Climate Change Vulnerability and Impacts of Ethiopia

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Abstract: Climate change affects majority of the people in particular poor communities, because of their weak adaptive capacities. Droughts and higher variability of rainfall are a consequence of climate variability and change. The people of Ethiopia have been experiencing delay rainfall, droughts and flash floods by reason of climate change. In this paper an effort is made to study climate change vulnerability and impacts of Ethiopia using the method to analyzed the degree of exposure, sensitivity and adaptive capacity. CHIRPS Africa monthly, CORDEX rainfall gridded dataset and population projection of Ethiopia data are used. It is found that in general, eastern, pockets of western, north eastern, Rift Valley areas, south western, south eastern and southern parts of the country are highly likely to be most vulnerable. Climate change vulnerability and impact assessment studies presents the results and the lessons learned from the climate variability and change of Ethiopia.

Keywords: Climate Change, Exposure, Sensitivity, Adaptive Capacity and Vulnerability

1. Introduction

Ethiopia is located between 3°-15°N latitude and 33°- 48°E longitude. The country covers a land area of about 1.12 million km^2, occupying a significant portion of the Horn of Africa. Ethiopia is the most populous nation in Eastern Africa and the second-most populous in Africa.

The climate of Ethiopia is mainly controlled by the seasonal migration of the Inter Tropical Convergence Zone (ITCZ) and associated atmospheric circulations as well as by the complex topography of the country. It has a diversified climate ranging from semi-arid desert type in the lowlands to humid and warm (temperate) type in the southwest.

Mean annual rainfall distribution has maxima (>2000 mm) over the Southwestern high lands and minima (<300 mm) over the Southeastern and Northeastern lowlands. Mean annual temperature ranges from < 15°Cover the highlands to > 25°C in the lowlands. In terms of rainfall occurrence one can generally identify three seasons in Ethiopia namely; Bega: - dry season (October-January), Belg:- short rainy season (February-May) and Kiremt:- long rainy season (June-September).

The diverse of the land resource contribution has resulted in a number of mixed ecological conditions ranging from semi-desert to mountainous and different types of land use patterns. The major land use forms are grazing and browsing, cultivation and forests and woodlands. More than 50% of Ethiopia's land is utilized for grazing and browsing. It has to be noted here that grazing and browsing occurs in cultivated areas, in wood lands and forests, bush lands, shrub lands, grasslands, etc. Cultivation forms the second largest (nearly 23%) land use while forests and woodlands cover about 7% of the country. Over 16% are bare land, in the form of exposed rock, salt flats and sand. (First Communication of Ethiopia for Climate Change) Natural forests in Ethiopia are believed to have once covered 40% of the country's land area. Estimates of the 1994 Ethiopian Forestry Action Plan indicate that the closed natural forests have been reduced to 2.7% of the country and these are found mainly in the south western highlands. The annual loss of natural forest cover is estimated to be in the range of 150,000 to 200,000 hectares.

This study to assess the implications of climate change in all spectrum of the Ethiopian community livelihoods in the entire Ethiopia. It seeks to compile some of the perceptions and experiences of local communities and individuals who are on the frontlines of climate change. The definition used by the Intergovernmental Panel on Climate Change's (IPCC), climate-related vulnerability is understood in terms of climate change exposure, sensitivity, and adaptive capacity (IPCC, 2001).

2. Data, Tools and Methodology

This climate change vulnerability and impact assessment studies presents the results and the lesson learned from climate variability and change of Ethiopia in general. The monthly precipitation CHIRPS Africa monthly gridded dataset used in this study is obtained from Climate Hazard Group (CHG). The gridded dataset has a 0.05 X 0.05-degree spatial resolution having records from 1984 to 2014 and for climate change scenario used

CORDEX data. Population projection of Ethiopia for all regions is acquired from Federal Democratic Republic of Ethiopia Central Statistics Agency.

Exposure is defined by the magnitude, character and rate of climate change in a given geographical area. Sensitivity to climate change is the degree to which a community is adversely or beneficially affected by climate-related stimuli. For the purposes of this analysis, sensitivity largely depends on the main livelihood activities practiced in a community (including its dependence on rain-fed agriculture and livestock), including the specific natural, physical, financial, human and social resources needed to carry out these activities, as well as the impacts of climate hazards on these key livelihood resources. The adaptive capacity of a community is its ability to adjust to climate change, to moderate or cope with the impacts, and to take advantage of the opportunities that may arise with climate change. It is understood in terms of some basic socio-economic factors or determinants (income, access to resources and services, literacy, etc.), a community's past and current strategies for coping with climate stress, whether these strategies are feasible in the face of future climate change, possible strategies to prepare for and cope with future changes, as well as the different enabling conditions and barriers to adaptation.

3. Discussion

3.1. Climatology of Ethiopia

The climate of the country varies from humid to arid zones. Mean annual rainfall distribution over the country is characterized by large spatial variation which ranges from about 2000 mm over some pocket areas in the Southwest to less than 250 mm over the Northeast and Southeast low lands (Figure 1). Rainfall during a year occurs in different seasons. Unlike most of the tropics where two seasons are common (one wet season and one dry season), three seasons are known in Ethiopia, namely Bega (dry season) which extends from October-January (Figure 2), Belg (short rain season) which extends from February-May (Figure 3), and Kiremt (long rain season) which extends from June-September (Figure 4).

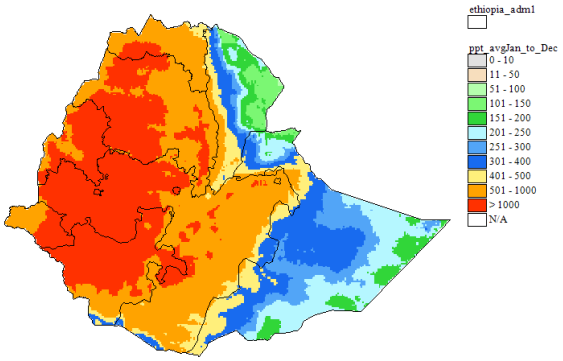

Figure 1. Total annual (January-December) rainfall (mm) distribution over Ethiopia

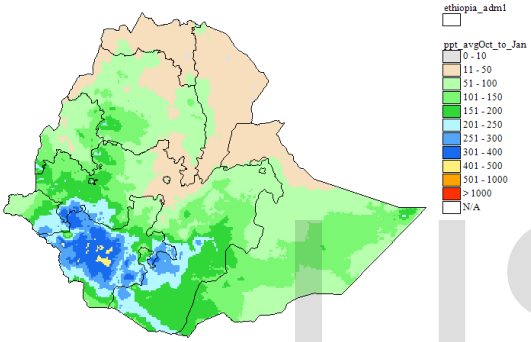

Figure 2. Total Bega (October-January) rainfall (mm) distribution over Ethiopia

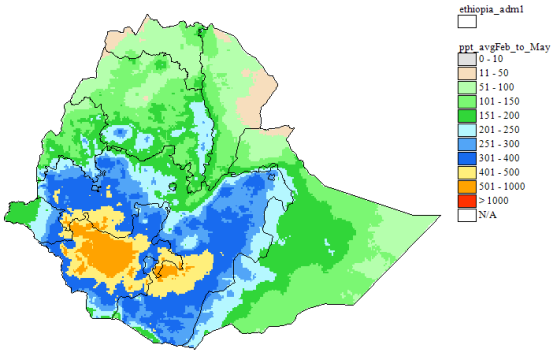

Figure 3. Total Belg (February – May) rainfall (mm) distribution over Ethiopia

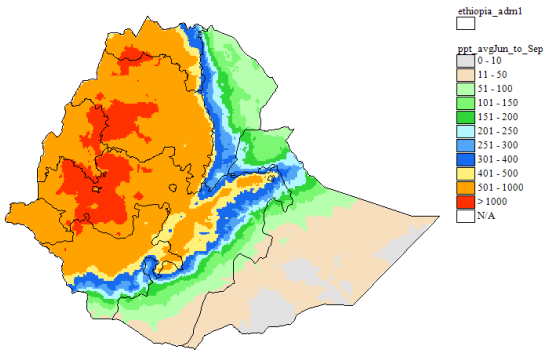

Figure 4. Total Kiremt (June-September) rainfall (mm) distribution over Ethiopia

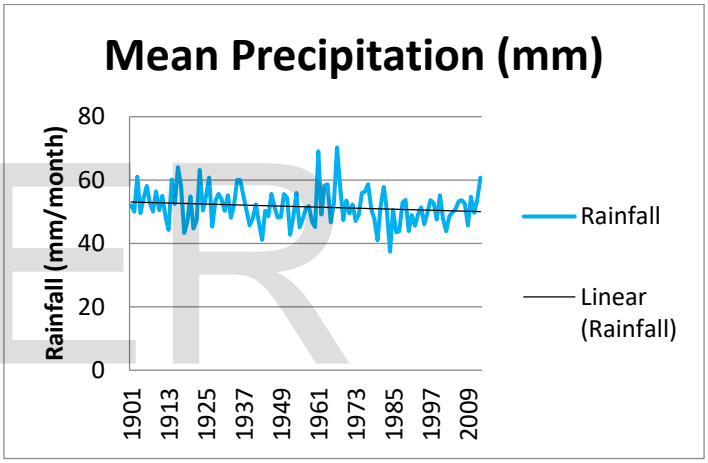

Figure 5. Ethiopian annual cycle of Rainfall (mm), 1901-2011)

Temperatures are also very much modified by the varied altitude of the country. In general, the country experiences mild temperatures for its tropical latitude because of topography. Mean annual temperature distribution over the country varies from about 10^0C over the highlands of northwest,

central and southeast to about 35^{0}C over north-eastern lowlands (Figure 6 and 7).

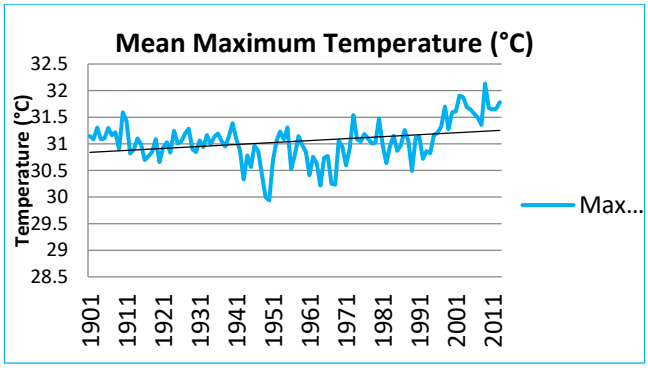

Figure 6. Ethiopian annual cycle of mean maximum temperature (^{0}C), 1901-2011

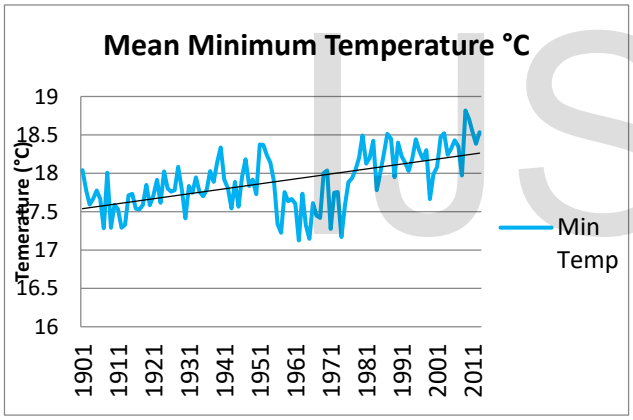

Figure 7. Ethiopian annual cycle of mean minimum temperature (^{0}C), 1901-2011

3.2 Analysis of climate change vulnerability

The purposes of this analysis, vulnerability is understood in terms of climate change exposure, sensitivity, and adaptive capacity. Each of these components of vulnerability consist of a series of indicative conditions (e.g. livelihood characteristics, socio-economic status), trends (e.g. observed changes in climate, environment, society), and experiences (e.g. impacts of hazards on livelihoods, coping strategies). Understanding these components of vulnerability relies on a combination of quantitative and qualitative information, which allows for a more nuanced and dynamic understanding of vulnerability.

3.2.1 Exposure to climate variability and change

Climate change exposure is defined by the magnitude, character and rate of climate change in a certain geographic area. The long-term and/or continuous meteorological records in many parts of the developing world, as well as the lack of scientific projections at more localized scales, scientific information (summarized and presented later in this section) in is often insufficient for analyzing local exposure to climate change. As a result, scientific information must build upon and be complemented by an analysis of local-level climate observations through consultations with communities and other local actors who are on the frontlines of climate change.

3.2.2 Climate- related hazards and impacts in Ethiopia

The main climate-related hazard affecting Ethiopian communities in most of regions are drought and flood. In the country, when asked to rank the main (climatic and non-climatic) hazards affecting their livelihoods, ranked drought has the main hazard all community groups The other hazards mentioned included flood that follow comes mentioned as one of the main hazards human diseases (mostly malaria).

3.2.3 Climate change projections

According to the UNDP Climate Change Country Profile for Ethiopia, the mean annual temperature is projected to increase by 1.1 to 3.1°C by the 2060s and by 1.5 to 5.1 °C by the 2090s. It is also projected that the mean annual minimum and maximum temperature there will be a substantial increase by 1.0 to 4.0°C by the 2100s (Figure 8&9)as well as in the frequency of days and nights that are considered 'hot' in the current climate, and a decrease in the frequency of days and nights that are currently considered 'cold'. It is projected that 'hot' days will occur on 19-40% of days by the 2060s and 26-69% of days by the 2090s. The number of 'hot' days and nights will increase most rapidly in the months of July to September. Cold nights will decrease in frequency more rapidly than cold days, and are projected by most models to not occur at all by the 2090s (McSweeney et al., 2008).

Mean annual rainfall in Ethiopia is projected to show slight increase (Figure 6), mainly as a result of increasing rainfall in the short rainy season (October to December) in southern Ethiopia. Projected changes in the April to June and July to September rainy seasons, which affect larger portions of Ethiopia, are more mixed but tend towards small increases in the south (especially in the south-west) and decreases in the north-east parts of the nation. It is also projected that the proportion of rainfall that falls in heavy precipitation events will increase throughout the country, especially during the July to September and October to December rainfall (McSweeney et al., 2008).

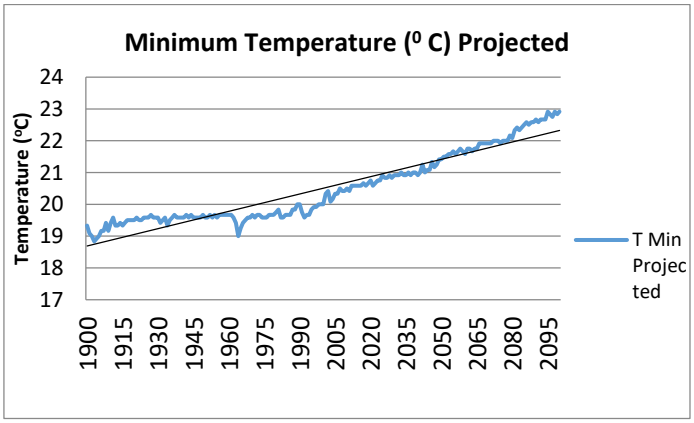

Figure 8. Ethiopian mean minimum temperatureprojection (^{0}C), 1900-2100

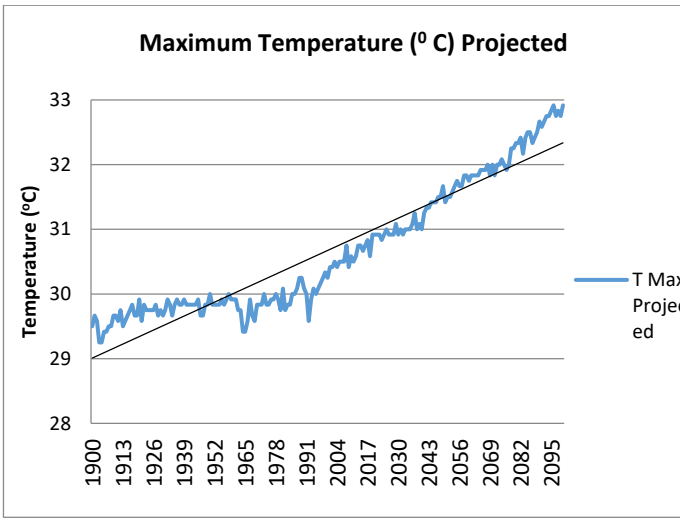

Figure 9. Ethiopian mean maximum temperature projection (^{0}C), 1900-2100

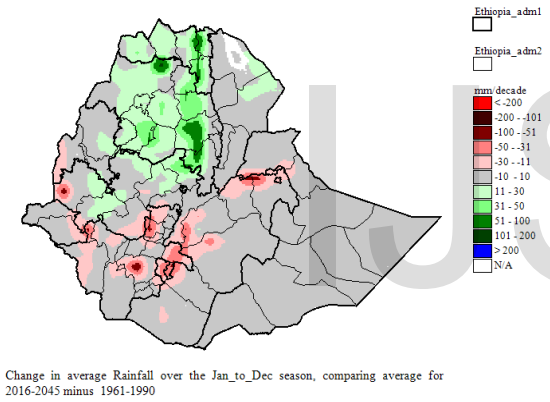

Figure 10. RCP 2.6 Scenario

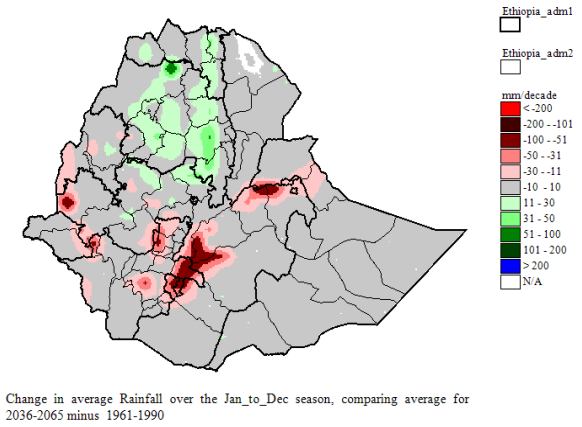

Figure 11. RCP 4.5 Scenario

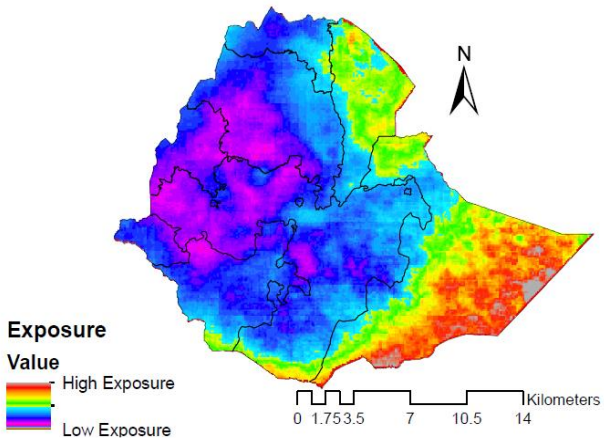

Figure 12. Exposure vulnerability (Rainfall)

3.3 Sensitivity to climate change

Sensitivity to climate change is the degree to which a community is adversely or beneficially affected by climate-related stimuli. It largely depends on the main livelihood activities of the community (including its dependence on crop and rain-fed agriculture), its key livelihood resources, and the impacts of climate hazards on these key resources.

3.3.1 Sensitivity of main livelihood activities

Agriculture (crop & livestock), water availability, Health (human & animals) and Hydro power energy are considered to be highly climate-sensitive sectors. Agricultural systems are impacted by changes in rainfall patterns, extreme events, ecology of pests and diseases and temperature. Vulnerability to these changes varies with time, geographic location, and economic, social, and environmental conditions. Climate change impacts on the above-mentioned sectors are

therefore highly region, social and economic, determining whether they result in net benefits or losses. In countries like Ethiopia, however, where dry land pastoralist and rain-fed agriculture predominate, the productivity of many livestock, pasture and crop species, which are already near their maximum temperature and drought tolerance, is expected to decrease, even with minimal increases in temperature (IPCC, 2001).

3.3.2 Impacts of climate hazards

Drought in Ethiopia tends to have severe environmental, economic and social impacts. It aggravates environmental degradation through ecosystem and climatic effects, including deforestation, livestock overgrazing, soil erosion, wild land fires, biodiversity loss and water pollution. Social effects include reduced potable water supplies with negative health and sanitation consequences, especially for vulnerable groups, a higher burden on women who collect water for household consumption and migration pressures. Droughts can also have adverse effects on disease prevalence. For example; in the 1984/85 drought Ethiopia experienced a severe outbreak of cholera as well as high cases of epidemics both in urban and rural areas.

Flash and seasonal river floods are becoming increasingly common in Ethiopia due to a number of human-induced causes such as land degradation, deforestation, increased population density, ` the lives of hundreds of people, displaced hundreds of thousands and destroyed physical, natural and economic assets.

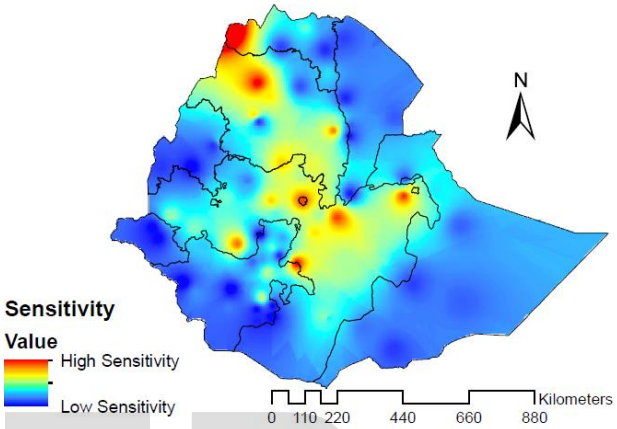

Figure 13. Sensitivity vulnerability (population density)

3.4 Adaptive capacity

The adaptive capacity of a community is its ability to adjust to climate change, to moderate or cope with the impacts, and to take advantage of the opportunities. Adaptive capacity is often a determined by a range of factors, processes and structures such as income, literacy, institutional capacity, social networks, as well as access to information, markets, technology, and services, (IPCC 2007). Because the availability of these resources and services is limited in many developing countries, their adaptive capacity in the face of climate change is

correspondingly low compared to developed countries.

Communities in Ethiopia are already undertaking activities to cope with drought and flood as well as other climate-related hazards (i.e. land slide, disease and pest outbreaks and land degradation). An assessment of current local coping strategies, as well as their effectiveness and sustainability, can give us an insight on local adaptive capacity.

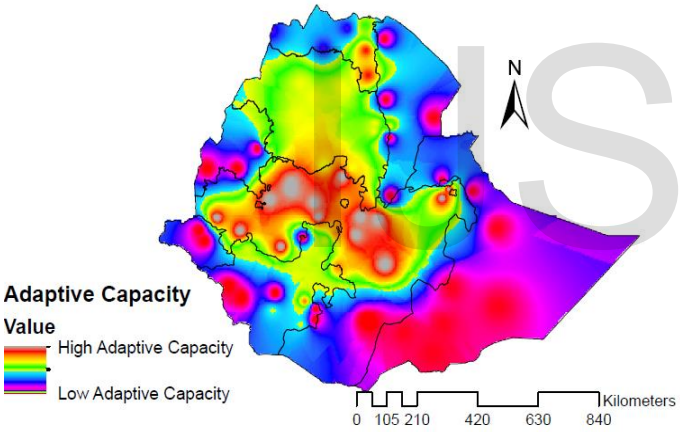

Figure 14. Adaptive Capacity vulnerability (Level of Literacy)

3.5 Vulnerability assessment associated with major hazards

Drought is not necessarily a disaster by itself (rather a natural phenomenon or hazard), in the Ethiopian context, drought hazard is more or less synonymous with disaster. The country's vulnerability to drought and other natural hazards is due to the dependence on rain-fed agriculture, under-development of water resources, land degradation, low economic development, weak institutions and rapid population growth (ISDR/WB, 2009). In Ethiopia, minor climatic variations or other adverse factors can trigger acute food security, which can easily escalate to full scale disaster. In recent years, 1973-74, 198485, 1999-2000, 2001-2002, 2005-2006, and2015-2016a significant amount of population was affected by drought related disasters.

Different factors contribute for the vulnerability of Ethiopia to floods. Primarily, its rugged topography and steep slopes aggravate floods. The highlands are extensively deforested; rains are sometimes heavy and torrential; water converges in river basins and causes swelling of rivers. The watersheds of the major rivers are highly degraded with negligible vegetation cover, reducing infiltration into the ground and increasing runoff.

Analysis of vulnerability assessment based on levels of exposure, sensitivity and adaptive capacity presented levels of vulnerability experience in Ethiopia as described in Figure 13 to 15. The overall hazards vulnerability map (figure 15) shows that eastern, pockets of western, north eastern, Rift Valley areas, south western, south eastern and southern parts of

the country are highly likely to be most vulnerable.

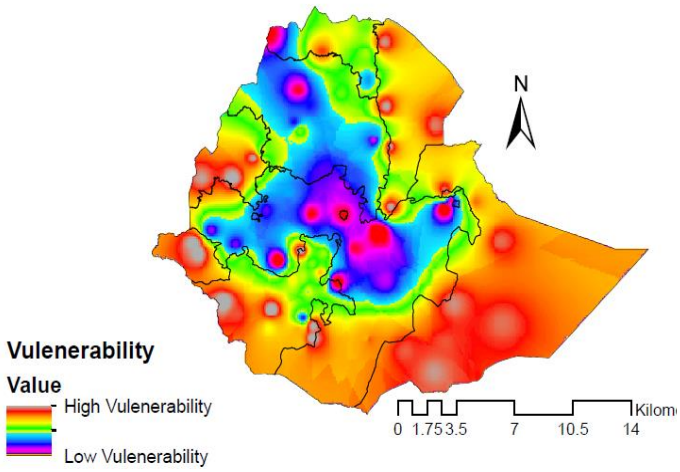

Figure 15. Overall Vulnerability

4. Conclusion:

Analysis of vulnerability assessment based on levels of exposure, sensitivity and adaptive capacity presented levels of vulnerability experience hence, eastern, pockets of western, north eastern, Rift Valley areas, south western, south eastern and southern parts of Ethiopia are highly likely to be most vulnerable.

Such kind of climate change vulnerability assessment study can contribute to enhanced adaptive capacity and has a positive impact on those livelihood countries resources endangered by climatic risks.

References

[1] Central Statistical Agency (CSA), 2008: Summary and statistical report of the 2007 population and housing census.

[2] Cordaid and FSS, 2009: Assessment of climate change-induced hazards, impacts and responses in the southern lowlands of Ethiopia.

[3] Ethiopian NAPA, 2007: Climate Change National Adaptation Program of Action.

[4] IPCC, 2007, Africa, Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L, Parry, O.F, Canziani, J.P, Palutikof, P.J., van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

[5] McSweeney, C., New, M., and Lizcano, G. 2008: UNDP, Climate Change Country.

[6] SCUK and DPPA, 2008: Livelihoods and Vulnerabilities – An Understanding of Livelihoods in Somali Regional State, Ethiopia, SCUK and Disaster, Prevention and Preparedness Agency, Addis Ababa, Ethiopia.

[7] FEDRE, (2013): National Policy and Strategy on Disaster Risk Management Policy.

[8] Disaster Risk Management Strategic Program and Investment Framework (DRM-SPIF), (2013): DRMFSS.

[9] IGAD, (2007): Disaster Risk Management Training Manual. December 2007.

[10] International Federation of Red Cross and Red Crescent Societies, (2013): Ethiopia,

Country Case Study Report, How Law and Regulation Supports Disaster Risk Reduction.

[11] Mulugeta Abebe, (2010): Disaster Management in Ethiopia, A Review of Its Checkered History, Its Transformation and Some Implications for a Vibrant Disaster Management System, 1975-2008. Journal of Sustainable Development in Africa. Vol. 12; No. 4. Clarion, University of Pennsylvania, Clarion, Pennsylvania.

[12] Korecha, D., and Barnston, A. G., 2007: Predictability ofJune–September Rainfall in Ethiopia. Mon.WeatherRev., 135,625-650.

[13] Kassa Fekadu, 2015: 4(3): 112-119 Published online June 3, 2015) doi: 0.11648/j.earth.20150403.14ISSN: 2328-5974 (Print); ISSN: 2328-5982.