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People's Awareness and Perception Level on the Risks of Climate Change and Constraints of Their Adaptation Strategies in Mekelle City, Tigray Regional State, Ethiopia

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Abstract
All over the world Climate change is creating significant environmental, ecological, social and economic threats mainly to the cities of the developing nations. Likely, in Ethiopia, climate change induced risks such as drought, flooding and hot temperature are rapidly increasing and causing adverse effects. Adequate level of community's awareness and perception about the cause, indicators and impacts of climate change and its adaptation measures to effectively cope climate change related impact is essential. Therefore, the main objective of this journal article was to evaluate the level of people's awareness and perception on the risks of climate change and the challenges of their adaptation strategies in Mekelle city. In order to realize this objective, the study employed descriptive type, survey method and mixed approach of research. Primary data were collected using questionnaire, interview, focused group discussion and observation. The study also used secondary data using literature and document review from secondary sources. Moreover, the data analysis methods utilized in this study were SPSS and Excels through graphs, line graphs, cross tabs, chi-square and simple linear regression to show the trends of temperature and rainfall. Finally the study has identified lower level of awareness and perception on climate change; increased daily temperature; reduced amount and duration of rainfall, increased incidence of disease; drying of wetlands and rivers and fluctuation of rainy season as the major findings. Consequently, the communities confronted with water shortage, heath problem, fuel wood shortage, loss of assets and shortage of food supply. The most common adaptation strategies were planting of seedlings, efficient use of fuel stove and water, agro-forestry practice awareness raising and soil and water conservation. Nevertheless, lack of up-to-date climate change related information, limited adaptation technologies, poverty and financial shortage can be considered as the major constraints of adaptation strategies of the people.

1. INTRODUCTION

There is a universal consensus that global warming is a real, rapidly advancing and widespread risk facing humanity this century. Scientists have presented evidence and tested models to verify this truly alarming fact (Huq, 2003 and Marye, 2011). Today, there is strong evidence and understanding that climate change is happening and it is recognized as being one of the greatest challenges of our time. These challenges cause the significant environmental, social and economic threats to all of mankind. According to NCCF, (2009), changes in climate are undoubtedly happening everywhere and it is affecting every communities. But how much the local people are aware of and perceive it determines how they formulate strategies to cope the short term changes and to adapt to the long-term changes.

Contemporary climate change is imposing a significant challenge to all communities by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters. In view of this fact, understanding, awareness and Perception about the cause, impacts and necessary adaptation mechanisms to cope up with climate change related impact is important for any population in a given community (Marye, 2011).

Climate change is commonly defined as a continuous change in the elements of climate system over periods of decades, regardless of cause (Houghton, 2001). The United Nations Framework Convention on Climate Change, UNFCCC, (2007) also defines it as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods. Since the world is rapidly urbanizing and majorities of the global population are concentrated in urban areas, they are familiar with climate change and its impacts. Climate change aggravates the existing urban environmental management challenges in cities. Additionally, it is the urban poor in the developing nations, who are often forced to reside near flood and landslide-prone areas, face other vulnerabilities and bear a disproportionate share of climate change risks (UCCRN, 2011).

Africa is the most vulnerable region to climate change, because of the low adaptive capacity of the population which is also a result of extreme poverty situation. The main impacts of climate change are on the water resource, food security, air temperature, agriculture, human health, natural resource and biodiversity management (Huq, 2003). Most of the atmospheric, weather and environmental changes that are being observed in Africa are potentially linked to climate change, or could be exacerbated by climate change in the future. However, people rarely perceive these changes as impacts of global climate change. Some people link changes in the weather to

their faith regardless of region. Particularly extreme weather events are often considered as punishment for human sin. Some people feel that there are other supernatural causes for extreme weather. A few, for example, speak of the sea as a goddess (Nigeria) or a mermaid (South Africa), whose anger can unleash flooding and destruction (UNFCCC, 2007).

As stated in NAPA (2007) Current climate variability and change is already imposing a significant challenge to Ethiopia by affecting food security, water and energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters. For example the impacts of past droughts such as that of the 1972/73, 1984 and 2002/03 are still fresh in the memories of many Ethiopians. Floods in 2006 caused substantial human life and property loss in many parts of the country. But, many people are unfamiliar with climate change, global warming and related terms.

Changes in climate are certainly happening everywhere, but how the community or people perceive it determines how they devise strategies to cope with the changes in the short run and adapt the long term changes. In many areas the outlook of communities about the ongoing Changes in climate, its causes and impacts is entirely different from what science has explained. Thus, due to lack of information, and appreciation of potential harm of projected climate change and misplaced belief, the subject climate change is not a priority issue for developing countries. Communities are not well aware of about climate change instead they understand only rainfall and warming system (Maddison, 2007)

In line with this Anthony Leiserowitz (2006) describes that large majorities of respondents had never heard of global warming in Indonesia, Nigeria, and Egypt. This lack of basic information and awareness on the problem has a wide range of implications including lack of political commitment and potentially greater long-term vulnerability when individuals and communities pass decisions about urban development, agricultural and water management, etc. Similarly, in the past or at present time there is a wide spread of traditional and cultural opinions and beliefs among the Ethiopian community for the causes, indicators and consequences of climate change. There are many communities who believed consequences of climate variability and Change such as floods, drought, famine and diseases are the acts of God/Allah against human sin (McKee, 2008, and Mesfin, 2012). Public perception to climate variability is a way by which we seek to understand climate variables and phenomena as well as its variability from time to time. Therefore, local community's perceptions and awareness play its own paramount roles. Adequate public awareness and perceptions help to arrive for good policies, strategies, and action plans to respond the economic and social impacts of climate variability at the local and national level (Palutikof, et al., 2004). In line with this, unless the concept of climate change, its impacts and adaptation measures are known and evaluated at the local level it would be difficult to convince and motivate local communities to enhance their adaptation measures.

Therefore, the main objective of this study was to evaluate the people's level of awareness and perception on the risks of climate change (mainly on rainfall and temperature variability) and challenges of their adaption strategies in the study area. Based on this general objective, the study addressed the following questions:

1. To what extent the people are currently aware and perceive climate change (mainly temperature and rainfall pattern) and its indicators?
2. What major risks of climate change are being experienced by the people?
3. What are the existing adaptation strategies being practiced by the people and stakeholders to cope up with the perceived climate change risks in the city?
4. Which major constraint factors are hindering the effectiveness of adaptation strategies of people and stakeholders in response to perceived climate change impact?

Since the study has identified the peoples level of awareness and perception on climate change, major risks of climate change and practical challenges related to the adaptation strategies of the people and stakeholders, it is significant for the concerned bodies to give due attention on these areas and it may contribute to rectify the gaps and enhance the capacity of people and stakeholders for the realization of effective climate change adaptation strategies in the study area and in the region. As far as research methodology is concerned, the study was undertaken using descriptive research type, survey method and mixed research approach. Relevant primary data was collected using questionnaire, interview, FGD and observation where as secondary data was collected by document and literature review.

2. Concepts of Climate Change

United Nations Framework on Climate Change Convention (2007), define climate change as a change in the elements of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods. Climate change is a reality; it has changed in the past, it is changing at the present, and it will change in the future. This is due to natural causes such as volcanic eruptions, ocean current, solar variations etc, and anthropogenic causes (human activities) such as the burning of fossil fuels as well as deforestation and various agricultural and industrial practices. But, the latest scientific evidence indicates that human activities are leading to increased accumulations

of greenhouse gases in the atmosphere, which are altering the Earth's climate patterns at unnatural rates (Burroughs, 2007 as cited in Marreye, 2011 and Thaddeus, 2011).

Many theories of climate change contend that human emissions of greenhouse gases (GHGs), principally carbon dioxide (CO2), methane, and nitrous oxide, are causing a catastrophic rise in global temperatures. GHGs gases in the atmosphere absorb the outgoing reflected or internal thermal radiation, resulting in Earth's atmosphere becoming warmer than it otherwise might be (IPCC, 2007). Regarding to urban heat islands**,** Cities tend to be warmer than suburbs, and suburbs warmer than rural areas, because they have greater concentrations of energy-producing machines and vehicles and large amounts of concrete, asphalt, and other building and road materials that absorb solar energy and then re-emit thermal energy (IPCC, 2007 and Pielke, 2009).

2.1 Awareness and Perception of People on Climate Change phenomena

Public awareness and perception to climate change is the means by which community seek to understand climate variability and change, its indicators, causes and other climatic phenomena in order to arrive at a more effective response for the consequences and risks. It is a process of perceiving the variability of temperature and precipitation and other elements or variables of climate. This leads to suggest a particular meaning and responses for the perceived variability of climate by individual's cognitive and affective domains. Therefore, it is a set of mental processes by which an individual become aware of and interprets information about climate variability and change to give certain response and feed back for the risks (Karen A., 2010). Local communities' awareness and perception level about the existing climate change condition is essential because their perception basically determine the socio-economic activities in their area. Successfully mitigating and adapting to climate change require changes in the behavior of billions of human being, who each day make individual choices that collectively have enormous impact on the earth's climate (Brechin, 200 cited in marreye,2011).

However, very little is known about international local community opinion regarding climate change including Ethiopia. For the few Ethiopians in urban areas even aware of human-caused climate change, global warming is inaccurately associated with their prior knowledge of ozone depletion. Regardless of people's awareness and understanding of climate change, Ethiopians recognize that their weather is changing and that these changes (such as unreliable and insufficient rainfall, dwindling water sources, failed harvests and dying livestock) are profoundly affecting their lives. They explain that the land simply cannot support them anymore. Moreover, most Ethiopians, regardless of their religion, feel that God alone has the power to change the weather (John and Sons, 2011). This literature indicates that understanding community's awareness and perception on the indicators of climate change is critical in order to address the economic, social and ecological risks of climate change.

2.2 Climate Change Impacts and Risks on the People

Literatures indicate that mainly cities of the developing countries are the major victims of climate change risks including extreme weather events such as drought, flooding, increased air temperatures, and shortage of water and public health problems. These climate change risks ultimately affect human well-being, ecological quality and the economy which are the threats to the livelihoods and assets of communities living in these cities. In addition, the most vulnerable social groups to these risks are the urban poor, the elderly and disabled, women, children, farmers, slum dwellers and communities residing on hill sides and near river banks (World Bank, 2011). Various theories also revealed that due to extreme weather events climate change is likely to increase the frequency and intensity of flood risks in cities in three ways. The first one is connected with precipitation changes, which bring rainfall more than historical records. Second, higher levels of the sea and storm flows will end up with coastal flooding. Finally, increased river flows due to glacial and snow melts may cause floods in urban areas (Satterthwaite, et al., 2007).

Urban heat waves and temperature increases may have several consequences on human life and urban economies. First of all, higher temperatures will increase energy demand for indoor cooling. These consequences would be harsher in hotter climate, where space cooling is already a major concern. Second, heat waves and temperature increases are likely to affect human health in terms of increased heat related diseases and health problems and of higher rates of summer mortality. Furthermore, higher temperatures and heat waves will contribute to water stress due to increased water consumption in warmer periods, and cause degradation of urban greenery and ecosystems (Hunt and Watkiss, 2007). Cities and their water catchment areas will get less precipitation. Hence, changes in precipitation regimes will bring about reductions in river flows and falling in groundwater tables. Secondly, high temperatures will increase the rate of evaporation, and thereby decrease water supplies. Besides, climate change will also bring reductions in water quality (Hunt and Watkiss, 2007).

Deterioration of air quality or increase in air pollution is another likely consequence of climate change. As concentrations of air pollutants, such as photochemical smog and ozone precursor biogenic volatile organic compounds (VOCs) are linked to level of temperatures, solar radiation and humidity, air pollution may increase during heat waves. Increased air pollution and reduced air quality are expected to bring about health problems like diseases related to respiratory system, such as asthma (Satterthwaite, et al., 2007).

Cities are home to over half of the worlds people and are at the fore-front of the climate change issue. Climate change exerts added stress on urban areas through increased numbers of heat waves threatening the health of the elderly, the infirm, and the very young; more frequent and intense droughts and inland floods compromising water supplies affecting inhabitants and essential infrastructure, property, and ecosystems (UCCRN, 2011). Likely, urban areas in Ethiopia entail a high vulnerability to the impacts of climate change due to their geographical location and topography and low adaptive capacity. In addition, rapid rate of urbanization which is attributed by rapid population growth and rural to urban migration and lack of affordable housing, has contributed for the development of informal settlements on marginal lands and near cities. Health problems of crowding and increased exposure to concentrated waste, unsustainable resource consumption and settlement on environmentally fragile land are major environmental impacts of such rapid urbanization (UNDP, 2004).

2.3 Adaptation Strategies to Climate Change

Climate change adaptation is the changes in processes, practices and structures to moderate the potential damages but to maximize the benefit from opportunities associated with climate change. Adapting involves taking the right measures and appropriate adjustments to reduce the negative effects of climate change and utilize the positive ones (UNFCCC, 2007). Therefore, the purpose of adaptation is reducing vulnerability of individuals, communities, regions and nations to climate variability and change and then promoting sustainable development (IPCC, 2001). Adaptation varies both spatially ranging from local to global and temporally such as short term (coping mechanisms) and long term (adaptive capacity) together with options and opportunities such as structural, technological and behavioral changes. Depending on its timing, goal and motive of its implementation, it involves various approaches and can serve various functions and take numerous forms (IPCC, 2007).

For the most climate change vulnerable groups such as cities of developing countries including Ethiopia, adaptation strategies are crucial and the priority. This is because of first; no matter how strong mitigation measures are a certain degree of climate variability is inevitable due to historical emissions. Second, while the effects of mitigation may take several decades, most adaptation activities take effect almost immediately. Third, adaptation also addresses the risks associated with climate changes in the future usually reduces risks linked with current climate variability. Fourth, such measures can be applied on a regional or local scale and their effectiveness is less dependent on actions of others (IPCC, 2001). Besides, because of their greater dependence on rainfall and natural resources and lower capacity for mitigation, failure to adapt could lead them into significant deprivation, social disruption, population displacement, increased disease and mortality (Downing, et al., 1997).

2.4 Constraints of Climate Change Adaptation Strategies

In the cities of developing nation, the implementation of climate change adaptation strategies by different actors are the subjects of several challenges. First, although the developing nations are more vulnerable to climate change, their governments do not give the policy and practical priority to the climate change issues rather to the existing economic growth issues. These policy constraints significantly challenge the existing adaptation strategies (IPCC, 2007). Second, the unavailability up-to-date and well organized data and climate change projections at a scale that is relevant to local urban communities is a serious challenge. This lack of information is also the result of limited convenience and helpfulness of climate models at the community level (OECD, 2009).

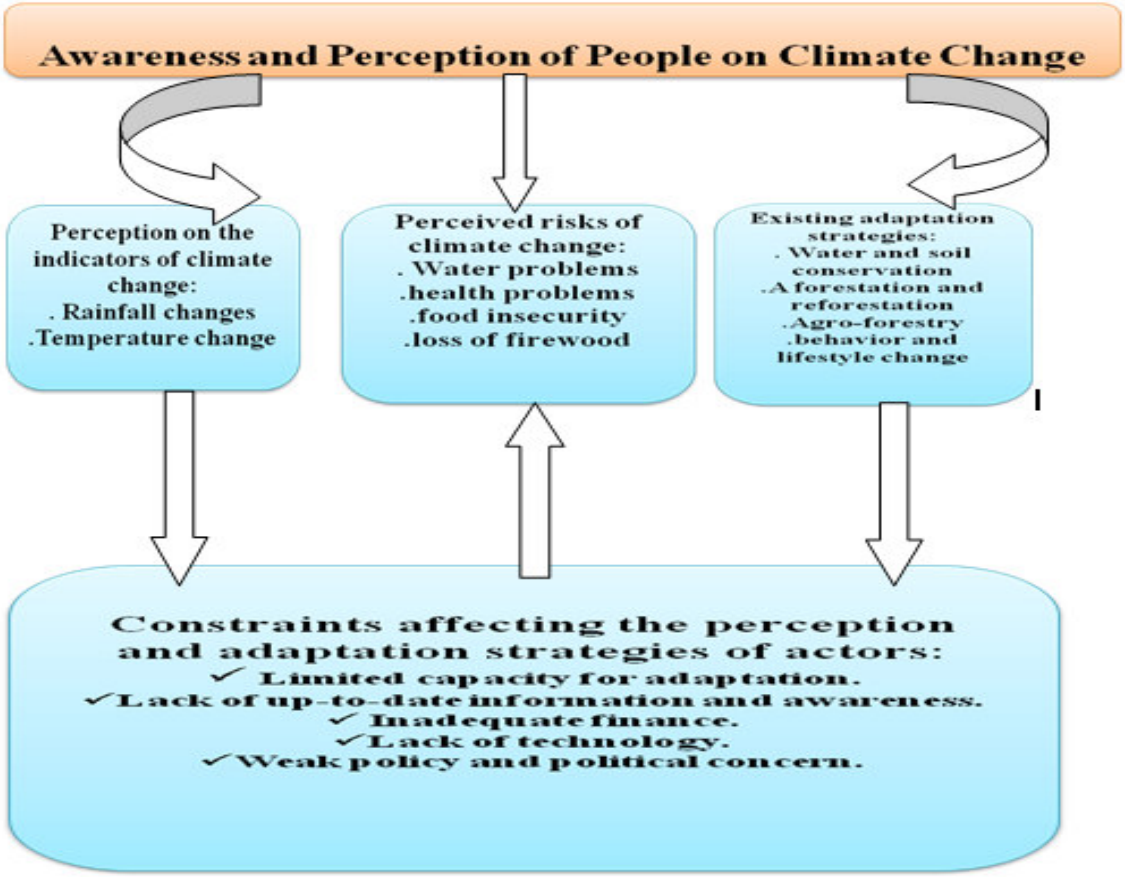
Third, although, adequate level of awareness about climate change risks is very important to help communities deal with current climate variability and change, lack of awareness on the urban communities, government authorities, policy makers and practitioners, educationalists and trainers represents a significant barrier to incorporate and effectively implement climate change considerations and adaptation strategies at all decision-making levels (OECD, 2009). Fourth, there are individuals and groups within any communities that have inadequate capacity to adapt to climate variability and change. The capacity to adapt is dynamic and determined by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology (IPCC, 2007).

Fifth, the development of new technologies to cope and adapt climate change and technology transfer to the developing countries is an important component of the UNFCCC. However, there are also potential technological limits as a constraint for adaptation response to climate change risks at shorter or longer periods (Adger,et al ,2007). Lastly, in the developing countries in particular, the implementation of adaptation measures faces a number of financial barriers. Individuals and communities at local and city level are greatly constrained by lack of adequate financial resources. More importantly people involved in the Agriculture sector often faced lack of adequate monetary resources which significantly hinder their adaptation measures such as irrigation systems, improved or new crop varieties, and diversification of farm operations (Adger,et al. (2007).

2.5 Conceptual Frame Work

Based on the above literature review, the following conceptual framework is prepared to evaluate people's awareness and perception level on climate change and challenges of their adaptation strategies.

Figure 2.1: Conceptual Frame Work of the study



Source: Researcher's own survey, (2016).

This conceptual framework or model depicts the relationship of concepts such as people's awareness and perception on climate change, adaptation measures and their constraints. Due to variability and change in rain fall and temperature pattern, people and households faced climate change related risks and consequences such as health impact, water scarcity, shortage of food supply and fuel wood. People and other actors choose various kinds of adaptation strategies depending on the capacity, information and assets they have such as soil and water conservation, planting of seedlings, reforestation, agro forestry and efficient use of water. But, the awareness, perception and adaptation measures of the people are determined by constraints such as by lack of capacity for adaptation, information and awareness about climate change, shortage of technology and finance, inadequate policy and political support etc. Hence, the intention of this research was to evaluate the level of people's awareness and perception on climate change phenomena, indicators and risks of climate change, current adaptation strategies and their constraints or challenges.

3. Results and Analysis

3.1 People's level of awareness and perception on climate change

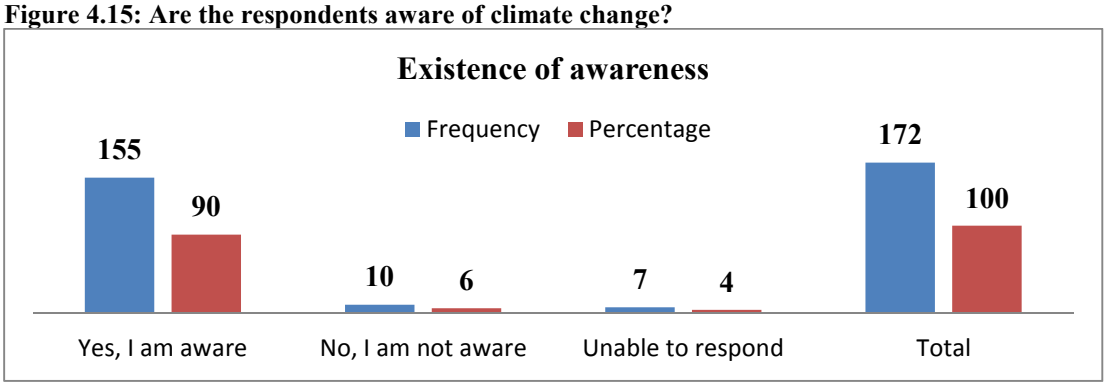
As indicated in the literature review part, the level of people's awareness and perception on climate change indicators, causes and risks is key determinant factor to effectively implement climate change adaptation strategies in urban areas. When the level of awareness and perception is lower, the effectiveness of climate change adaptation strategies would be greatly affected and challenged. Therefore, the people's awareness and perception on climate change issues and the challenges of adaptation strategies in Mekelle city are examined in the following sections.

3.1.1 People's level of awareness on the prevalence and indicators of climate change

People's level of awareness and perception is a set of mental processes by which an individual become aware of and interprets information about climate variability and change to give certain response and feed back for the risks (Karen A., 2010). Local communities' level of awareness and perception about the existing climate change condition is essential because their perception basically determine the socio-economic activities in their area. Successfully mitigating and adapting to climate change require changes in the behavior of billions of human being, who each day make individual choices that collectively have enormous impact on the earth's climate (Brechin, 200 cited in marreye, 2011). Therefore, taking this concept in mind, the first objective of this study is to evaluate the extent or level of people's awareness on the prevalence and indicators of climate change mainly temperature

and rainfall changes. The evaluation in the study area has been carried out and the responses and/or findings are presented and analyzed as follows:

Figure 4.15: Are the respondents aware of climate change?



Source Field survey, 2016

According to figure 4.15, out of 172 respondents about 90%, 6% and 4% respond Yes, I am aware, No; I am not aware and unable to respond respectively. This shows that 90 percent of the total respondents are aware of the issues of climate change. Therefore, majority of the respondents have awareness about climate change related issues in Mekelle city.

Table 4.8: Adequacy of people's awareness and awareness raising efforts

Level of Agreement	Questions and Responses			
	Adequacy of existing awareness level		Adequacy of existing Awareness raising measures	
	Frequency	Percentage	Frequency	Percentage
Strongly disagree	84	54	91	58.5
Disagree	45	29	54	35
Neutral	4	2.5	-	-
Agree	15	10	10	6.5
Strongly agree	7	4.5	-	-
Total	155	100	155	100

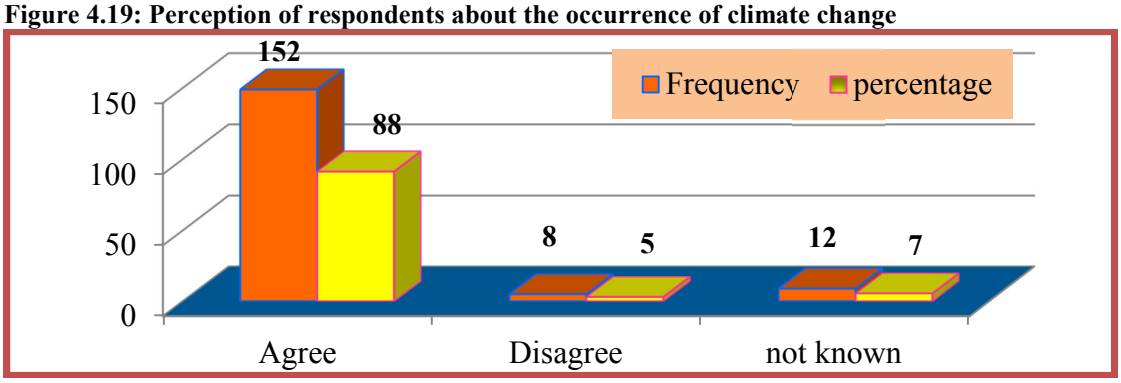
Source Field survey, 2016

As it is indicated on Table 4.8, out of 155 respondents who have awareness on climate change, 54% and 29% of the respondents replied strongly disagree and Disagree respectively for the adequacy of people's level of awareness. This implies that a total of 83 percent of the respondents do not agree on the adequacy of the people's existing level of awareness. The remaining respondents, 2.5%, 10% and 4.5% respond Neutral, Agree and strongly agree respectively on the adequacy of existing level of awareness which is much less than the disagreed response. With regard to the adequacy of existing awareness raising efforts out of the total 155 respondents 58.5% and 35% of the respondents respond strongly disagree and Disagree respectively. About 93.5% of the respondents do not agree on the adequacy of existing awareness raising measures. On the other hand 6.5% of the respondents indicate their agreement on the adequacy of existing awareness raising efforts which is much less than the cumulative response of strongly disagree and disagree.

Although, majority of the respondents in Mekelle city have awareness on climate change issues, they do not agree on the adequacy of existing level or extent of their awareness as well as on the adequacy of existing awareness raising efforts by Government agencies, NGOs, mass media, schools and community associations. Moreover, in Mekelle city the respondents' understanding about the concept of climate change shows great variation. The study indicates that 59.2 % of respondents cannot literally and satisfactorily explain what climate change mean, its causes, indicators and risks in scientific ways. Whereas 41.8% of them explain climate change as simple localized change only in the form of daily air temperature change. This demonstrates that in the study area there is inadequate level of awareness on the causes, indicators and risks of climate change which ultimately affects the effectiveness of climate change adaptation strategies.

3.1.2 Perception of the people on the occurrence of climate change

Figure 4.19: Perception of respondents about the occurrence of climate change



Source: Field survey, 2016

Regarding the occurrence of climate change and variability, the researcher raised a question for the respondents about their perception and occurrence of climate change in their city. Accordingly, Figure 4.19 reveals that 88% of the respondents agree that there is climate change in the city and 5% respondents disagree that the presence of climate changes in the city. On the other hand, 7% of respondents answer "I don't know" whether there is climate change or not in the town (see figure 4.19).

In order to support their replies with concrete occurrences in climatic characteristics, they were also asked the indicators of the climate change condition using both open ended and closed ended questions in the form of cross-check. It is clear from their responses presented on Table 4.9 that daily air temperature increase; reduction of rivers water volume; fluctuation of timing of rainy season, decreasing of duration of rainfall, drying up of wet land; increase in the incidences of disease as well as occurrence of flooding and runoff are considered as major indicators of climate change in the study area (See table 4.9 below).

Table 4.9: Respondents' perception towards indicators of climate change

No	Indicators of climate change	Frequency	Percentage
1.	Daily air temperature increase	150	98.6
2.	Reduction in the amount of rain fall	124	81.5
3.	Fluctuation in the timing of rainy season	132	86.8
4.	Decreasing of duration of rain fall	135	88.8
5.	Reduction in the amount of river water	143	84
6.	Drying up of wet lands	103	67.7
7.	Incidence of flooding and runoff	126	82.8
8.	Increase in the incidence of diseases	134	88.1
	Total	1047	678.3

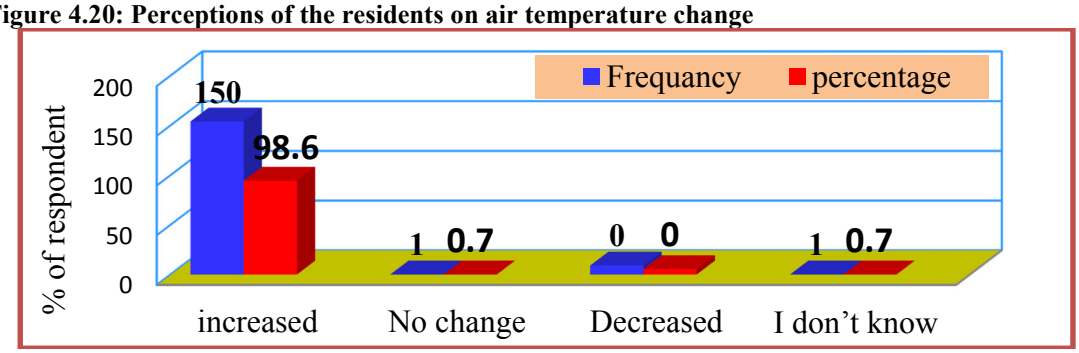
Source:-Field survey, 2016

***** The sum 1047 is greater than the sample size due to the fact that a single respondent could give more than one answer

4.4.2.1. Perception of the people on the change in air temperature

In the Focused Group Discussion (FGDs) all the participants including key informant and household respondents with single voice whispered that air temperature pattern of Mekelle city has changed over the last 25 years.

Figure 4.20: Perceptions of the residents on air temperature change



Source: Field survey, 2016

With regard to air temperature change, Figure 4.20 shows out of the total 152 household that have perception on climate change, nearly all of them (98.6%) perceive the air temperature has shown an increase whereas the remaining 0.7% perceives that there is No change and I don't know respectively. Moreover, those households (about 150) who perceived the increasing change of air temperature were asked to categorize the

changes they have perceived resulting from increase in air temperature over the past 25 years. Thus the following Table 4.9 indicates the perceived increasing changes and impacts acknowledged by the respondents as a result of increased temperature over time.

Table 4.10 indicate that, House roofs getting hotter (77%), feeling of tiresome (71%), increased body sweating (61.8%), increased feeling of thirsting (53.4%), and reduced growth of plants (48%), Unable to move around due to hotness (42%) Difficulty of sleeping at night hotness (48.1%), lowering of water amount (61.1%) and Lands are getting dried and cracked are some of the perceived impacts of temperature increase stated by the respondents. In addition, about 89% and 92% of FGD participants and key informant respectively also demonstrate drying up of rivers, increasing water demands, feeling of tiresome, Unable to move around due to hotness during a day and painful feelings are also indicators of increasing air temperature in the study area.

Table 4.10: The Perceived increase or change of air temperature over the past 25 years

No	Perceived impact	Frequency	Percent
1	Feeling of tiresome	93	71.0
2	House roofs getting hotter	101	77.1
3	Reduced growth of plants	64	48.9
4	Lowering of amount of water	80	61.1
5	Increased feeling of thirsting	70	53.4
6	Unable to move around due to hotness	55	42.0
7	Difficulty of sleeping at night hotness	63	48
8	Increased body sweating	81	61.8
9	Lands are getting dried and cracked	80	61.1

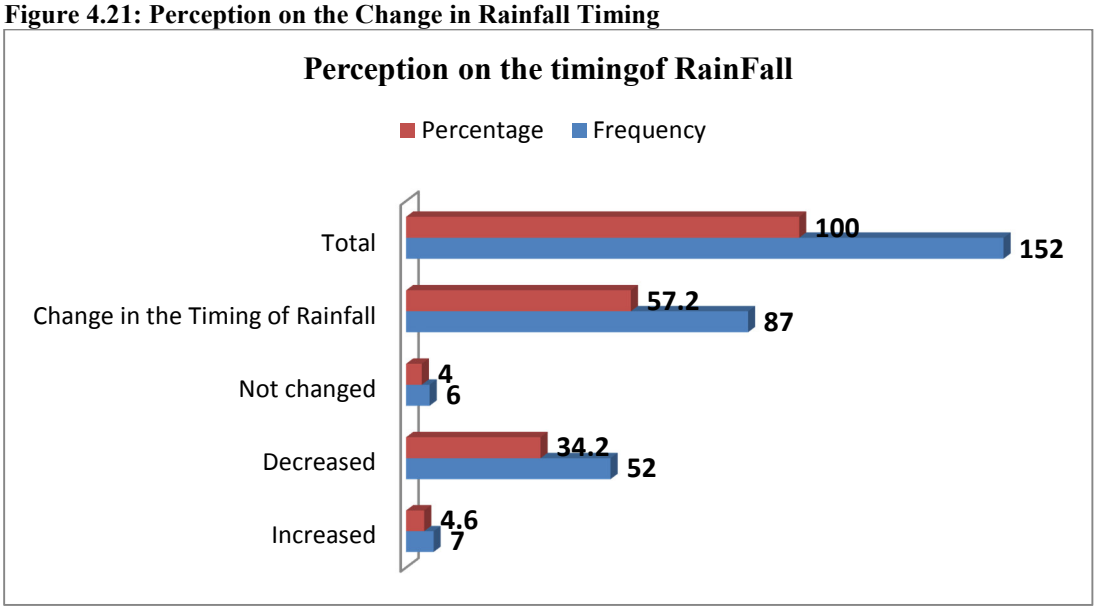
Source: Field survey, 2016

***** Here the sum is greater than the sample size because of the fact that a single respondent could offer more than one reply.

4.4.2.2. Perception of the people on the change in Rainfall Timing

Out of those respondents who have perception on the occurrence of climate change (88%), several of them directly or indirectly perceived changes in rainfall time, pattern and distribution in the study area over the past 25 years.

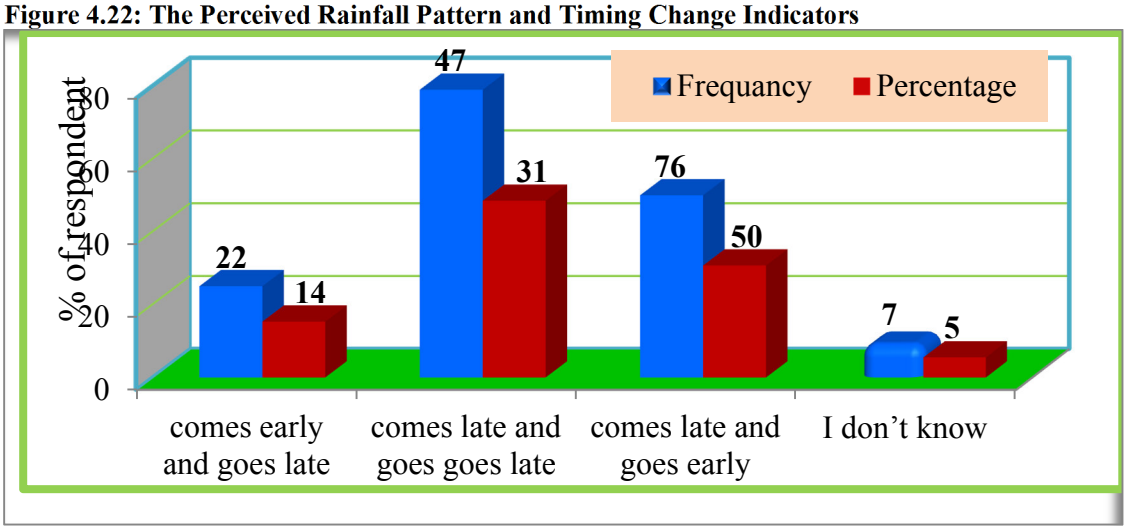
Figure 4.21: Perception on the Change in Rainfall Timing



Source: Field survey, 2016

As depicted in fig 4.21 the greater part of the respondents which is 57.2% made clear that there is a change in the timing of rains; 34.2 % of the respondents stated rain fall patterns in the area is decreased; whereas about 4.6% explained an increment in rainfall and lastly only 4% of the respondents perceived that there is no change in rain fall timing and pattern. Additionally, most of the Key informants, focus group discussion respondents and the researcher's personal observation also indicated a decreased rainfall amount and change in the timing of rainfall.

Figure 4.22: The Perceived Rainfall Pattern and Timing Change Indicators



Source: Field survey, 2016

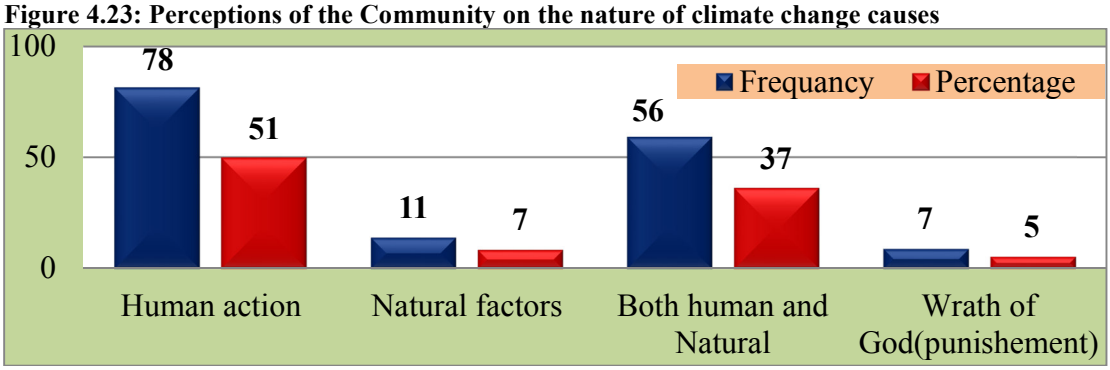
With regard to the perception of the community of the city about the indicators of changes in timing and pattern of rainfall over the last 25 years, Figure 4.22 indicate that for the 50% of the total 152 respondents rainfall starts very late, sometimes at the end of June and also goes early sometimes before August. Whereas, for 31% and 14% of the respondents rainfall comes and goes late and it comes early and goes late respectively.

According to the majority sample interviewees and FGD participants, 20-30 years ago the normal rainy season (kiremt season from June-August) in the study area started late and ended early. As a result, rainfall in the study area commonly started on mid June and ends toward the beginning of August. This finding indicates that the main rainfall or kiremt season of the study area is not only coming late but also lasting earlier. As a result the duration or time of normal rainy season is getting shorter due to climate change. Similarly, the data obtained from National Meteorology Agency indicated and witnessed the change in the timing of rainfall.

3.2 Climate Change Causes

The household respondents and interview and FGD participants indicated their perception regarding the nature of causes of climate change in the study area as follows:

Figure 4.23: Perceptions of the Community on the nature of climate change causes



Source: Field survey, 2016

According to Fig 4.23 which shows the respondents' perception on the causes for climate change, out of 152 respondents majority of them (51%) indicated that the major causes of climate change are the results of human actions. Besides, 37% of them indicated that the causes of climate change in the study area are both human and natural factors. The rest 7% of the respondents showed that natural factors are the main cause of climate change and 7% of them perceived that climate change is the punishment of God/Allah for human sins.

Similarly majority (91%) of the interviewees and FGD participants also indicated that in the study area the significant causes of climate change are dominantly the direct or indirect consequences of anthropogenic or human action related factors. They also listed down the major human activities which are affecting and causing the weather and climate change and variability in the study area. These causes include burning of fossil fuels, rapid growth of population pressure and associated over consumption of natural resources, deforestation of the vegetation covers for different purposes such as charcoal, construction and farm land in and around the study area and emissions from various vehicles and industries.

Likely, Mekelle city Agriculture and forest protection office report of 2014 indicated that due to the city's rapid urbanization and horizontal expansion, nearly 5.5 hectare of surrounding forests are cut down annually

mainly for the purpose of extracting charcoal, fire wood, for the construction of residential area and roads as well as expansion of farm lands the surrounding area. Haftom Girmay (2012), also indicated that the major sources of energy for about 72.1% of the residents of the city are forest products such as charcoal (45.35%) and firewood (26.75%) which became the major cause of deforestation in the study area. Therefore, actual size of the forest of the city remains to be only 3842 hectare.

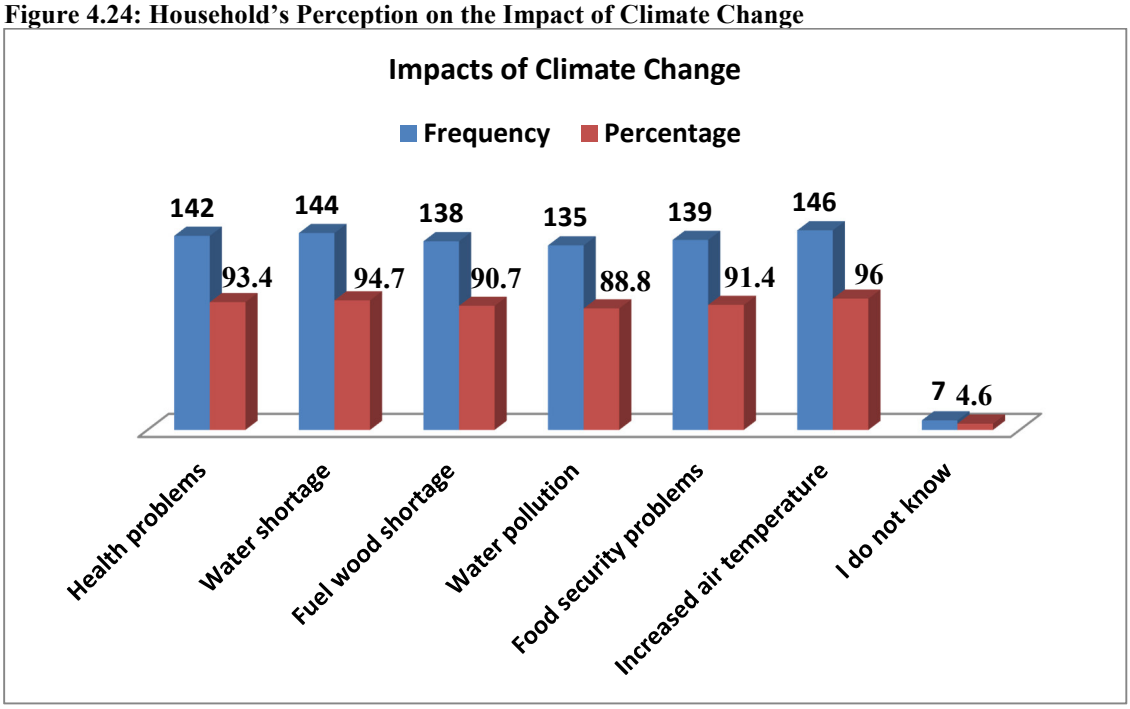
Plate4.1: Researcher's observation on deforestation of forests for farmland expansion and extraction of charcoal & fuel wood.

Source: Field survey and Observation, 2016

3.3 Impacts of Climate Change in the Study Area

Figure 4.24 reveals the perception of the community on the impacts of climate change based on the objective of the study which aimed to confirm the impact of climate change using the responses of Mekelle city community.

Figure 4.24: Household's Perception on the Impact of Climate Change



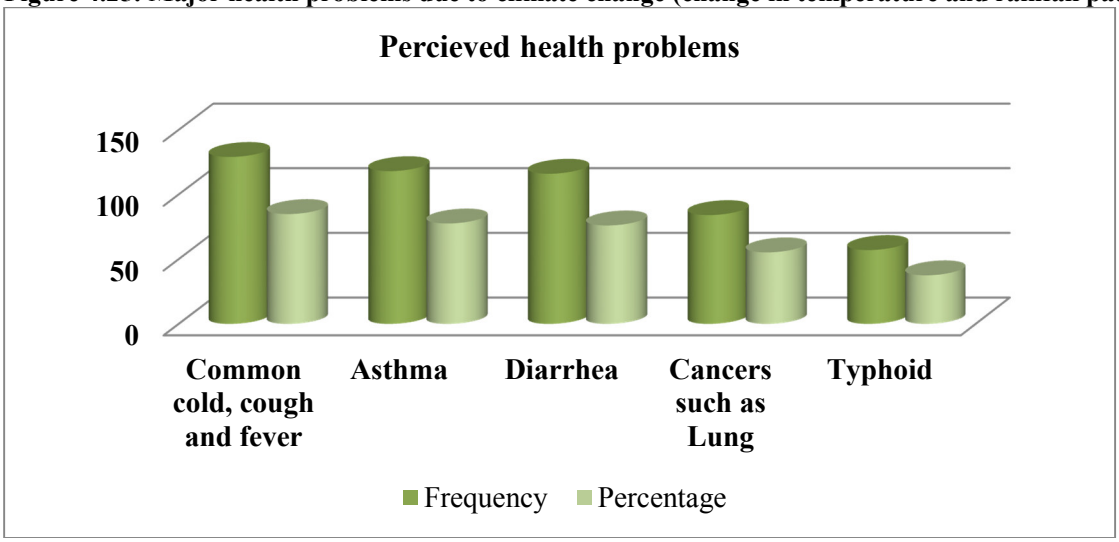
Source: Field survey, 2016

Figure 4.24 indicates the ranking of impacts of climate change perceived by those 152 household respondents in the study area. According to 96%, 94.7% and 93.4% of the respondents indicated, increased air temperature, shortage of water and health problems are ranked as the first, second and third negative impact of climate change in the area respectively. As per 91.4%, 90.7% and 88.8% of the respondents food security problems, shortage of fuel wood and water pollution are also the fourth, fifth and sixth impacts of climate change respectively. Finally, the result indicates about 4.6% of the respondents do not know the impacts of climate change.

In addition, the three problems such as air temperature increase, water shortage and various health problems are also indicated by the majority (about 84%) of interview and FGD participants as the dominant impacts climate change in the study area. The increased air temperature in the city of Mekelle is rapidly growing not only at day times but also at night and it is significantly affecting the health, clothing style and overall life style

of the community. Climate change in the area also resulted in the increasing shortage of water for household, Agricultural and industrial consumption. As a result the data obtained from health office of the Mekelle city also indicate that various health problems are growing in the study area such as respiratory disease, diarrhea, cancers and associated child and maternal mortality etc.

Figure 4.25: Major health problems due to climate change (change in temperature and rainfall pattern

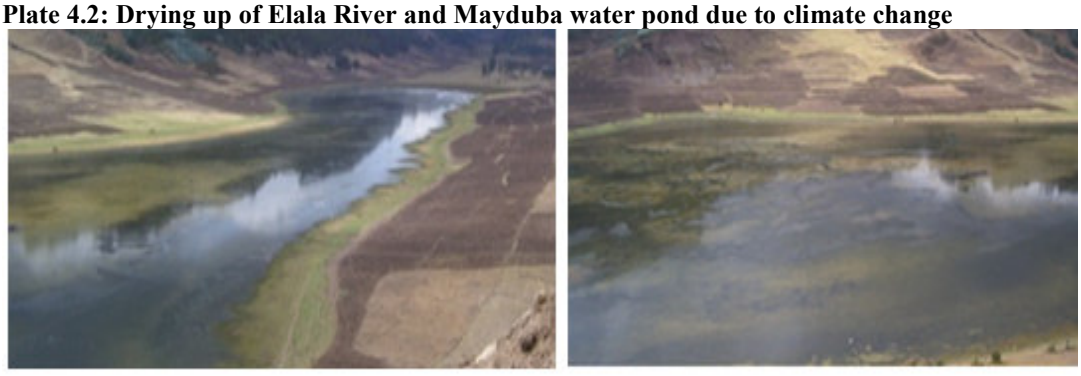


Source: Field survey, 2016

***** As a single respondent could give his/her response more than one times, the total sum of household respondents in this figure 4.25 is greater than the sample sizes that have awareness and perception on climate change i.e. 152.

Figure 4.25 above indicates the perceived health problems resulted from the climate change in their order or rank of seriousness. Therefore, out of 152 household respondents, about 84.8%,77.5% and 76% of the respondents showed that the first, second and third significant health problems in the study area are common cold, cough and fever; Asthma and Diarrhea respectively. Moreover, the fourth and fifth major health problems are also cancer such as Lung and Typhoid by the 55.2% and 37.5% of the respondents respectively. Similarly, the data obtained from majority of key informants and health office of Mekelle city indicate the dominant climate change induced health problems seen in the study area are those which are ranked from first up to third in the above figure 4.25. The frequent variation and fluctuation of air temperature and rainfall pattern are responsible for the occurrence of common cold, cough, fever Asthma and diarrhea diseases which are greatly affecting the more vulnerable social groups like children, women and the poor etc.

Plate 4.2: Drying up of Elala River and Mayduba water pond due to climate change



(A) diminishing Elala river (B) diminishing Mayduba water pond

Source: Researcher's Field observation, (2016).

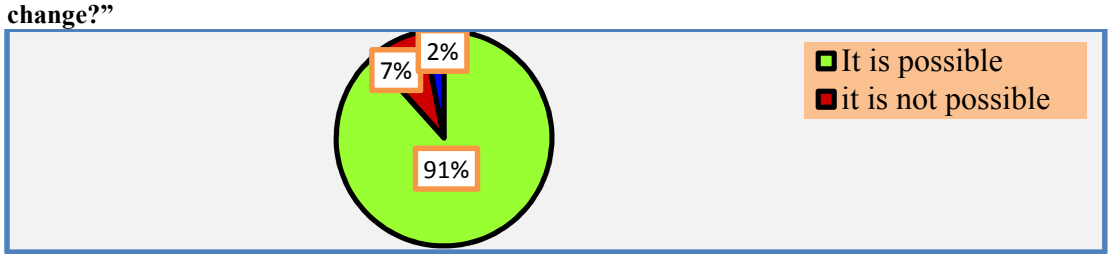
According to the data obtained from key informants the major natural sources of water for different Agricultural practices and domestic consumption in and around Mekelle city are Elala river and Mayduba water pond for very long period of time. As indicated on plate 4.2.both water sources and others are gradually diminishing in their size and volume of water due to humans actions and associated climate change mainly increasing air temperature, solar radiation, heat, reducing rainfall patterns as well as the siltation from urban runoff and flood which resulted in water scarcity. About 88% of the respondents also agreed that the water sources in the study area including these two are rapidly drying up and decreasing their water. Consequently, this reduction of water sources has significantly affected the water supply for Agricultural, industrial household consumption and

overall livelihood of the community.

3.4 Perception of the people on the adaptation strategies for the risks and impacts of climate change

As one of the objectives of this study is identifying the existing community's adaptation strategies practiced against the impacts of climate change and variability, the following findings showed there are main measures and strategies utilized by the communities to cope up or adapt the perceived climate change impacts and risks.

Figure 4.26: Perception of the community on "Is it possible to adapt or cope up the impacts of climate change?"



Source: Field survey, 2016

As it is revealed by Figure 4.26 out of 152 household respondents who have perception on the existence of climate change impacts, majority of them i.e. 91% said 'Yes, it is possible" for the question which aimed to determine whether it is possible to adapt climate change impacts or not. On the other hand the rest 7% and 2% of them replied that "It is not possible to adapt" and "Difficult to decide" respectively. The reason for about 79% of those respondents who said it is not possible to adapt climate change impacts is because the major causes of climate change are natural forces which are beyond the control of humans. For these people climate change and its impacts are the outcome of super natural power, God/Allah as a punishment for the sins or wrong doings of human beings. Likely, most of the key informants and FGD participants also believed that it is possible for the local community to adapt or cope up the existing climate change impacts using various measures.

3.4.1 The existing adaptation strategies of the people against the impacts of climate change

The following findings of the study are about the most common types of adaptation strategies utilized by the community against the risks or impacts of climate change.

Table 4.11: Adaptation strategies of the people against the impacts of climate change

Adaptation strategies	Frequency	Percentage
Catchment, soil and water conservation practices	133	96
Reforestation and rehabilitation of deforested areas	121	87.6
Planting of seedlings on hilly, streets & residential areas	130	94
Utilization of fuel efficient stoves and ovens	76	55
Urban flood risk management measures	46	33
Efficient use of water	83	60
Adjusting food, clothing, farming and other life styles	55	39.8
Agro-forestry practices	126	91

Source: Field survey, 2016

N: B The sum is greater than the total 138 respondents who believed that it is possible to adapt the existing climate change impacts because they were asked to freely indicate one or more adaptation strategies being employed in the study area.

Table 4.11 indicates that out of 138 household respondents who believed it is possible to adapt the existing impacts of climate change, the first three significant climate change adaptation strategies of the community in the study area are catchment, soil and water conservation practices; Planting of seedlings on hilly, streets and residential areas and Agro-forestry practices for 96%, 94% and 91% of the respondents respectively. In addition, the fourth, fifth and sixth important climate change adaptation strategies of the people in the study area for the 87.6%,60% and 55% of the respondents are Reforestation and rehabilitation of deforested areas; efficient use of water and Utilization of fuel efficient stoves and ovens respectively. Finally for 39.8% and 33% of household respondents the main climate change adaptation strategies being used by the people are Adjusting food, clothing, farming and other life styles and urban flood risk management measures respectively.

Similarly majority or about 83% of key informants and FGD participants also showed that the most dominant climate change adaptation measures of the community in the study area are soil and water conservation measures; planting of seedlings on hilly areas, streets and neighborhoods; Agro-forestry practices; Reforestation and rehabilitation of deforested areas and adjusting farming and life styles. According to the 2015 annual report of Mekelle city Agriculture and forest office indicated by Table 4.12 below, due to the reforestation, planting of new seedlings, water and soil conservation and Agro-forestry measures (such as Bee keeping and harvesting of grass), the forest cover of the city including the seven sub-cities is showing progress from 1747 hectare into 3842

hectare between 2011 and 2014.

Table 4.12: Forest cover of the city from 2011-2014

Year	Forest cover in hectare
2011	1747
2012	2903
2013	3617
2014	3842

Source: Mekelle city Agriculture and forest office, (2015).

As indicated by plate 4.3 below, the researcher has observed that the forest cover in one of the areas in Semen sub city indicated dramatic progress within about seven years because of the existing adaptation measures.

Plate 4.3: Researcher's observation on Forest cover change within 7 years from 2008-2015

Source: Field observation at Mesebo area (Semen sub-city), (2016).

Plate 4.4: Researcher's observation on water and soil conservation practices as climate change adaptation strategy

Source: Field observation, (2016) at Lachi area (Semen sub-city)

The researcher has observed that the people, government and other actors are implementing climate change adaptation measures such as soil and water conservation which has played a major contribution in the forest cover; water storage and protection of soil erosion (see plate 4.4).

Plate 4.5: Researcher's observation on Agro-forestry measures as climate change adaptation strategy

A. Grass and animal fodder harvest **B. Bee keeping by the community**

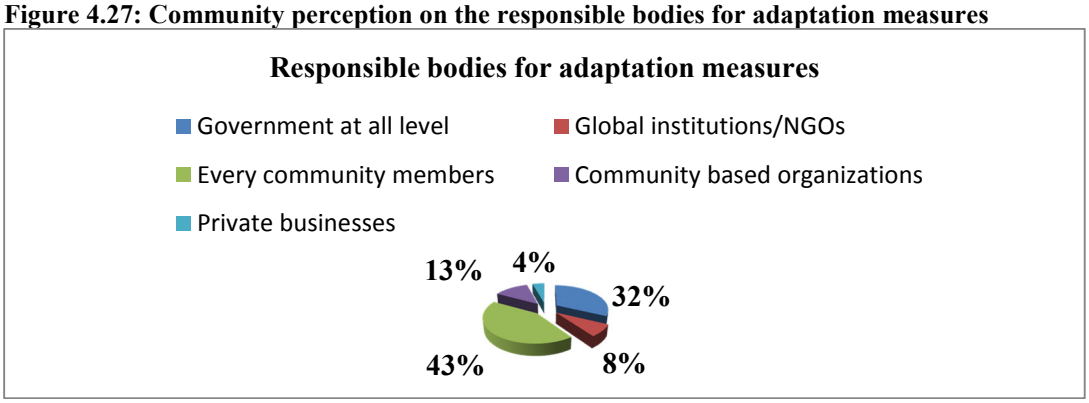
Source: Field observation, (2016).

Plate 4.5 also indicates the researcher's observation regarding the other significant climate change adaptation measure which is being employed in the study area. This adaptation measure is Agro-forestry which has a multi dimensional benefit such as protecting the soil loss, saving storm water, increasing the vegetation cover and creating source of employment and income mainly for the youth and females such as bee keeping and harvesting of grass or fodder.

3.4.2 Responsible bodies for climate change adaptation strategies

The following findings show the perception of household respondents about the responsible bodies of climate change adaptation strategies and measures in the study area.

Figure 4.27: Community perception on the responsible bodies for adaptation measures



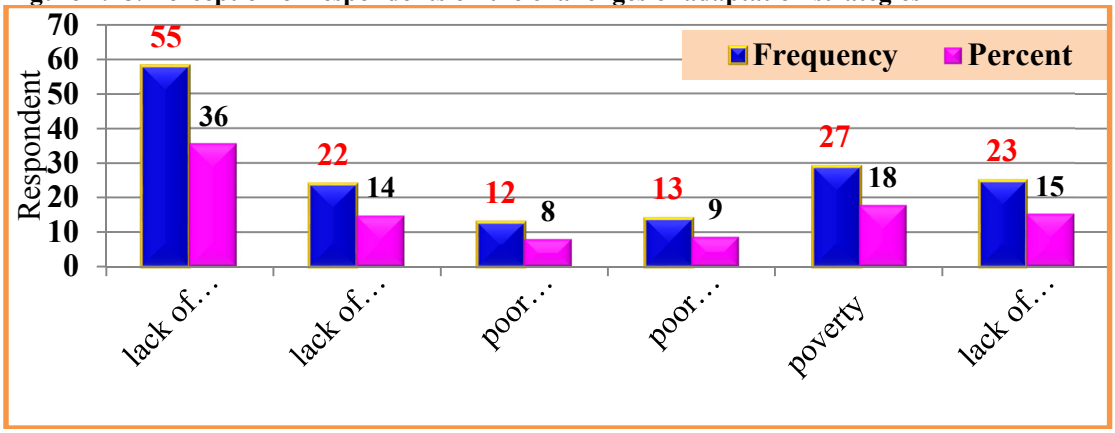
Source: Field survey, (2016).

According to Figure 4.27, out of 152 household respondents majority of them i.e. 43% of replied that the major responsible bodies to implement climate change adaptation measures in the study area are every community members of the city. 32% of the respondents also indicated that Government bodies from local to national level are the main responsible bodies for the implementation of climate change adaptation measures. Finally, 13%, 8% and 4% of the respondents showed that the responsible bodies for adaptation measures are community based organizations, global institutions/NGOs and private businesses respectively. Majority of key informants and FGD participants also believed that the responsibility of implementing climate change adaptation strategies primarily lie on every community members of the city and then on the government institutions at all levels. Although, every community members and government bodies are the major responsible bodies for most of the adaptation measures, integration and collaboration of all actors is very essential for the effective climate change adaptation strategies.

3.5 Challenges Affecting Climate Change Adaptation Strategies

In line with the last objective of the study, these findings focused on the perception of the respondents regarding the significant challenges or constraints that affect the effectiveness of implementation of existing climate change adaptation measures by the responsible bodies in the study area.

Figure 4.28: Perception of respondents on the challenges of adaptation strategies



Source: Field survey, 2016

On Figure 4.28, it is revealed that out of 152 household respondents, majority or 36% of them indicated that lack of information about meteorological data, climate change and better adaptation strategies is the primary and significant challenge of adaptation measures of the community and other actors in the study area. In addition, for the 18%, 15% and 14% of the respondents the challenges of climate change adaptation are poverty, lack of finance and lack of access to technology respectively. On the other hand for about 9% and 8% of household respondents poor administration and poor infrastructure provision respectively are the challenges of climate

change adaptation strategies in the study area.

Likely about 87% of key informants and FGD participants also confirmed that the major challenges of the existing climate change adaptation strategies in the study are lack of access to adequate and up to date information on the meteorological data, issues of climate change and its adaptation measures. They also indicated that as majority of the community members in the study area are poor, poverty and shortage of financial capacity are also the constraints that affect the implementation of adaptation measures by the people and other actors in the study area.

3.6 Conclusions

From the overall presentation, discussions, and analysis of the study, Community's awareness and perception about the cause and impacts of climate change issues as well as appropriate adaptation strategies are greatly necessary to cope up climate change related impact for any community mainly in the developing country cities such as Mekelle city. The level of awareness and perception also determines the level of implementation of climate change adaptation strategies by the community as well as other actors. The higher the level of awareness and perception of the people the better level of adaptation measures and the lesser the risks of climate changes impacts. Although, the local community and other bodies such as Government are implementing various climate change adaptation measures, their achievement and perceived outcomes are inadequate due to existence of various challenges. The significant challenges facing the community members and other actors in their efforts to implement climate change adaptation measures and strategies in the study area is lack of access to information which determines their level of awareness and perception on meteorological data, climate change issues and related adaptation mechanisms. The other constraints in the area include poverty, poor financial capacity, and inadequate infrastructure provisions and technology.

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