Climate change perception and adaptation practices in Bahir Dar City, Ethiopia

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Abstract

This study was conducted in Bahir Dar city, Ethiopia, to assess climate change perception and adaptation practices of Bahir Dar city's community. In this study, primary and secondary data had been collected and utilized. The required primary data were collected through the specialized procedures. The researcher stratified the nine administrative units of the city in to three categories based on their development level; then after, one administrative unit was randomly selected from each; finally, a total of 242 household heads were randomly selected and interviewed. Primary data collection was done through key informant group, focus group discussion and field observation. published research papers, working documents of NGOS and government were consulted. The data was analyzed using Statistical Products Services and Solutions (SPSS version 22). The result displayed that 64% of the community has perceived the presence of climate change in the city. Accordingly, they started practicing adaptation measures including tree plantation, wise utilization of water resource and compound greening. However, low level of community awareness, financial constraint, and weak urban development planning were identified as the main factors that significantly affect the adaptation practice at full-scale. On the other hand, demographic variables such as, education level, age, occupation and family size did not significantly influence perception level of the community. We, therefore, conclude that provision of adequate finance and adequate climate related information to the community can play an important role to increase community's perception level and climate change adaptation practices.

Key words: Climate change, adaptation, awareness, perception, Bahir Dar City.

1. Introduction

Climate change means the alteration of the world's climate due to the increasing concentration of greenhouse gases (GHGs), such as CO_2, methane, nitrous oxide, etc., in the atmosphere (IPCC, 2007). Climate change can mostly be monitored based on temperature and precipitation. Climate change has appeared to be a global issue that poses threat to human, animals and plants lives (Emerta Asaminew, 2013) and sustainable development

Climate change has both positive and negative implication for water access. These impacts are manifested in the form of flood and water availability for the developing countries. The positive impact can be manifested in the form of availability of more water that can be used for different purposes (Alebel Bayu, 2014). Climate change increases number of warm nights in urban areas substantially more than in rural areas. This is because rural areas cool off faster at night than cities, which retain much of the heat stored in roads, buildings, and other structures. As a result, the largest urban-rural temperature difference, or maximum heat island effect, is often three to five hours after sunset. These results provide evidence that urban and rural areas respond differently to climate change and climate change impact is intense in urban areas compared to rural (Martina *et al*., 2015).

Now a day, climate related field professionals accepted that climate change is not only the issue of rural areas but also urban areas. Different urban areas are being affected, becoming risky places for dwellers, investments, manufacturing, plants' and animals' lives, and development practice. Realizing this fact, different universities, and research institutions are engaged with research works to solve urban climate change problem (Alebel Bayu, 2014). Concerning level of identification, rural communities are very much cognizant of seasonal fluctuations (rainfall and cropping pattern than urban) than urban. Since they lived long years in their areas of farming, animal rearing and fishing activities. As a result, they have adequate indigenous knowledge regarding their localities, environment and they used to predict or protest their environmental situations easily (Negash Mulatu, 2014).

Despite this fact, climate change is an issue for both rural and urban areas; urban contexts are more vulnerable and devastated than rural settings. Because, almost all urban areas are home for people, machineries, factories, and production centers. Thus, urban areas produce more greenhouse gases rather than rural areas. As the volume of gases increases, climate change impact also would increase (Meherun, 2013).

peoples' climate change perception level may differ from place to place due to their experience, context and backgrounds. Some people may understand the root cause and the effect well and others may not. Likely, their response to this problem may differ based on their level of basic information they have at hand (Emerta Asaminew, 2013).

The right perception is crucial aspect for effective response or climate change adaptation. If it is managed with adequate awareness, the adaptation program might help the people to reduce the negative effect from them and save lives, unless the adaptation process may be worsening the issue more (Joseph, 2013). However, adaptation practice of developing countries' cities like African have so far been fragmented, lack strong link between national climate change strategies and plans, existing disaster risk reduction and other related policies. These shortcomings are partly due to lack of conceptual understanding about adaptation, experience and capacity (Napi, 2014). Due to lack of conceptual understanding, experience and capacity, the idea of urban adaptation was not effective in most developing countries like Ethiopia

(Emerta Asaminew, 2013). For example, most of Ethiopia's regional cities are not applying the planned adaptation strategies and practices of climate change due to low financial capacity, low technology, and limited conceptual understanding (World Bank, 2015).

Recently two climate related studies on Bahir Dar city were conducted by both Galena and Habtamu (2012). Habtamu (2012) reported that there is climate change problem in Bahir Dar in his study. However, his study emphasized and focused on only climate change presence but failed to explain the adaptation and mitigation status of the city. Therefore, this study was designed to fulfill this gap by identifying the community's climate change perception and adaptation practices. The objective of this study was to investigate climate change perception and adaptation strategies of Bahir Dar community.

2. Materials and Methods
2.1 Description of the study area
The study was conducted in Bahir Dar city, the capital city of Amhara National Regional State, Ethiopia. Geographically, it extends from 11º37' N and 37º25' E (Figure 1). It lies between 1786 -1886 masl. The size of Bahir Dar city is 28.7 km^2. The city consists of nine administration units.

Bahir Dar city is one of the most important tourist center in Ethiopia. and investment opportunities as the capital city of the region.
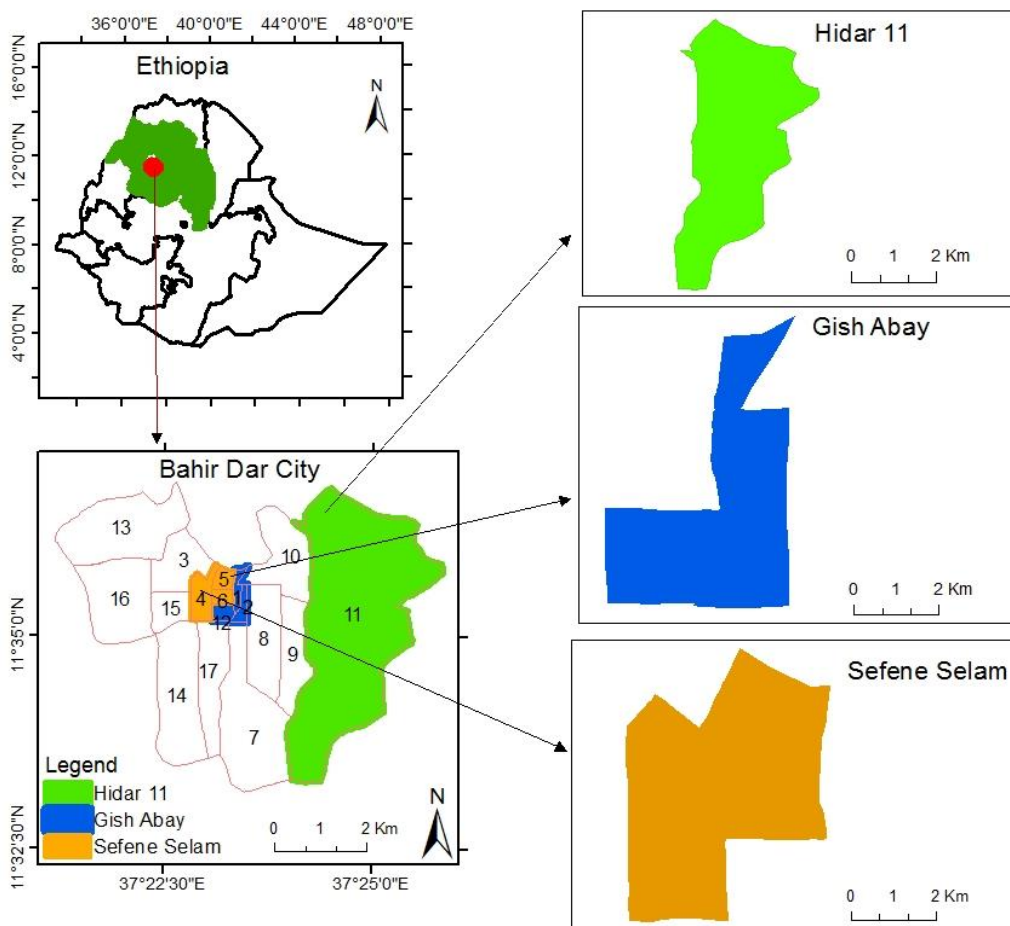

Figure 1: Location map of Bahir Dar City

2.2 Climate

Bahir Dar's climate is classified as warm temperate. The summer months have a good deal of rainfall, while the winters have very little (BCA, 2016). To understand the Climate change condition of the city, trend analysis on climate variables is very important. To do this, the researcher collected 53 (1961-2014) years 'rainfall and temperature time series data from the Bahir Dar metrology station.

2.2.1 Rainfall

According to time series data, July is highest rainfall month of the city whereas August is the second rainy month next to July. The rainy months of the city are from June-sept. As it is depicted in data, 1973 and 1974 were the highest rainfall years of the city with 2036.9 ml and 1946.4 ml, respectively; however, the lowest rainfall amount was scored in 1982 (894 ml) and 1994 (1076 ml). Even though rainfall amount had fluctuated within those years, the trend analysis indicated that there is a declining trend from time to time. Overall, the total annual rainfall showed a decreasing trend, which is similar to global rainfall pattern (Habtamu, 2012).

2.2.2 Temperature

According to the time series data, the highest temperature months of the city are February, March, April and May. Unlikely, October, November, December and January were lowest temperature months. Maximum temperature is indicative of daytime temperature while minimum temperature is indicative of night time temperature. According to Habtamu (2012) study, Bahir Dar city's minimum temperature has cyclic behavior as the maximum temperature. Despite the cyclic pattern, the minimum temperature as that of the maximum temperature indicated increasing trend. It has experienced mean annual temperature change of about 0.04 $^{\circ}$C per decade, which is higher than the global average 0.08 $^{\circ}$C per decade.

Bahir Dar city's temperature increment over the global average is attributed by the rapid urbanization and reduction in vegetation cover and increased heat absorption by the soil (Habtamu, 2012). The three major heat sources are building sector, transportation sector and human metabolism. The building sector is assumed to be the main contributor at Bahir Dar. Building heat is associated with heat generated from electrical lighting and use of other electrical and cooking appliances (Galena and Habtamu, 2012).

2.3. Demographic characteristics

During the 1984 census, the population size of Bahir Dar city was 54,800, and after 10 years in 1994, the second census, the total population size had increased to 96,140 (CSA, 1994). According to the 2007 Census report, Bahir Dar special zone has a total population of 221,991, of whom 108,456 (49%) are men and 113,535 (51%) women; 180,174 (81%) are urban inhabitants, the rest of population are living at rural kebeles around Bahir Dar.

The three largest ethnic groups in Bahir Dar were the Amhara (96 %), Tigray (1%) and Oromo (1%); all other ethnic groups made up 2 % of the population. A religion composition of the city is 90 % Ethiopian Orthodox Christianity, 8 % were Muslim, and 2 % was Protestants (CSA, 2007). Regarding religious services, there are 50 churches for Orthodox Christians, 15 churches for Protestants, 10 mosques for Muslims (BCA, 2016).

2.4. Economic activities

The major investment opportunities of the city are: hotel and tourism, horticulture, agro–industry processing, urban agriculture and different types of industries. The city has economic linkages with the surrounding areas, medium and small towns and Addis Ababa. In Bahir Dar there are 10 banks and 15 hotels of 1-4 stars (BCA, 2016). The average annual revenue of the municipality within the 2008–2012 periods was 49,741,020 Birr and the major sources of revenue were taxes, rent from shops, and service charges (BCA, 2016).

2.5. Sampling method

Thefore, this city should be protected from natural and man-made hazards to make it suitable for tourist, dwellers and investors. Seven Kebeles were selected for the study using simple random selection method among the above mentioned kifle ketemas (Sefene Selam, Gishabay and Hidar 11).In this study, both qualitative and quantitative research was applied to collect primary data from the field. Through cross-sectional survey, quantitative data was collected and the sample size was determined using (Kothari, 2014) method.

2.5.1 Household sampling technique

Standard population survey formula using multi-stage sampling technique is suitable for the determination of number of households that age going to be targeted for the household survey. (Kothari, 2014)

It is formulated as $n = \dfrac{Z^2 * P * q * N}{e^2(N-1) + Z^2 * P * q}$.

Where,

n = Sample size

N: the total population of the sample Kifle ketemas. N=13,872. Refer Table 1.

Z = confidence interval. The researcher used 95% confidence interval for this research.
The Z score value of the 95 % confidence interval is 1.96.

P = probability of communities with positive perception to climate change and adequate Adaptation practice. Its value is (20%).

Q = 1- P

e : margin of error (precession). its value is 5%.

$$n = \dfrac{1.96^2 * 0.2 * 0.8 * 13{,}871.83}{0.05^2(13{,}871.83 - 1) + 1.96^2 * 0.2 * 0.8}$$

$$n = 242$$

The calculated sample size is 242.

The total calculated sample sizes were distributed to each sampled kifleketams' Kebeles based on the population size ratio using this formula (ni=nWi.)

   ni: sample size from sampled Kebeles

   n: the sum total sample size of the study =242

   Wi: the weight for each kebeles. (Cochran, 1977)

Table 1: Sampled kiflektema Profile

Kiflekema Name	HHS in Kiflekema	No of HHS contacted
Sefeneselam	5515	96
Gishabay	4190	73
Hidar 11	4167	73
Total	**13,872**	**242**

(Source: Bahir Dar municipality report)

As we can see from Table 2, households were screened and contacted from Sefen selam, Gishabay and Hidar 11. From these, 242 households were drawn for household survey purpose. Simultaneously, 6 FGD were conducted.

On top of the FGD and households' survey, eight KII were conducted at eight different Bureaus (Environment, Forest and Wildlife Authority, Municipality, Transport, Water, Irrigation and Energy, Construction and Design, Agriculture and Rural Development, Road Authority and Health).

2.5.2 Data collection techniques
In this study, both secondary and primary data were collected and used. Primary data was collected through household survey, FGD and KII whereas secondary data was collected through document review from different organizations' and sector offices' published and unpublished documents.

 Cross sectional survey was conducted to assess the current climate change perception of the community and also to diagnosis the correlation between explanatory variables (age, sex, income, education level, and access to information, family size, occupation and stay) and dependent variable (perception).

2.5.3. Data analysis method
Tobit model is used to make regression of dependent variable with values between 0 and 1. Tobit model assumes that any observations for which the dependent variable takes zero or negative value are observations not observed. STATA software was used to analyses quantitative data using the Tobit model. The multivariate Tobit model is denoted with formula (Mkikel, 2007):

$$Y_i = \max(f_i(X; \theta) + \varepsilon_i, 0), i = 1 \dots\dots M$$

εi is Error term.
$Y i$ is the matrix of explanatory variables by X.

3. Results and Discussions

Of those 242 respondents who involved in the household survey, 86 % of the respondents had lived in the Bahir Dar city for more than 6 years and 14% lived for less than 5 years (Table 5).

Table 5: Respondents' stay in Bahir Dar

Respondents' stay	Respondent Number	Percentage
less than a year	9	4
between one year and five years	24	10
between 6 and 20 years	64	26
between 20 and 40 years	108	45
greater than 40 years	37	15
Total	**242**	**100.0**

Concerning occupation status, 46 % of the respondents were engaged in trade business (petty trade, hotels, restaurant, café, shop, hair salon, laundry, tailors, drugstores and Pensions). 19% of the respondents used to earn income from government as pension and from organizations; Faith based institutions, relatives and friends as gift. Fifteen percent of the respondents were employed by government/ NGOs; 10 % of the respondents were employed in private sectors. Apart from the above; 7% of the respondents used to generate income from daily labor selling and house renting and 4% of the respondents used to earn income from farming activities (Table 6).

Table 6 Respondents' Occupation type

Respondents' occupation	Respondent Number	Percentage
Trade	112	46.
employment in government or NGO sector	35	15
employment in Private sector	25	10
Other incomes (pension, support from relatives, children)	45	19
daily labor and house rent	16	7
Farming	9	4
Total	242	100.0

3.2.1 Climate change perception of the community

In line with the time series temperature data, the min, max and average temperature of the city has indicated an increasing trend (Figure 5). Habtamu (2012) reported that the maximum temperature had slightly increased by $0.03^{\circ}C$ per year from 1961 to 2010. Similarly, the minimum temperature as of the maximum temperature was increasing. However, change in minimum temperature over the years is higher than that of the change in maximum temperature.
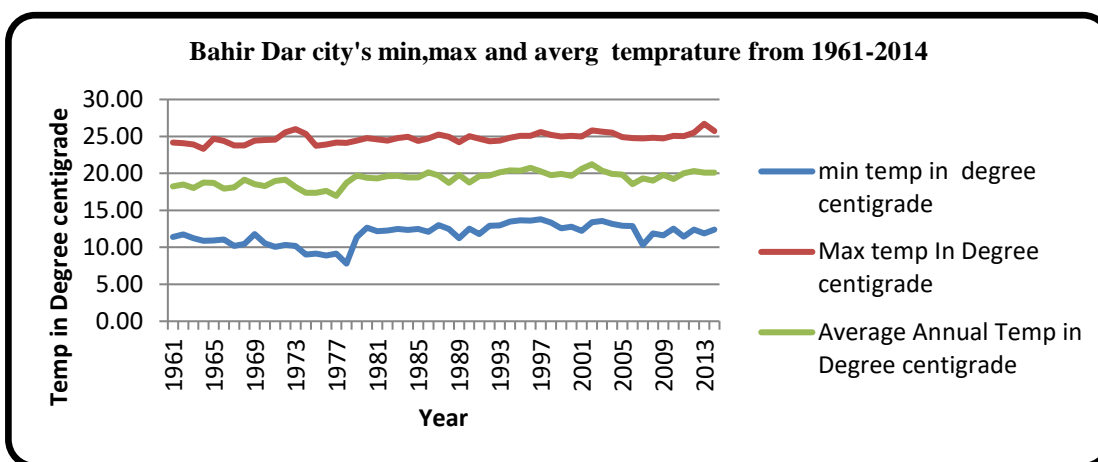
Figure 5: Bahir Dar city' min, max, average temperature from 1961-2014.

According to the study of Galena and Habtamu (2012) between 1961–1975, annual rainfall above 1500 mm occurred ten times, and after 1975, the same amount occurred only seven times. Overall, the total annual rainfall depicted a decreasing trend, which is similar to global rainfall pattern. Generally, from 1961 to 2010, Bahir Dar has shown decrement of rainfall by 30 ml per decade (Figure 6).
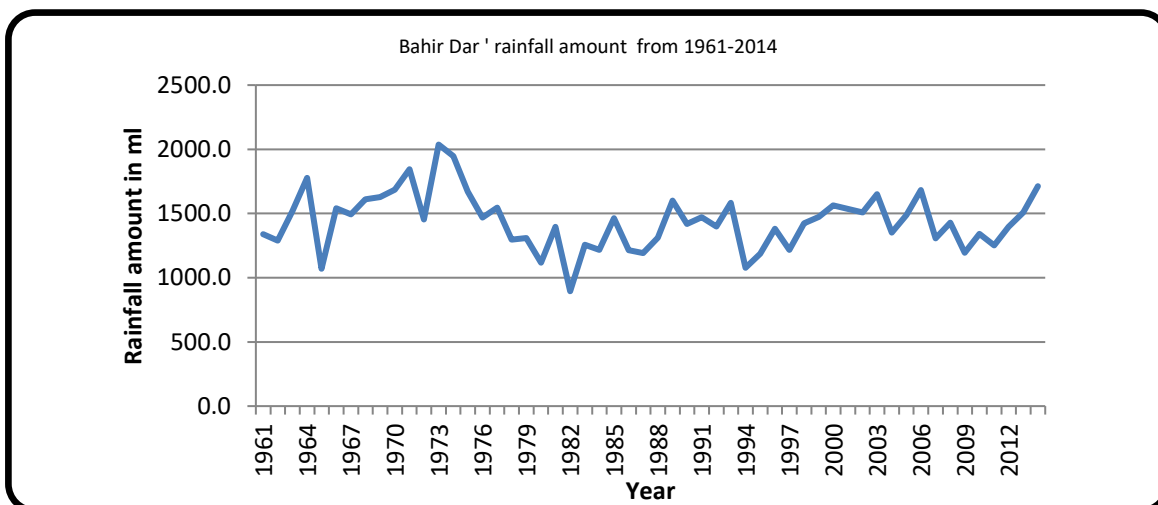

Figure 6: Bahir Dar's average rainfall amount from 1961-2014.

Perception index of the community was calculated and stated under the operation definition part in chapter three. In line with that the perception level of the community was 64%. Most of the respondents who contacted in the household were matured enough to understand Bahir Dar's climate change situation and provide reliable information (Figure 4). This figure approved that the community had recognized the change. Apart from that, most of the focus group discussion members believed that there was there was climate change in Bahir Dar community.

One respondent from men group said that, "*climate change is the result of people' actions exerted upon the surrounding. For example, people drop solid and liquid wastes outside, along the people's presence. These wastes produce bad smell and people get diseased. Besides, the waste produce greenhouse gases and aggravates climate change. We cut trees for fuel,*

*construction, from the bush without replacement. As human body dies and replaced with the
other bodies, it needs replacement to avoid the impact of climate change.*"

TV, radio One young lady of women group stated that, *"even though we heard the information
through and people, we daily sensed it through strong heat waves, water shortage, drought,
and flooding around us. This is eye witness of climate change presence. Everybody is under the
stress of this as you see people are moving to get water."*

On contrary, some of the respondents do not have climate change information. One old man
from other men group said that, "there was no rain fall problem, there was no water problem,
and our Cattel were well and productive in the earlier years. The presence of climate change
is announced recently; our sin is the cause of it. *The solution is at the hand of
Alah rather than us. Therefore, we have to pray and reverse accordingly."*

Regarding climate change information sources, television was the first priority information
source for 29% respondents, 15 % used radio and 5% used peer discussion (Table 7).

Table 7: Climate change Information sources

Source of information	Respondent number	Percentage
Radio	35	15
Television	70	29
peer discussion	13	5
All	124	50
Total	242	100.0

In line with data collected from key sectors through key informant interview, 88% of the sectors
'head and experts have adequate climate change information compared to the community. They
articulated the causes and effects of climate changes well. However, 12 % of the sectors' heads
and experts have low climate change knowledge. Even though the sectors' heads with low
climate change knowledge are few in number, they have high influence on the community.
Generally speaking, adaptation will not be effective unless appropriate measures are taken
timely to raise the awareness of all segments of the community in general and heads of
institutions in particular.

3.2.2 Community 's adaptation practice

As it is mentioned in the above paragraph, Bahir Dar communities had adequate climate change
perception. As a result, they used to adapt to it using their own local adaptation practice. The
most crucial types of adaptation practice are categorized as: water stress adaptation practice,
flood hazard adaptation practice and temperature adaptation practice.

A. Water shortage adaptation practice

Water shortage is being experienced in Bahir Dar city starting from few years. Even though there are many water shortage aggravating factors (rapid urbanization, population growth and rural –urban migration and climate change), climate change is one of the most common reasons. To cope up with climate change issue, people used different adaptation practices. According to the descriptive analysis, 26% of the respondents believed that fetching water from the other kifleketeama was the most preferred adaptation practice. Twenty-five percent of the respondents confirmed that water consumption reduction was the most preferred adaptation practice. This is the second most common adaptation practice of the community. (Table 8).

Table 8: Water stress adaptation Practice in Bahir Dar city

Water stress adaptation practice	Respondent number	Percentage	Rank
Fetch water from nearby water sources	64	26	1
fetching water from rivers, well ,Abay and Tana	16	7	5
Construct new /maintain water suppliers by community/ government	12	5	7
Reduce water consumption level	60	25	2
buy water from shop	27	12	4
All	15	6.	6
None	47	19	3
Total	242	100.0	100.0

Likewise, most of the focus group participants agreed that fetching water from the other kfileketama and consumption level reduction were the two major water stress adaptation practice of the community. Some of the focus group discussants said that water purchase from the shops is the best community adaptation practice. Only few of the focus group members' said that the best adaptation practice of the community was fetching water from the surrounding natural water sources like small rivers, Lake Tana and Abay River.

One man from men group mentioned that, *"since we are in shortage of water resource, let alone for washing our clothes and body, in the afternoon session we used to buy water from shop for drinking purpose. The problem was not only because of hot temperature rather skilled persons are drawn from other nearby villages without adequate knowledge or comes in corrupted ways. Bahir Dar is seat for Abay and Lake Tana. But thanks to the poor water management, we are suffering with water shortage. "YeAbayn lij wuha temaw""*

One old woman among the women group 3 stated, "*the community around ayere-tena village fetch water from nearby river which was polluted with human faces and dead dog bodies. These communities tried to clean the river and used it for drinking purpose. There was water Pipeline extension from Addis Alem to Ayere tena. But, it is not functional by now. Therefore, people are exposed to water shortage. As a result, they look for water Rivers, Wells, Lake Tana and Abay.*"

According to the data collected from water, irrigation and energy bureau through key informant interview, the bureau do not have its own adaptation plan rather mainstream sector 'specific adaptation activities with the usual annual plan and implement it through the existing structure,

system and human labor. For example, rehabilitation of water sources like springs, pipe line extensions and shallow wells, construction of new deep and shallow wells along Meshente, Entrance and Bezawit areas in the city is being going on. However, the sector office' adaptive capacities (Budget, Skilled person, and number of staffing) are not adequate to implement these additional adaptation practices of the office (Table 13).

B. Flood hazard adaptation practice

There were times when flood hazard happened in the city so far. Kebele 16, 13, 12 and 10 are flood prone kebeles and many people were affected and properties were damaged. According to the descriptive analysis, most of the communities used new drainages and maintained the old ones to prevent flood hazard problem. The second most flood hazard adaptation practice of the community was sand sacks usage to prevent Lake Tana overflow. The 3rd significant practice practiced by the community was selecting flood free zones for construction (Table 9).

Table 9: Flood hazard mitigation practice

Flood hazard adaptation practice	respondent number	Percentage
flood free zone for construction	15	7
New drainage construction/ old	134	57
sand sacks	34	14.
None	4	2
All	45	17
Evacuation	7	3
Total	**242**	**100**

According to focus group discussion results, most of the participants agreed that most of the community members used drainage infrastructure to protect flood hazard problem in the city. One of the group participants from men group 2 pointed out that, *"people do not have sympathy for those dream lights. While dream lighters clean the drainage infrastructure, dwellers drop any wastes inside the drainage. After that, the drainage got filled with dry and liquid wastes. Due to this reason, most of the drainages are not suitable for flood protection currently."*

Even though most of the participants acknowledged the accessibility of drainage for the flood protection in the city, they argued each other on the quality issues. Only 77 % of the participants realized that the drainages have good quality; they are comfortable to protect flood hazard in the City. Seventeen percent (17%) of the respondents stated that drainages have poor quality. Due to this poor quality, the flood hazard protection was not effective in some Kebeles especially Kebele 4, 5, 10 and 6.

C. High temperature pressure adaptation practice
As it is seen in the descriptive statistics analysis, 30% and 23 % the respondent mentioned that shower taking, light clothes dressing and tree planting were adaptation practices of the community respectively (Table 10).

Table 10: Heat adaptation mechanism

Heat adaptation mechanisms	Respondent number	Percentage
Ventilator	38	16
Planting trees.(sitting under the trees)	55	23
taking shower and dressed with light	64	30
All	27	11
Planting trees, taking shower and dressed with light clothes	49	20
Total	242	100

All of FGD participants agreed with the presence of heat adaptation mechanisms in the city. Regarding the type of heat adaptation practice few of the respondents mentioned that people used taking trees shelter, taking shower, sitting outside of the houses and dressed with light clothes to adapt heat pressure. In line with their response, all of these 8 sector offices were expected to mainstream climate change adaptation activities, however, intentional planning and incorporation was limitation of all Bureaus. Despite the above facts, most of the bureaus tried to implement adaptation activities together with their daily routine activities.

3.2.3 Climate change adaptation obstacles
According to the descriptive result, even though most of community members were using the above mentioned adaptation strategies; there are hindering factors that affect the community. The series most obstacles were lack of finance, weak urban development plan, low community awareness and land shortage to plant trees (Table 11).

Table 11: Challenges of climate change adaptation practice

adaptation practice	respondent number	Percentage	Rank
Finance constraint	69	29	1
Land Inaccessibility to	32	13	4
Low community	33	14	3
Weak Urban development	36	15	2
Deforestation	22	9	5
All	50	21	6
Total	**242**	**100**	

All KII participants agreed that financial constraint is the first critical challenge for adaptation. For example, Bahir Dar municipality wanted to implement green infrastructure technologies (green area, parking, and plaza) in the city. The solid and liquid wastes of Institutions like Bahir Dar prison, Bahir Dar University, felegehiwote hospital and textile factory were discharged into Lake Tana and Blue Nile River. However, due to finance shortage the municipality was not able to improve the service. Lack of space for waste water collection and treatment seems to be the most important problem especially in the downtown. Finance is very crucial to apply new technology for the waste management for health bureau and municipality (Fesseha Hail, 2008).

The other critical adaptation challenge was weak urban plan. According to the focus group discussion members, large buildings had been constructed along Lake Tana. This has great negative effect on community life especially for Sefeneselam and Gishabay areas. It has blocked fresh air flow to down town. It is lack of urban planning.

The other remarkable challenge was lack of land to plant trees along the residence and market places. Fifteen percent (15%) of the respondent said that it was the critical challenge to implement climate change adaptation in the area. Most of the focus group discussants believed that most of residence places had no free space to plant trees like the market places. Likewise, these residential and market places are located along the road. This resulted in shortage of free space to grow plants along these places. Together with the land shortage, sometimes, ELPA orders some of the city dwellers to cut the trees which had already grown up due to its attachment to the electric cables in the city.

According to key informant interview respondents' arguments, the major challenges of climate change adaptation for most bureaus were absence of skilled and adequate person, lack of finance and other resources, absence of institution that works on this field, low leadership commitment, and low community awareness. Coordination gap among sectors like water, irrigation and energy, road authority and transport sectors is critical challenges for all these mentioned bureaus. Lack of strategic planning and close follow up, less engagement of investors and civil society in the field of climate adaptation were the major challenges for municipality bureau (tsedat and wubet).

3.2.4 Climate change remedy

Besides elucidating the major challenges of the community, the household survey participants forwarded their crucial recommendation as remedy for climate change (**Table 12**). The first top practice suggested was planting trees in different parts of the city and also on water sources of the city. Bahir Dar water sources are located somewhat outside the City; these water sources are located at Meshenti, Entrance and Bezawit with high exposure of sunlight due to lack of trees/terracing around it.

The second most important practice suggested by the respondents was community awareness creation. Community awareness creation is mandatory for climate adaptation. Even the leadership team assigned in different sectors should get intensive awareness creation trainings on climate change concepts and adaptation mechanism. The third important solution proposed by the respondent was appropriate urban development plan practice to ensure climate change adaptation. The most important focus areas of the urban development plan should be green areas, drainage, building construction along Lake Tana, and dry and solid waste management, income generating activities development, etc.

Table 12: Community adaptation suggested solution

suggested solutions	Respondent number	Percentage
Awareness creation for community, experts, and leaders.	49	20
Planting trees and ensure water shed management.	83	34
urban development plan	22	9
All	68	28
None	10	4
Total	242	100.0

All of FGD recommended that Bahir Dar's community should plant trees, create community awareness and engage the community to participate on the development activities like drainages cleaning. However, majority of the respondents recommended invitation of investors for local level drainages, cleaning and construction and other development activities and public discussion with local leadership to realize climate change adaptation well.

According to sectors' heads' and experts' suggestions, community empowerment and capacity building is the best solution. Capacity building should be given for both leaders and experts who work on climate change. The second suggestion was to strengthen coordination among different institutions such as the steering committee established with health; municipality and water office in order improve the beauty and effectives of the adaptation practice of the city.

A. Green areas development in Bahir Dar

Open space or green area is a land including working and natural forests, rangelands and grasslands, farms, ranches, parks, stream and river corridors, and other natural lands within rural, suburban, and urban areas. Open space may be protected or unprotected, public or private (USDA, 2016). It is clear that open space or green areas are areas where it is covered with forests of any kind, grasslands and fruits. Bahir Dar city has these types of green areas or green spaces. According to this key informant interview, Currently, Bahir Dar city has 68 Green areas, covered with 60 hectare; supervised by each Kifleketeam' administrations. The overall coordinating body of these 68 green areas is Bahir Dar municipality. These areas do have different kinds of forests trees, Fruits and grasses.

Besides green areas supervised by the municipality, private and institutional green areas were there in Bahir Dar. These are located in different institutions, Hotels, resorts, lodges, residence houses, market center, churches, mosques, public centers, and others. The most important institution with such green areas: Amhara cemetery, Bahir Dar University, ALMA, ICT Bureau, and Mulu Alem meeting center. Private organizations like Kuriftu Lodge and SPA, Desset Lodge, Avanti Hotel, Tana Hotel, Abay Minch Lodge, Agare Lodge, and Lake Shore are familiar with green areas in Bahir Dar, town. Besides the above key informant interview information, during household survey and focus group discussion, most of the community members declared that urban trees/green areas are the most important adaptation strategies of

Bahir Dar City. Overall, according to this study, tree plantation /green area is one of most recommended climate change adaptation practice by both community and different sector offices. Besides this study, a lot of researchers came up with this solution, different countries had already implemented it.

Most of developed countries like USA, Canada, England, Denmark, Brazil, and developing countries like Vietnam, India, in east Asia , and Lagos, Cap town in Africa are using urban Green space to make their lives comfortable (ADB, 2012). Green areas and parks are also started in Addis Ababa city and are making the city conducive to its citizens. As the seat of the African Union, the city has made vast effort to rehabilitate the degradation of open green and recreational areas (Zelalem, 2015).

According to Roberto (2014) study, besides recreation and public gathering service, green areas would also provide low cost opportunities for adaptation and mitigation strategies. Trees help to remove (sequester) CO_2 from the atmosphere during photosynthesis.

Therefore, trees act as carbon sinks, alleviating the greenhouse effect (USDA, 2014). It is the mitigation function of urban trees. The Adaptation function is also mentioned by Robert. According to Roberto (2014), urban trees lessen the impact of the urban heat island effect and reduce changes in weather patterns and reduce temperatures. Even though the total number of urban trees and their carbons sink contribution was not known until now, it has great impact on carbon absorption and climate change mitigation.

The sequestering capacity of urban tree depends on different factors. It depends on species, growing conditions and how a tree is managed. In addition, young trees absorb carbon dioxide quickly while they are growing, but as a tree ages a steady state are eventually reached (FCE, 2016). A recent study carried out at Kielder Forest has calculated that the Forest's 150 million trees lock up 82,000 tonnes of carbon* annually. This means that as a rough estimate each tree at Kielder is locking up 0.546 kg of carbon per year – equivalent to 2 kg of carbon dioxide. One ton of carbon is equivalent to 3.7 tons of Carbon dioxide ((FCE, 2016). Based on the above calculation, if Bahir Dar city has 20, 000,000 urban trees, 10933 tons of carbon would be lock up annually. However, the amount of carbon dioxide removed in Bahir Dar due to the presence of certain urban plants requires context based further research.

3.3. Determinant of Perception level of the community

Tobit regression	Number of abs	=	242
	LR chi2 (8)	=	31.65
	Prob > chi2	=	0.0001
Log likelihood = 252.88391	Pseudo R2	=	0.0668

Table 13: Regression result

Perception index	Coefficient	Standard error	T	P(t)	95% Confidence interval
Sex	-.0315293	.0114473	2.75	0.006 ***	-.0540822 , -.0089764
Income	0.0006	3.18e-06	1.89	0.060 *	-2.59e-07 .0000123
Stay	.0189562	.0066447	2.85	0.005 ***	.0058651 .0320474
info index	.0668181	.0289026	2.31	0.022 *	.0098756 .1237607
Occup	.0118022	.0146597	0.81	0.422	-.0170796 .040684

Educ	.0087096	.0167754	0.52	0.604	-.0243406	.0417598
Age square	3.82e-06	5.42e-06	0.70	0.482	-6.86e-06	.0000145
HHS	.0010697	.0032525	0.33	0.743	-.0053381	.0074775
Cons	.5561037	.0311534	17.85	0.000	.4947267	.6174807

Obs. summary: 1 left-censored observation at percepindex<=.28888889

240   uncensored observations

1 right-censored observation at percepindex>=.82222222

***, **and * are significant at 1%, 5%and 10% respectively.

3.4 Regression result analysis and discussion

Household income: household Income is significant at 10 %. As the income level of the people increases, perception level of the people increases by 0.06 %. This means that there is a direct relationship and positive relationship between income and perception level of the people. The very reason is that when an individual household get adequate income, he/she is able to buy TV and radio to get information and this would enhance the household perception level. According to Kide Gebru (2014) study, one ETB increases in the income of the household from the farm, the probability of farmers' to perceive and use adaptation strategies of soil and water conservation and irrigation increases by 13.3% holding other variables constant. Similarly, according to Anbesu Bikila (2013) study, Wealth (farm land Size, livestock, and extra income) is positively related and has significantly affects farmers' adaption to Climate change. As the farm income level of the household increases by one unit, perception level of the household increases by 179.2%.

Access to information: It is the most important variable that is significant at 10%. When people do have adequate information access, people perception level would increase by 6.68%. Thus, access to information and perception level of are positively related each other. Because perception level of a household is the direct result of household's information that he/she had in mind. The result of this research is supported with other researchers' result like Anbesu Bikila (2013), Oluwatusin (2014) and Kide Gebru (2014). According to their analysis, as farmers get adequate information and education, their climate change perception level would get increased. Therefore, accesses to information and climate change perception are positively related each other. Madison's (2006) study supported the above research results that access to information from different sources has significant impact on the adaptation to climate variability Indeed, it is an important precondition for farmers to take up adaptation measures.

Duration: - stay in Bahir Dar city is another important variable that is significant at 1%. There is a direct and positive relationship between duration and perception. As people stay in Bahir Dar city increases by one year, their perception level would increase by 1.9%. The very reason might be that the longer the people live in Bahir Dar would have good information about their surroundings; as a result, they would have adequate knowledge of climate change.

Sex: Sex is significant at 1%. The interpretation of the result is that being women would decrease perception by 3.2%. Thus, the two variables sex and perception level are directly and negatively related each other. Most of Women communities are far from information since they restricted with income generation and domestic works for their family. Thefore, their perception is inversely related with sex. Contrary the result to this study, Oluwatusin's (2014) indicated that, sex is positively related to perception level of the household. His study mentioned that female-headed households are more likely to perceive climate change and adaptation as they

are more affected by impact of climate change. However, Anbesu Bikila (2013) reported that sex has negative and significant impacts on the perception of household's climate change.

Age: according to this study, age is insignificant variable and it does not have any influence on household perception level. Even though most of this study respondent is old aged and familiar to the area, most of them were female headed households with low climate related information. As the result of this, age is insignificant to explain the perception level of the community. The other assumption is that old people are not very eager to know new information about their environment from internet, radio, or TV rather they prefer to make social cohesion with others or be isolated. Due to this fact, as people gets older, they may be far from information access. As a result of the information gap, their perception level may not be influenced. From literal observation, younger generations are fast and eager to know new information than old people.

On contrary this, Oluwatusin (2014), Anebsu Bikila (2013), Mesfin Tesfay (2012) and Kide Gebru (2014) studies indicated that the age of the respondent has positive influence on the perception level of the household. As the age of the respondent increases by one year, the perception level of the respondent increases by certain percent. Age has been observed as significant and positively related with household's perception level, adaptation decision to take up climate change adaptation measures in the study area. It increases the probability of using crop diversification; use of improved crop varieties and using of early maturing crop variety. Thus, increasing the age of household head by one Unit increases the probability of perceiving change in climate by 7% (Anebsu Bikila, 2013). According to Oluwatusin (2014) research result, age has positively affected the perception status of the cocoa farmers. The implication of this result is that farmers with old age would describe change in climatic conditions correctly than the young farmers. This shows that perception is directly proportional to the age of the farmers and that older respondents are more efficient in perceiving climate change than the younger respondents.

This study is contrary to Anbesu (2013) and Oluwatusin (2014) studies, but Mesfin Tesfay (2012) study forward this study approved that Young farmers of age 25 to 45 were found relatively better aware about the causes of climate variability and change than the old age.

Family size: according to this study, family size is insignificant variable and it does not have any influence on household perception. However, family size is very significant variable to explain the variation of climate change perception in Anbesu Bikila's (2013), Oluwatusin's (2014) and Kide Gebru's (2014) studies. In general, household with large family size has positive and significant effect on the awareness of rainfall change, drought and drought frequency and damage of crop due to climate change. Even though this study area is urban and the three researchers' study area is rural context, the explanatory variable had influenced perception level of both areas households. According to Oluwatusin (2014) study, the perception level of farmer is enhanced when he/she has a large family size and also the rate of adoption of adaptation strategies to climate change by farmers with large family size is higher and better. This may be so because those with large family size are always conscious of what will destabilize their ways of living.

Education level: according to this study, education level is insignificant and it does not have any influence on household perception. As it is well known, as people get more education, their level of perception would also increase. However, the result of this study is quite different from

the above mentioned researchers' results and also from the reality. The suspected factor that promoted this result might be two. The first reason might be that most of the respondents did not complete the secondary school: 29% of the respondents were in grade (7 -10), 17% illiterate, 4% basic education and 12% primary grade (1-4). As a result of this, they might not be equipped with the necessary information of climate related courses. The second one is that since these people live in very vulnerable situation, they might be engaged with other labor works together with their education. Because of this, they might not able to understand environment changes and current situation. However, according to Anbesu Bikila (2013), Mesfin Tesfay (2012), and Kide Gebru (2014) studies, it is significant variable and does have positive influence on household's perception level. In line with Mesfin (2012) research, there is significant association between farmers who attend formal education. Similarly, according to Oluwatusin (2014) study, educational level of farmers also plays a good role in perceiving climatic change conditions.

There is direct relationship between education and ability to know whether climate has changed or not. Anbesu Bikila (2013) study supported this study that farmer's perception level increases with more education. For exam, as the educational status of the farmer increases by one unit, using improved crop varieties increases by 93.9 %.

Conclusions

64% of Bahir Dar' city community perceived that climate change problem has happened in Bahir Dar. Realizing this problem, they were using their own adaptation practices like water consumption level reduction, water fetching from the other kifleketeam, and water fetching from nearby waterbodies (Abay and Tana) to manage water shortage problem. Besides, they were using drainage structure and flood prone area selection techniques for flood hazard adaptation. Likewise, tree planting, frequent shower taking, and dressing light clothes were heat adaptation mechanism.

The most important perception influencing factors (sex, stay, access to information and income) were identified. Accordingly, access to information and duration/stay variables were significant at 1% whereas sex and income were significant at 10 %. However, education, age, occupation and family size were not able to influence the perception level of the community. Even though there are sectors and NGOs who are able to support the climate change adaptation practice at the city, there is no common platform for these partners to share their experience and failures.

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