coefficient of variation	0.41	0.70	0.57
F	2.37	3.56	6.71
P	0.001	0.000	0.000

Murnaghan (2001) considering a bulk density of 1.3 for recently cultivated tropical soils mentioned in Fitzpatrick (1992).

Table 4. Rates of soil erosion by study site and village

RKAs & Villages	Mean		SD	Range
	mm yr^{-1}	(t ha^{-1} yr^{-1})[a]	mm yr^{-1}	mm yr^{-1}
Gayta				
Giorgis	1.1	14	0.41015	0.57-1.93
Ashina	1.52	20	0.23245	1.15-1.83
Gishen	1.51	20	0.36353	0.83-1.94
Selassie	0.55	7	0.36472	0.13-1.25
Total	1.15	15	0.51448	0.13-1.94
Dubi				
Village One	0.21	3	0.08348	0.12-0.43
Village Two	1.94	25	0.66832	0.77-2.80
Village Three	1.72	22	0.69851	0.50-2.71
Village Four	1.51	20	0.45639	0.67-2.14
Total	1.37	18	0.86240	0.12-2.80
Grand total	1.26	16	0.71498	0.12-2.80

[a]mm yr^{-1} values converted to t ha^{-1} yr^{-1} based on 1 mm ~13 t ha^{-1} suggested in Stocking

Bodoque *et al*. (2005) estimated mean annual soil loss rate as ranging between 1.1 to 2.6 mm in their study in Central Spain. These rates are almost nearer to the rates recorded in this research (0.12-2.80 mm yr^{-1}). The slight differences may be caused by variations in local climate, geographic location and the methodology used. Ethiopia is a tropical

country while Spain is in the temperate zone. Trail was the base of measurement in Bodoque *et al*. (2005) and they used ring dating methods while this study relied on recording age of trees by consulting tree owners on farm plots. Natural erosion rates (1.24-1.90 mm yr^{-1}) cited in Krusic (1990) for the Hiking trails, New Hampshire (USA), is not much far from the findings of this research. But, their trail erosion rates ranging 6.6-7.5 mm yr^{-1} is much greater from the natural rate cited in their paper and from the results recorded in this paper. Such variations are expected because the natural rates are resulted from purely natural geological factors and the rates cited in this paper are initiated by tillage erosion and also natural factors.

3.1.1. Soil erosion variations across the study sites

Villages Two, Three and Four in Dubi RKA, and Ashina and Gishen in Gayta RKA face the largest soil removals (Table 4). These villages all lie on degraded parts of the two communities. They are dominated by shallow red soils and steep slopes. The highest erosion rates occurred in areas characterized by steep topography, and coarse and shallow soils. The lowest erosion rates were observed as expected in what were classified by the FGs as non-affected villages (village One in Dubi and Selassie in Gayta). The results in general indicate that soil erosion differs at micro-levels. Results of the two-way ANOVA (Table 5) show significant mean erosion difference across the villages at $p < 0.001$.

Table 5. Results of the two-way ANOVA

Grouping variables	Soil loss (mm yr^{-1})		Exposed root length (mm)	
	F	Sig.	F	Sig.
Study site	0.001	0.973	7.37	0.008
Slope	32.88	0.000	14.17	0.000
Interactions	4.77	0.010	1.09	0.340
Study site	1.15	0.287	1.72	0.192
Soil type	8.25	0.000	7.38	0.001
Interactions	7.83	0.001	7.51	0.001
Village	21.99	0.000	9.042	0.000
HIGs	0.242	0.786	0.340	0.713
Interactions	2.099	0.020	1.544	0.113
Slope	36.6	0.000	11.24	0.000
HIGs	0.254	0.776	0.301	0.740
Interactions	0.223	0.925	0.513	0.726

The variations are expected as the villages differ in slope gradient, soil type and overall extent of land degradation and the results matched with the ranks given by the FGs (Table 1).

3.1.2. Soil loss variations by slope and soil type

Table 6 summarizes the proportion of measured farms and soil removals at the various slope categories and soil types. The results of the two-way ANOVA (Table 5) indicate that there are significant soil loss differences among the three slope categories (at $P < 0.001$). Steep slope areas that comprised 36% of the measured farms faced the largest soil removal (52% of the total soil loss). In this area mean soil loss has been about 1.77 mm yr^{-1} (Table 7). Soils here are coarse textured and shallow in depth. Hence, slope and soil properties have contributed to the high rate of soil erosion by water. Average soil loss was moderate (about 1.2 mm yr^{-1}) on gently sloping mid-stream areas where 45% of measured farms are located. These areas accounted for about 35% of the total soil loss.

Table 6. Proportion of measured farms and soil loss by slope, soil type and HIGs

	Measured farms (%)			Total soil loss (%)		
Variables	Gayta	Dubi	Total	Gayta	Dubi	Total
Slope						
Plain	18	21	19	22	6	13
Gentle	59	29	45	34	38	35
Steep	23	50	36	44	56	52
Soil types						
Red	65	43	55	44	43	43
Black	12	21	16	36	15	23
Brown	23	36	29	20	42	34
HIGs						
poor	35.3	35.7	35.5	27	35	32
Medium	35.3	35.7	35.5	38	31	34
Rich	29.4	28.6	29.0	35	34	34

Table 7. Soil loss rates by slope, soil type and HIGs

	Mean		SD	Range
Variables	mm yr^{-1}	t ha^{-1} yr^{-1}	mm yr^{-1}	mm yr^{-1}
Slope				
Plain	0.44	6	0.43816	0.12-1.90
Gently sloping	1.20	16	0.53190	0.13-2.47
Steep	1.77	23	0.60329	0.50-2.80
Soil type/ depth				
Red/shallow	1.46	19	0.56556	0.13-2.80
Black/deep	0.80	10	0.58037	0.12-1.94
Brown/moderate	1.17	15	0.85004	0.13-2.75
HIGs				
Poor	1.19	15	0.82740	0.13-2.71
Medium	1.29	17	0.63780	0.12-2.75
Rich	1.30	17	0.68418	0.13-2.80

Erosion rates range from 1.7-36.4 t ha^{-1} yr^{-1} on red soil areas, 1.7-35.8 t ha^{-1} yr^{-1} over brown soils and 1.6-25.2 t ha^{-1} yr^{-1} at areas covered with black soils (Table 7). These results are by far very low compared to 17-176 t ha^{-1} yr^{-1} for red and 59-167 t ha^{-1} yr^{-1} for brown soils (luvisols) cited in Herweg and Ludi (1999) in Anjeni, northwest Ethiopia. The results for the black soils; however, indicate larger rates as compared to 0-16 t ha^{-1} yr^{-1} recorded at Hunde-Lafto, southeast Ethiopia (Herweg and Ludi, 1999). The reason for the mentioned differences may probably be the methodology applied, soil mineral and organic matter content and topographical and climatic variations of the research areas. It is obvious that this research was based on field survey while those cited in Herweg and Ludi (1999) were based on test plot experiment. With regard to soil type, higher mean erosion rates were recorded on farms with red soils where 55% of the total farms are found (Table 6). These soils are coarse and shallow occupying steep slopes. They are intensively cultivated for long time and are significantly affected by erosion. Black soils that make up 16% of the measured farms contributed to some 23% of the total soil loss. These soils face low erosion rates as they occur in level topography.

3.1.3. Soil loss variations by household income groups

Soil erosion rates were compared by the income status of the households cultivating the sample fields. It was found that in the plain areas, farms cultivated by the poor households suffered more than those cultivated by the other income groups. On gently sloping lands, both the poor and medium household farms faced large soil erosion rates of about 1.2 mm yr^{-1}. In the steep slopes, farms cultivated by the rich households suffered the most (Figure 4).

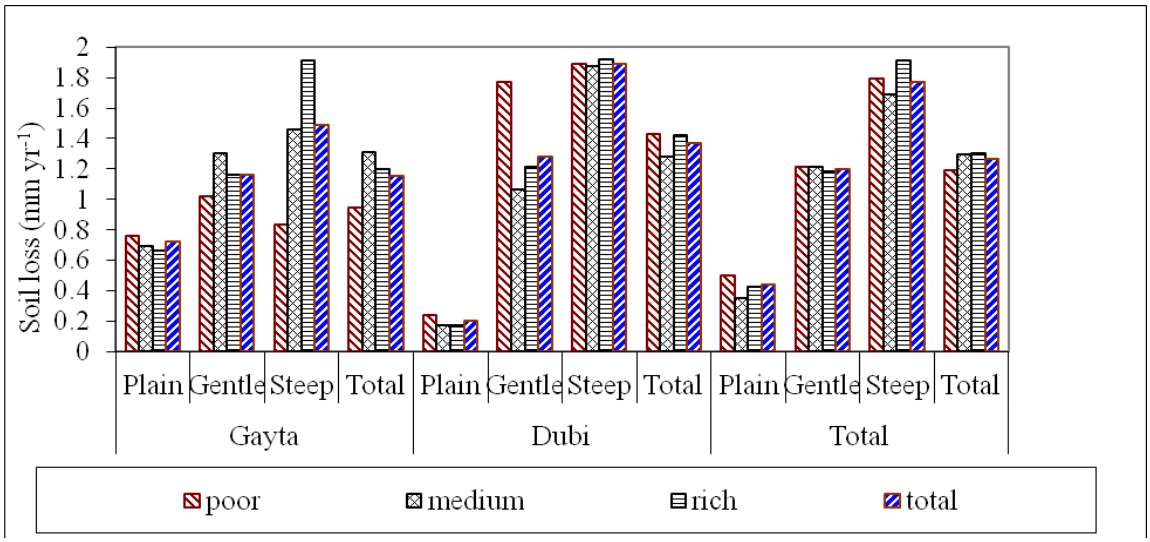

Figure 4. Soil loss on poor, medium and rich people farms by slope.

But, the results of the two-way ANVOA (Table 5) show statistically non-sgnificant differences in soil loss by the household income groups. Household income is thus not an important factor in determining soil erosion rates from individual farm plots.

3.2. Soil and Water Conservation Practices

Farmers in the study areas use different soil and water conservation measures. These include contour farming, terracing, check dams, water ways, cutoff drains, grass strips, and planting trees.

3.2.1. Contour ploughing

Contour ploughing is a very common traditional practice elsewhere in Ethiopia. It was expectedly used by all of the farmers sampled for this study (data not shown here). Ploughing is the practice of land preparation before sowing to make the soil more porous to water seepage, minimize weed emergence and improve land productivity (Yifru and Taye, 2011). In the study villages, farm lands are commonly tilled three to seven times depending on the requirement of the specific crop. Millet and maize fields are often ploughed three to five times while tef fields are tilled four to seven times. As Woldeamlak (2003) notes; however, repeated tillage and fine seed-bed formation prepares the soil to more erosion. Nyssen *et al*. (2000) remarked that traditional contour farming practices encourage gradual down-slope soil translocation and material accumulation in the lower farm margins. Therefore, there is the need to assess the benefits and adverse effects of the traditional practice of repeated tillage.

3.2.2. Terraces and bunds

Terraces and bunds were applied in 32% and 19% of all the farms, respectively (Table 8). In Dubi, 36% of the farms had soil terraces and 29% contained stone-bunds. The proportion of these SWC structures is less in Gayta compared to Dubi. Soil terraces were seen on 29% and stone-bunds on only 12% of the assessed farms in Gayta.

Table 8. Proportion of farms with SWC structures by study site (% of farms having SWC structures calculated for each site from all measured farms in each RKA).

SWC practice	Gayta	Dubi	Total
Soil terraces	29	36	32
Stone-bunds	12	29	19
Grass strips	41	36	39
Ditches/water ways	53	50	52
Cutoff drains	47	36	42
Trees	100	100	100
N^0 of farms	17	14	31

These SWC structures were generally applied on steep slope farms. They were first introduced to the area in the 1980's. Soil, stone, wood or a combination of both were used in construction of terraces and bunds (Figure 5). Both terraces and bunds are important to cultivate grass but they require large labor to build. Vancampenhout *et al*. (2006) for instance indicated spaces occupied by stone-bunds were used to grow fodder grasses in Tigray, northern Ethiopia. They are important measures in steep slope areas. But, farmers in the study villages complain that terraces and bunds take part of their plots and host pests that attack crops. Such complaints were also reported in Herweg (1992). But, Vancampenhout *et al*. (2006) reported that yields increased by 7% through application of stone-bunds and no yield reduction occurred due to 8% land occupied by stone-bunds.

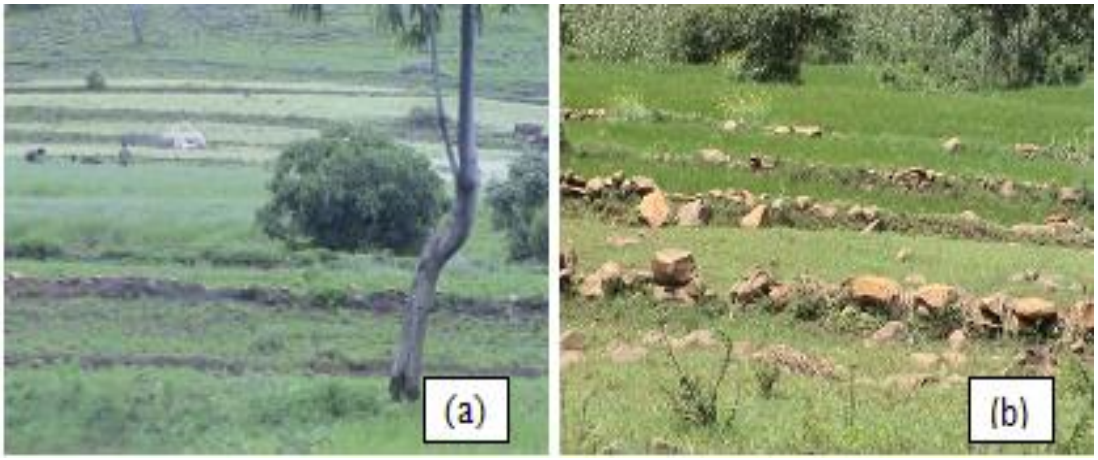

Figure 5. a) Soil terraces in Gishen (Gayta) and, b) stone-bunds in village three (Dubi), (Photo Sept. 2010)

3.2.3. Water ways and cutoff drains

Water ways (locally known as *feses*) are commonly constructed diagonally from the top to the bottom edge of a farm to drain out excess water. Cutoff drain, locally called *tiras boy* is however built horizontally at the head of farms to collect and channel upcoming runoff.

Water ways were observed in 53% of the farms in Gayta and in 50% farms in Dubi. Cutoff drains were observed in 47% of the farms in Gayta and in 36% of the fields in Dubi. Using water ways is common in level and water-lodged farms. In total, over 50% of the measured farms were observed having water ways, while cutoff drains were found in only 42% of the fields. As they are easy to construct using a plough during tillage operations, they are exercised by many farmers.

3.2.4. Grasses and Trees

Grasses and trees are planted to serve numerous purposes such as: control of soil erosion, source of animal feed, fuel and construction material. They are also sold in towns to generate income. Almost all of the measured farms contain trees and 39% of them contain grass strips (Table 8). Trees were found at the centers as well as at the margins of the fields. Grasses commonly occupied farm boundaries and planted on strips across the centers of few fields. Both grasses and trees were adopted by many farmers because they require less labor and provide diverse benefits. Grass and tree barriers in general deter the speed of running water and improve soil stability and sediment deposition.

4. Conclusions

The objective of this study was to assess the extent of soil erosion using tree root exposure measurements and examine farmers' SWC practices in the northwestern part of Ethiopia. The results show that the annual average rate of soil loss in the study area is about 16 tonnes per hectare or a soil depth equivalent of 1.26 mm. Soil loss rates significantly differed within farm fields, villages, soil types and slope categories (at $p < 0.001$). This implies that SWC and land management practices should be designed and implemented considering land slope, soil type and topographic location of farms. Each particular site thus requires specific SWC measure that fits its unique characteristics. Contour farming, ditch construction, grass and tree planting were observed most widely practiced SWC structures by the local farmers. Future SWC and land management should focus on integrated interventions that involve biological and structural measures and participation of land users.

The results obtained in this participatory research indicated that the 'farmer-perspective' framework is a good mechanism to estimate soil erosion rates on cultivated fields by simply measuring exposed roots. Since trees are familiar objects on farm plots farmers can

easily and quickly measure exposed roots and assess the amount of soil removed by dividing the measured lengths to the tree ages. This farmer participatory research approach is thus practical, simple to implement in local contexts and help to reverse the long existing 'scientist-to-farmer' to a 'farmer-to-farmer' approach. The participatory survey methodology, therefore, can be taken as a good alternative to complex models to estimate soil erosion rates at the farm level, where other more reliable measurements are unavailable.

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A History of Derbé Belanbel Historical and Cultural Site.

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Abstract

The objective of the study is to reconstruct the history of Derbé Belanbel historical and cultural site. Methodologically the researcher mainly used the qualitative method and culled data from secondary literature but the study heavily relies on field observation and information gathered from knowledgeable informants. As far as I have tried to establish, Derbé Belanbel was a medieval center of culture and civilization of the Harla Somalis characterized by stone built houses, steles, and a Mosque that appropriately suggest a religious settlement. The stone built houses are similar with those located in the Harar, Dire Dawa and Zeila areas as well as with those located in the northern parts of proper Somalia. Though differences in the softness and hardness of the surfaces of the materials used in their productions and the artistic elements we see in them, many of the steles found at Derbé Belanbel display interesting geometric similarity with the Ţiya steles located in the Guraghe Zone of southern Ethiopia. Fragments of pottery, grains of beads, and fragments of glasses that we recovered from the very site suggest the people were skilled in the preparation of household materials from clay soil and had established commercial link as far as the port of Zeila in the northwest and Mogadishu in the east. Overall, though the site is found in a precarious condition owing to lack of attention by the concerned bodies, Derbé Belanbel represented a medieval culture of greater importance, which would immensely contribute to the history of the Ethiopian Somalis and for the growth of the tourism industry of the Regional State. Depending on the effort of the Regional State, the site could be registered in UNESCO as world heritage site.

Keywords: Dhuhun, Stele, Harla, Ritual Ablution, Qedon.

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1. Introduction

A considerable amount of research has been done on the country's historical and cultural sites found in northern, and to some extent central and southern Ethiopia to such an extent that some of the sites received the status of world heritage sites registered in UNESCO. Such is the case, among others, with the obelisks of Axum, the historic city of Harar together with her Jegol Gimb, Ţiya megalith, and the castles of Gondar or the Fasil Gemb. Though the Ethiopian Somali Regional State is rich in historical and cultural sites scholars have not yet given the attention it deserves. Researchers who have developed interest for the study of archaeological and historical sites in eastern Ethiopia in recent years focused only on the areas located between the historic city of Harar and its environs and the port of Zeila. Derbé Belanbel is no exception. To the best of my investigation no scholar has ever conducted research over this historical site. Thus, a comprehensive study of the region's historical and cultural sites would be incomplete without having an idea of such important centers of culture and civilization as Derbé Belanbel and other similar sites of varying degrees of significance. How much significance does the site in question play for the history of the Ethiopian Somalis and for the promotion and growth of the tourism industry of the region is the question, which this study addresses. My study endeavors to shed fresh lights on the relevance of the site for the history and image of the region and on how we integrate it with other sites already studied in the country before. By looking at such crucial areas of inquiry, it is hoped that a better picture of the region's historical and cultural sites could be formed. This study, the first of its kind in the area, is therefore, intended to fill some of these gaps in the extant thin literature about the Ethiopian Somalis by examining things found on the site that would potentially reveal the region's historical, and cultural contribution in the general history of medieval Ethiopia. Therefore, the study proposes to look at the history of Derbé Belanbel historical site the major themes being a) stone built houses, b) the Mosque, c) the different steles found at the site d) other objects found at the site, e) challenges and opportunities, f) summary and recommendation and related issues. As much as possible, effort was also made to examine the site vis-à-vis other sites that feature similar cultural remains and products of art in the country.

1.1. Objectives of the Study

The general objective of the study is to reconstruct the history of Derbé Belanbel historical and cultural site. Having this general objective in mind, the study aims to achieve the following specific objectives:

- To examine the historical and cultural significance of the site for the study of the Ethiopian Somalis of the medieval period.
- To examine how this site would contribute to the development of the tourism industry of the Ethiopian Somalis.
- To analyze the continuities and changes seen upon the site over time.
- To examine the contribution of the Harla Somalis in the history of Medieval Ethiopia.
- To analyze the role that the site under investigation would play in filling some of the gaps on the study of the Ethiopian Somalis of medieval Ethiopia.

2. Review of Related Literature

As far as I have tried to investigate, there is no pertinent literature leaving an account on Derbé Belanbel historical and cultural site. However, because we have associated the cultural achievements at Derbé Belanbel to the Harla Somalis, let us look into the literature dealing with the people in question.

The book that most speaks about Islamic principalities and peoples in southeastern Ethiopia is Ulrich Braukamper's *Islamic History and Culture in Southern Ethiopia: Collected Essays* (2004; 16-19, 89, 107, 109, and 110). In a chapter fully dedicated for Islamic principalities in southeast Ethiopia from the 13th to the 16th centuries, he gives interesting account on the Harla people. For example, he talks about a Mosque probably built by the Harla people located in Jigjiga Zone at a place called Fafun. The name of the Mosque is very interesting because it is called Derbé, a name that I find in the historical site I have taken up. The lexical affinity between the names of the Mosque and the name of the historical site together with the Mosque it hosts may not be accidental. Oral information gives us a measure of proof on the similarity between these places because it associates with a Harla culture. Besides, information on materials that speak about the Harla people of the 12th to the 16th century is interesting. One invaluable account in this book is the part that speaks about the reason for the destruction of the Harla culture, an account that my informants told me in an exactly similar way;

> *Rather the Harla, as a wealthy and mighty people and frequently even imagined as giants, were wiped out by natural catastrophes and hunger sent by God as punishment for their inordinate pride*.

However, the account that maintains the Harla as non-Somali origin who in the 16th century were assimilated by the expanding Oromo and Somali peoples contradicts the most widely held tradition of the present Somali people because it associates the Harla with the Darod clan. Again, he concludes that all Somalis and by extension the Harla economically as nomadic people, which my informants have refuted by claiming that, the Harla led a rich sedentary life who had practiced mixed farming. The many ruined stone built houses at Derbé Belanbel strengthen this latter account. Moreover, as Braukamper aptly states, the present Somali inhabitants attribute all ruins of stone-built structures located between the ancient port of Zeila and the historic city of Harar to the Harla.

Azais, Chambard, and Huntingford, cited in Braukamper, also suggest that the builders of these structures were a kind of "proto-Somali", perhaps the Harla. However, Braukamper downplays the achievements of the Somalis when he says;

> *But it is somewhat doubtful that a predominantly nomadic population without a distinct tradition of stone architecture- as far as the Ethiopian Somali are concerned-would have been able to accomplish such work.*(Braukamper: 2004, 16-17).

To substantiate his argument, Braukamper blames Arab Faqih, author of the *Conquest of Abyssinia*, who ascribes a non-Somali ethnic origin to the Harla, a position that modern traditions of the Somali people totally rejected. Overall, Braukamper gives us a very interesting account on the abode the Harla as well as their cultural achievement and final destruction the following way;

> *As far as it can hitherto be stated, the Harla were the oldest identifiable population in the Harar plateau. Between the 14th and 16th centuries, they held a highly developed peasant civilization with urban centers and stone architecture. Most probably, the present Harari are the last representatives of the ancient Harla whose majority was either wiped out by war and famine in the 16th century or subsequently assimilated by the invading Oromo in the west and by the Somali in the east*. (Braukamper: 2004; P 107).

Apart from the above account, Braukamper does not have an idea of a center of culture and civilization of the one in Derbé Belanbel, which according to Somali traditions is attributed to

the Harla people that had flourished some 500 kilometers southeast of the walled town of Harar.

Alexander T. Curle, who lived in the former British Somaliland as part of the Boundary Commission between 1934 and 1936, during which time he witnessed the Walwal incident, gives us a very pertinent but sketchy account on the ruined stone built towns that lay roughly half way between the ancient port of Zeila and the walled town of Harar. He, together with Captain Taylor whom I know in the literature, traced, visited and analyzed some 21 ruined towns located in both British Somaliland and Ethiopia in 1934 by grouping them into four. The accounts, however, sketchy, that interest me very much is the one he gives about an inland site located some 200 kilometers south of the town of Degahbur. As indicated in his map, the name of the site is Rugayi and not Derbé Belanbel. However, an informant told me that Curle's rendering is wrong because the term Rugay or Rugis is a Somali term, which explains a situation of deadlys fighting which often claims the lives of many people. Without mentioning the exact date of this deadly encounter, the informant told me that when the British tried to subdue the area of Derbé Belanbel, the Somalis put up stiff resistance against the "white cobra" from which many people died on both sides. Therefore, Curle must have called the site after this deadly battle to remember those collaborators and perhaps some British soldiers who died in Derbé Belanbel. Apart from this wrong rendering of the cultural site, the description of the rock built houses and especially of the Mosque are amazing in that they corresponds with what I personally have investigated at the site. The only major difference is that, at present, not of course in the time of Curle, the site is known by the name Derbé Belanbel but in his rendering is Rugayi. (A. T. Curle, 1937; 315-327). In addition to the sketchy nature of his account, Curle does not give us a full picture of the cultural remains and even he does not totally mention the interesting Steles found at the site. Moreover, he does not mention the Harla in this connection. Again, Curle's sketchy account would have been of great use for us today (to reflect on the continuities and changes) if he could have picked some photographs of what he had observed.

Meftuh S. Abubaker who has compiled a report on recent archaeological findings in the areas between the walled town of Harar and Dire Dawa dedicated few pages about the achievements of the Harla. During his tour, he visited ten villages that left behind cultural remains and ruins of stone built houses of the Harla. In his words, the Harla who used to trade with merchants who came from China and India were accomplished in business, and had developed a civilization to their credit located between Harar and Dire Dawa. The Harla, he

adds, were once a powerful nation that occupied southeastern Ethiopia. Meftah has captured a very interesting photograph of a ruin of stone built house that features a striking architectural similarity with the one we find at Derbé Belanbel at a place called Ganda Harla, an area located 12 kilometers southwest of Harar. (2014; 9-12). In addition to the architectural similarity, both the extant literature and oral informants ascribe such ruins of stone built houses including the ones found at Derbé Belanbel to the Harla Somalis. Therefore, though he has no idea of the site that I have taken up because he only focuses on those found within 12 to 50 kilometers from the town of Harar, the account together with the photographs that he has taken from these sites are useful to my study.

A)

B) 

C) 

D) 

Figure1.The structures in “A” and “C” represents the Derbé Belanbel and “B” and “D” represents the Ganda Harl structures. Look the architectural similarity between the two. Photographs “A” and “C” by the researcher while those in “B” and “D” from the material of Meftah.

The Harari People Regional State Culture, Heritage, and Tourism Bureau (October 2015) prepared the history of Harar and the Hararis. By using different source materials, the bureau has prepared a very interesting material that touches upon every aspect of life of the Harari and their relation with other peoples. The part that deals with the Harla captures my interest because like other written materials it discusses their cultural achievements especially in trade and architecture. However, the fact that it mainly focuses on the history of the Harari, the scope of the study does not consider the Harla of my interest located around 500 kilometers inland from the city of Harar.

Muhammed Ibrahim Wersame gives us invaluable information about the cultural achievements of the Harla people whose genealogy is fetched from Kerenle. For him, the Harla, an account that substantiates our position, had constructed the various historical sites of stone built houses found in eastern Ethiopia all the way to northern Somalia. The information about the Harla as a trading community who had once (c. 11th century) commercial relationship with China and India is also interesting in that it correlates with the information I have got from informants. Equally important is the account that associates the collapse of the Harla culture because of their inordinate pride, something that I heard from my informants, too. (2014, 20,70)

Central to all kinds of explanations is the assumption on the existence of a highly civilized culture often attributed to the Harla people who used to live in eastern Ethiopia that stretches from eastern Hararge all the way to Somalia proper. There is over-reliance in their discussion among scholars, too. Besides, studies tend to focus on the Harar-Dire Dawa-Zeila corridor. Because of this narrow scope, studies conducted so far on the civilization of the Harla are not comprehensive. One such gap is, despite its paramount significance on the history of the Harla, the absence of a well-researched paper on Derbé Belanbel. Therefore, this study is meant to fill some of these gaps.

3. Methodology of the Study

This research applies the analytical and narrative approaches. The typical form of analysis employed in this research is critical analysis. Source materials are, therefore, criticized both externally and internally during and at the end of the data collection, namely before interpretation of data commenced. The methodology that is deployed in this research is a combination of fieldwork and collection of oral testimonies with the emphasis on cultural remains found at the site. Attempt is also made to interrogate the cultural remains in light of information obtained from oral informants. I selected the method of individual interviews as the best way of extracting information from informants because it is flexible and adaptable, which often results in a much higher response rate than a questionnaire. From the very beginning, I decided against the use of questionnaires because my informants are elderly people who do not find it easy to respond to a long series of questions in writing. They would rather feel at ease to reminiscence about their experiences and observations during interviews. This method also enables the researcher to bring out the perspectives of his interviewees. To

this effect, the researcher asked them leading questions to support their opinions, views, and perceptions.

Probing questions of the unstructured type were prepared to avoid the problem of limited response questions, which is often evident in structured questions. The questions were open-ended which allowed me great latitude to raise broad issues in whatever order seemed appropriate. Similarly, informants were allowed to raise questions or any other concerns at any interval during the conduct of the interview. To avoid possible bias and to make them reflect upon their true experiences, the researcher presented himself neutral and explained his purpose as purely academic. During the progress of interviews, the researcher probed, followed up, clarified, and elaborated responses to attain accurate responses. In the meantime, the narrative of the interviewees is recorded by means of written notes. The researcher's effort to procure information from secondary literature was not as such rewarding.

3. Geographical Location and Description of the Study Area

The Ethiopian Somali Regional State has nine zones- Shinile, Jigjiga, Degahbur, Fiq, Nogob, Qorahe, Gode, Werder, Afder, and Liben. The town of Jigjiga, located 625 kilometers from Addis Ababa, is the administrative center of the regional government. About four hundred kilometers away from the town of Jigjiga is Derbé Belanbel historical site located in Dhuhun *wereda* of Nogob *zone*. The site is located about six kilometers from Dhuhun town, the administrative capital of the *wereda*.

There are two similar but different accounts on the etymology of the study site. The two accounts do agree on the meaning of the word Derbé that, in the Somali language, means a wall. However, we have two completely different explanations on the meaning of Belanbel. First, the word represents a kind of plant, which grows in the area abundantly. This, we have also confirmed. Secondly, the word entails to a burning fire along the sides of mountain slopes, which the Sheiks used to burn at night while they had taught the holy Quran to their students.

In the Somali language, the word Dhuhun means stone, a name given to a mountain located in the immediate outskirts of the town in its western direction so named because of the enormous quantity of rock found inside the mountain. Therefore, the town gets its name from the mountain that overlooks the flourishing settlement that spread over east of the mountain. It is the eastern most part of a mountain terrain called Qerchiqod (Qarijiqood in the Somali

language) that runs from west to east. When seen from the village town of Barmill, located some 25-kilo meters west of Dhuhun, the mountain terrain portrays a majestic look almost uninterrupted. However, the residents of the area told us that the mountain terrain has seven parts. Dhuhun is a somehow projected eastern most part of this mountain terrain before it turns southeast. From the foot of the mountain upwards to its top is a driveway, and at the top a helipad, which the Italians had constructed during their second invasion of Ethiopia in 1935.

In military terms, one can easily control the activity of the enemy from the top of the mountain. The insurmountable mountain terrain coming from the vicinity of Barmill and runs from west to east until it reaches Dhuhun and then to the southeast adds its strategic importance. That is why; the Ethiopian Somali Regional State stationed an army unit to protect the area from any possible attack coming both from within and from the outside. We sought to visit the area but the authorities told us that that is impossible. The Semene River that comes from the west passes through the area half way between Derbé Belanbel and the town of Dhuhun leaving the town to its southwest direction. It is the main source of water to the people and their livestock living in the *wereda*. The river is one of small tributaries of the Wabe Shebele River that joins it in Gode *Zone.*

According to informants from the very town, settlement began beginning from 1927. However, it was not until 2000/2001 E.C. that it became a *wereda*. In the south Dhuhun *wereda* borders Gorob, in the north by Segag, in the northwest by Hamero, in the west Ayun and in the east by Iimay and Bare *weredas*. The area near the site is generally flat plateau covered dominantly with different species of acacia trees, which is squarely encircled by mountain terrains. Informants recount that, the area was suitable for agricultural activity where the people used to cultivate rather oddly *teff* and sorghum because the area had received abundant rainfall. Besides, stock in the form of cattle, camels, sheep, and goats thrive at the present day and therefore for sure did so in the past.

A)  B) 

Figure 1. The photograph in "A" represents Dhuhun Mountain from which the wereda and the town get their name and "B" Dhuhun town. Photograph by the researcher.

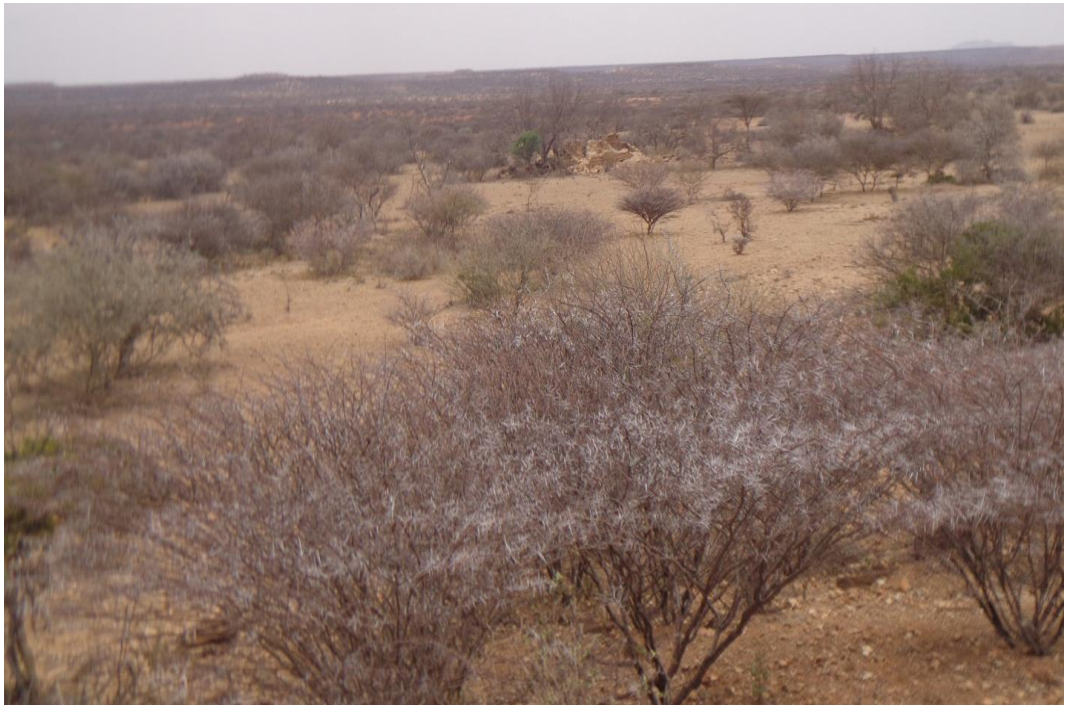

Figure 2. The study site. The photograph displays one of the already tumbled down stone built houses. Photograph by the researcher.

4. Data Analysis

As stated at the beginning, this historical site is located about 200 kilometers away from the town of Degahbur. It consists, among others, of an ambitiously planned Mosque, more than 40 ruined stone built houses together with their refuse heaps, and megaliths. The selection of the site seems a very calculated move in that it still has a quarry from which the people cut out

and shaped stone for the construction of the houses as well as that of the Mosque. However, unlike many of the medieval structures found in Ethiopia, the site left no sign of defense. We have at least two reasons to argue so. The first one is that the town had flourished in an almost lowland area as compared with the uplands and mountainous areas that pretend to be natural defensive formations erected by providence that squarely surround the site. Secondly, there is no protecting structure or walls like the Jegol Gemb of Harar and the castles of Gondar, constructed for defense purpose. Therefore, the size and number of stone built houses, one of these a lavishly constructed Mosque, and the absence of defensive precautions show the existence of prosperous and peaceful communities, an assumption confirmed by informants.

Neither scholarly studies nor widely held traditions provide precise information as to when this civilization thrived. However, the similar story in the extant literature and the oral information regarding this intriguing question is interesting in that both kind of explanations point to the medieval period. Informants maintain that these ruined houses flourished 600 years BP. When we deduct 600 years from 2017, we get 1417, a period in Ethiopian history that obviously falls in the medieval period. Similarly, scholars have speculated that ruined towns of the Derbé Belanbel types, that were located in the Zeila, Dire Dawa, Harar, and Jigjiga regions, had flourished between the 12^{th} and 15^{th}centuries.The major argument that they have maintained to substantiate their position is that they had flourished in the period mentioned above because they had enjoyed a relatively peaceful period to thrive while the Christian highland kingdom and the several Islamic Sultanates and principalities were pitting against each other for supremacy. Besides, both the existing literature and informants attribute the entire marine as well as the inland ruined towns to the Harla. Nevertheless, the other controversial issue that scholars who have developed interest in the study of historical and archaeological sites in this part of Ethiopia asked is whether the Harla people are Somalis or not. While the Ethiopian Somalis unanimously confirm that, as we shall see the short genealogy after a while, the Harla were an almost extinct Somali clan, the literature show a sense of skepticism over their Somali origin. Leaving this contested issue for further investigation, let us now focus on the subject of our interest, Derbé Belanbel.

According to informants, the Harla Somalis who used to practice mixed farming established the ruined town of Derbé Belanbel. For them, it was a religious settlement where the Sheiks set out for the "Great Commission" of preaching Islam among other Somali clans. The Ethiopian Somalis in general and the residents of the area in particular relate the genealogy of Harla with the Darod clan, one of the two major clans of the Somali peoples. Darod, they

recount, had a son by the name Keblala who gave birth to Kombé, the father of Harla. Now, let us give an analysis of the ruined stone built houses, the Mosque, the stone slabs and other related developments.

3.1. The Ruined Stone Built Houses

Before we set out for the site, people told us that there were above 50 stone built ruined houses. On having visited the site, however, we realized that they told us a somehow inflated figure, as we were able to count only around 40 including the Mosque. In a mixed feeling of excitement and regret, I lost no time to observe that all the stone built houses left no trace of roofing and a significant portion of the structures had already collapsed presumably many years before. All the houses built in the shape of a rectangle are of different sizes. The largest of this, situated at the hillock of the site, has six classes. As compared with the other houses, it displays walls in all its sides that measure 2 meters above the ground. The structure measures10 meters in length and 7 meters in width. Its strategic location and relatively large size make us to deduce that the house might have been the residence of those in charge of leadership role, a palace in modern times. Immediately in its southern side of the wall, a square displays sitting stones laid down east and west in the shape of a semi-circle. Outside the square, we observed some fallen stone slabs that measure 2 meters. The still standing external and internal walls of the house also suggest that the builders took utmost attention obviously to satisfy and please the authorities. Few meters, west and east, away from this structure are two ruined houses, may be the houses of those who had helped the leader in advisory and administrative as well as judicial roles. The presence of a stone slab engraved in the shape of a lion strengthens our speculation as to the ownership of the house because lions are often associated with leadership, power, audacity, reverence, and royalty.

The plans of the houses in this site indicate that there was the difficulty of obtaining local supplies of roofing timber, a difficulty that the exotic eucalyptus tree has solved now. The smallest of the houses has a single room measuring 3 meters width and 5 meters length. Unfortunately, the greater parts of these houses had already collapsed to the extent that some of them became heap of fallen stones. Some others are covered with trees, bushes, shrubs, and anthills.

Figure 3. A house almost entirely engulfed with an anthill. Photograph by the researcher.

The walls built of roughly dressed stones laid in alternate courses of large and small material seem to be bounded with mud instead of lime mortar. The partition walls inside the house stood detached from the outer wall. It is difficult to measure the original height of the rooms, but in some cases, they would appear to have been about 3 meters high. There were no windows in the modern sense of the word, and lighting and ventilation, other than from the door, must have come in through small rectangular holes, about 30 cm in height, set in the walls about 2.4 meters height from the ground. The floor was of flattened earth in all the houses investigated. The roof, though totally collapsed at the time of investigation, was probably formed of brushwood, laid over a framework of roof beams of local wood, made probably from any of the species of acacia trees which even today is the dominant tree there, and covered with earth; a tradition of roof making among the Ethiopian Somalis that has continued to our days. We have observed square or rectangular-headed niches or inner windows in many of the still surviving walls and must have served as cupboards where they placed different materials like knives, swords, and Holy Scriptures inside. There were no signs of doors fixed and it is probable that a cloth or skin, attached to fairly long rectangular stone slab placed horizontally, serving as a curtain, covered the opening.

Before we move to the discussion of other aspects of the site, let us devote few lines for a structure located North West of the Mosque. We render special attention for this house because it displays, as compared with the many stone built houses, a somehow different architectural style. For a better understanding of the things about which we shall discuss, let us first display a photograph of the house here under.

Figure 4. A structure somehow different in its architectural style from many of the ruined stone built houses. Photograph by the researcher.

The house is located southwest of the Mosque. As we can see from the above photograph, unlike other houses in this site, the greater part of the structure survived the perils of nature as well as human interference. One reason for this is perhaps the greater care that the builders had given at the time of construction. Another unique feature of this structure is that it has many large seized cupboards portioned in the middle with stone slabs laid down horizontally. In addition to the seize, the cupboards forms an arch at the top, a shape which we see only in the Mosque. Moreover, the part of the inside walls between the two cupboards as shown above are decorated with engravings in the shape of a diamond and floral as well as perhaps rather oddly a star instead of the crescent which add a measure of elegance to the structure. Its proximity to the Mosque and the similarity in their architectural style all suggest that the structure must have been the house of religious leaders or the Sheiks.

3.1. The Mosque

Of all the structures found at Derbé Belanbel, the Mosque was the most elaborate and energetically constructed building. This appears the only occasion in all the efforts exerted there where the masons if not the engineers had applied lime mortar to bind the stones. The '*Mihrab*' of the Mosque had collapsed and immediately outside the southeastern corner of the wall of the Mosque proper was storage well, the depth of which we cannot measure because

big stones filled its pit. There is no doubt in my part that believers had used the water from this well for ablutions before the prayers witnessing that the building was certainly a Mosque. Built in the shape of perfect circle, the water well, as shown below, displays the high level of knowledge and skill that the builders possessed in geometry.

Figure 5. The water well used for ritual ablution before the prayers. Photograph by the researcher.

The Mosque roughly measures15 meters length and 12 meters width. The roof as well as the external walls, with the exception of the eastern side of the building, had already collapsed. The internal part contains about 18 pillars each connected with elegantly built arches. Unfortunately, except the four arches, two of these located in the south and the other two in the east, and nine pillars, the rest had totally ruined.

The Mosque at Derbé Belanbel depicts Gothic architecture. The pointed arch as one defining attribute of Gothic architecture is reflected in the several arches built in the inner part of the Mosque, an architectural style employed in medieval palace and Christian as well as Islamic sacred constructions in many parts of Ethiopia. It is common knowledge that the Jegol Gemb and the castles of Fasiledes in the historic cities of Harar and Gondar respectively display such architectural style as the one in the Mosque at Derbé Belanbel. If we take what informants have said for granted, this settlement predated both the Jegol Gemb and the castles of Fasiledes.

Figure 6.The ruined Mosque at Derbé Belanbel, and parts from its interior sections. Photograph by the researcher.

Another fascinating test we observed in this structure is that, unlike what is common to the several stone built houses, the builders had used very beautiful sedimentary rectangular stone slabs that give the Mosque a graceful and attractive look. Almost the entire body of the Mosque was built with this stone, an indication of the high regard that the people had displayed for their religion. However, unless the concerned bodies would take immediate action to protect them, at present, the entire structure is in a perilous state and undoubtedly will totally collapse in the near future.

Figure7.This is one of the longest of the marble stones, which the masons significantly used to construct the Mosque. The stone slab measures about 1.3 meters long. The lime mortar firmly bounded the stones. Photograph by the researcher.

Between the water well and the southern right corner of the building, we find a rectangular structure that is attached from the main building but oddly projected to the east that roughly measures 5 meters length and 2 meters width. Few meters east of the Mosque, there is an open space perhaps a market place because the flattened ground displays pieces of cobblestones scattered over the surface of the earth, may be a coping mechanism of the rainy season. The fact that the structure about which we were talking above is projected towards the open space means that there might have been a shop attached to the Mosque, a tradition that has continued down to this day.

3.2. The Steles

Like the entire settlement, the steles at this site are of uncertain age. As far as I have tried to investigate, both the fallen and the sill standing stone slabs numbered above 40. They are not located in one place. Situated around the southern stone built houses especially near the big one built in the hillock, they form a bunch from some six in one place, the biggest number in one cluster, to two in another. Geometrically speaking, many of the structures are flat and are rectangular and conical in shape. There is a striking geometric similarity between these at Derbé Belanbel and Ṭiya megaliths located in the Guraghe Zone of Southern Ethiopia.

A)  B) 

Figure 8.The photograph in **"A"** represents the Ţiya stone slabs displaying the engraved sword, and **"B"** represents the Derbé Belanbel. The geometric similarity is interesting.

The major difference between them is in the kind of engravings, paintings, decorations, and symbols they feature. For example, unlike the ones in Ţiya, none of the structures in Derbé Belanbel features the symbol of a sword. Again, we do not find paintings in Ţiya that feature fauna while we find at Derbé Belanbel, at least in two occasions. One of these is a fascinating painting that displays a lion chasing after different wild animals and the other an impressive engraving that clearly depict a lion and its mane. The paintings and the engravings are live witnesses of the skills that the people had possessed in fine arts. They tried to represent the physical world of their time with the help of the artistic skill they had possessed. Such productions of art is a pointer to the kind of wild animals found in the area at the time and a very interesting portrayal of the prey and predator game among the animal world. There are also other stone slabs painted with enigmatic pictures, as it is difficult to decipher the meanings from the already faded away paintings.

A) 

B) 

Figure 9. The photograph in **"A"** represents a painting that shows a lion chasing after other wild beasts and **"B"** displaying an engraving of a lion's head and its mane. Photograph by the researcher.

As noted earlier, the typical tree of the area is acacia. In one of the fallen stone slabs, we see an engraving that features an interesting floral pattern, which resembles acacia trees found in the study site. Another difference is that the surface of the stones at Derbé Belanbel is harder than the ones at Ţiya. This is perhaps one reason for the absence of many engravings here at Derbé Belanbel and presumably the main reason to resort to painting. Informants told us that the artists had extracted the ink used for painting from Qedon (Qadhoon in Somali tongue) tree, which is still available in the area and even at the site, which produces red color.

Figure 10. Look how they interestingly engraved the branches of the acacia tree over the hard surface of this fallen stone slab. Photograph by the researcher.

A)  B)  C) 

Figure11.“A” and “B” display enigmatic paintings while “C” displays a lion chasing after a giraffe and a wild goat. Photograph by the researcher.

Figure 12. Qedon tree from which the painters extracted the reddish ink, a photograph taken by the researcher from the very site.

3.3. Other Objects found at the Site

As is often the case with such settlement sites, we have recovered different objects scattered on the surface of refuse-heaps and amongst the ruined houses. We have collected four kinds of objects. These are fragments of pottery, glasses, beads and bones. It is impossible to date the fragments. Therefore, we have to wait for further historical and archaeological studies that would come up hopefully with new findings with the help of radio carbon dating method.

Of all the material objects recovered at the site, coarse hand-made pottery fragments figures prominently followed by beads, bones and glasses. The fragments are mainly black and reddish in color.

A)  B) 

Figure 13 "**A**" represents black pottery fragments and "**B**" the red ones. Photograph by the researcher.

Very few of these feature different incised floral decorations and one of these display very interesting painting both on the inner and outer part of the fragment. This was more appropriately a fragment of a drinking vessel. Some of the fragments give hints as to what kind of objects they originally were.

Figure14. Pottery fragments of floral patterns. The patterns represent, I assume, birds and their feather as well as eyes. Photograph by the researcher.

A fragment of handle, for example, suggests that the object was undoubtedly a pot. Depending on the size of the fragment, this might have been a coffee pot or a pot used for containing water, butter or paprika. Those that feature floral decorations, some featuring the feathers of birds, might have been used to keep invaluable luxuries or for burning incense. Pottery products might have also used for storing grain, boiling water, roasting grain, cooking food and baking *injera* or bread.

Another remarkable pottery product is a small round ornament made from clay with a hole at the middle, which, according to informants, was used for ornamentation put around the necks of women and children.

Figure 15. Pottery fragments depicting broken handlings and circular clay made ornament. Photograph by the researcher.

The site also produced a number of fragments of thin green and black glass vessels. We have also recovered beads, which, according to informants, were imported from Arabia and were used for ornamentation, which women and children put around their neck. The bones found on the refuse heaps show that domestic animals like camel, sheep, or goats formed important items of diet.

Figure16. Fragments of glass and grains of beads recovered at the site. Photograph by the researcher.

4. Factors for the collapse of the Harla Culture and Civilization of Derbé Belanbel

No one speaks with certainty as to why this civilization collapsed. We have three reasons for the destruction of the Harla culture in general. Informants from that very area told us that these people had lived on mixed farming and trade and were very rich. The Harla, informants add, once got good harvest of *teff*, something that we need to verify with further archaeological findings, and sorghum, baked it, spread on the ground and sat on the *Injera*. They even had mounted on their horses and had walked on it. Because of their inordinate pride, God punished them with drought and famine, which in turn caused them to vacate the area and disappear. The second assumption relates their destruction with the expansion of other Somali clans who subsequently swallowed them. Finally, the 16th century Oromo population movement and expansion was regarded as the cause for the destruction of Harla civilization who in the process had assimilated them. However, the last argument seems erroneous because the site about which we are talking about is located deep in Somali territory, the Ogaden, an area that may not be easily affected by the Oromo population movement and expansion.

5. Challenges and Opportunities

Though Dhuhun *wereda* hosts the historical site we have discussed above which in some respects resembles the country's UNESCO world heritage sites like Ṭiya megalith, the ancient

city of Harar, and the castles of Gondar, we have observed the following challenges that heavily hamper the efforts of researchers to study the site. The major challenges include lack of transportation, electricity, and accommodation such as hotels and lodges. The nearest asphalted road that passes through Degahbur to Gode is far from the *wereda* by about 200 kilometers. The only transport service between Degahbur and Segag *wereda* is an Isuzu bus that shuttle on daily basis. Segag town is far from Degahbur by about 125 kilometers. However, because of the absence of an all-weather road, it takes the Isuzu bus 10 hours to arrive. The journey is precarious at least for two reasons. One is that the bus transports both human beings and merchandise often beyond its capacity. Secondly, the road is not paved. Therefore, the drivers, who have good knowledge of the topography of the area, have to choose the good grounds to move forward often at the snail's speed.

The worst is yet to come. On having arrived Segag town, unless it happens in a very rare and lucky occasion, one has to stay there even for weeks depending on the availability of transportation. There is no public transportation from Segag to Dhuhun *wereda*. So, one has to win the willingness of the local administrators to use their Land Cruiser which sometimes goes to the *weredas* whenever there are meetings. Besides, cooperation and willingness significantly wan as one move from Jigjiga to the remote *weredas*.

The other major problem is the attention that stakeholders give for the conservation of the historical site. As we have observed, the site received little or no protection from both the local level administration and the residents of the *wereda*. One manifestation of this is that, informants told us, people have continually used the blocks of stones from the ruined heaps to construct their houses with no one from the local level administration prohibiting them doing so. Therefore, natural factors like whirlwind and lightening, heavy showers of rain and bushes, shrubs and trees grown over the houses coupled with anthropogenic causes would undoubtedly hasten the total destruction of the historical site. This is a huge loss for the history and tourism industry of the region. Generally, poor conservation of the potential resources and absence of promoting them to the public are the main challenges.

Nevertheless, despite the above challenges, we are not very desperate in this direction. There are opportunities, which we need to use to do research, preserve and promote the historical site in question. One such opportunity is the presence of friendly communication between regional, zonal and *wereda* level administrators and workers. Had it not been the willingness and cooperation that we received from all levels of administrators, the success that we have so

far would have been a mere dream. Equally important is the warm welcome and cooperation that the people of the *wereda* displays whenever there is such a demand. The relative proximity of the *wereda* to the asphalted road that passes through Degahbur to Gode and the relative security of the area also render an easy and safe access to the site.

6. Summary and Recommendations

As much as I have tried to investigate in this very study and from the existing literature, the Ethiopian Somali Regional State has a huge potential of historical and cultural sites. One of these is Derbé Belanbel that, according to a widely held tradition, came into being 600 years BP. Both oral data and scholarly contributions ascribe the several stone built houses, Mosques, and necropolis to the Harla. Harla, according to informants, was forth from Darod. Therefore, the cultural and historical remains at Derbé Belanbel are probably the achievements of these people. The fact that this site is located deep in Somali territory removes our suspicion as to whether this cultural achievement is truly a Somali or not. Further archaeological studies will sufficiently answer the confusions, if any, as to the agency of the Derbé Belanbel civilization. Therefore, if what we have suggested above is to be believed, the assumption that all the Somalis have been pastoralists who have no traditions of stone building technology is wrong. Derbé Belanbel is but one testimony.

When we look into its historical significance, both the period of its establishment and the different cultural remains found there gives it the standard that some of the country's historical sites has attained. Chronologically, it predates both the Jegol Gemb and the castles of Gondar. The variety of still standing remains outshine other cultural sites because they display fine architecture, sculpture, and art, a collection of cultural achievement that we hardly find in other historical sites in one place. The architectural skill reflected in the construction of the Mosque, and the artistic skill that the people had demonstrated on the steles give the site a special place in the country's historical and cultural studies.

The study, therefore, shows that the cultural site is of huge contribution for the reconstruction of the history of the Ethiopian Somalis of medieval Ethiopia. However, to make use of its full potential, the region has to consider the following recommendations very seriously.

- ✓To prevent further destruction, the area must be reserved. This could be done by the immediate *wereda* in collaboration with the local community where the site is located.

- ✓All the trees, bushes, and shrubs that grow out of the walls have to be carefully removed because they would exacerbate the collapse of the still precariously standing structures.
- ✓The local level administrators with the collaboration of the Zonal and Regional authorities should create awareness among the residents of the *weredas* about the significance of the site. By doing so, it is possible to involve the community in the protection of the site from further destruction.
- ✓The *wereda* must give direction to the effect that people would no longer transport the ruined stones from the site to build their houses.
- ✓The site must be temporarily fenced to prevent people, cattle, and other domestic animals from entering into the site.
- ✓With the collaboration of the Federal and Regional Culture and Tourism Bureaus, an all-weather drive way has to be constructed from Degahbur to Dhuhun *wereda* so that things would be easy for researchers and visitors in the future.
- ✓The regional press and media have to do works of promotion.
- ✓If it fulfills the preconditions necessary to that end, it has to be registered in UNISCO as world heritage site.

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Appendix 1

List of Informants

S/N	Name	Age	Place of	Date of Interview	Occupation/Social Standing

			Interview	(E.C)	
1	Ahmed Abdulahi	55	Dhuhun Town	3/12/2009	Driver
2	Abdulahi Hassan	65	Dhuhun Town	4/12/2009	Member of the regional polis force in the rank of *Shambel*
3	Badal Abdulahi	67	Jigjiga	20/11/2009	Director of Somali language and poet in the CTBES
4	Dugsiye Ahmed	34	Jigjiga	19/11/2009	My translator who works in Cultural Case Studies of the ESCTB
5	Hassan Ismael	70	Dhuhun Town	4/12/2009	Sheik and elder who has good knowledge about the Harla civilization
6	Haybe Nur	82	Dhuhun Town	4/12/2009	An elder and resident of the town
7	Ise Osman	83	Dhuhun Town	4/12/2009	Sheik and elder who has good knowledge about the Harla civilization
8	Mahammad Ahmad	45	Dhuhun Town	4/12/2009	Qebele official in the town
9	Mahammad Muhummed	35	Dhuhun Town	4/12/2009	Resident of Derbé Belanbel qebele who showed us to the very site
10	Mahamed Mosse	26	Dhuhun Town	4/12/2009	A militia who told us the precarious situation of the site

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