Vulnerability to the Changing Climate and the Quest for Resilience Capacities: Agro-Ecology Based Analysis in Southern Ethiopia

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Introduction

Climate change is one of the most commanding environmental challenges facing the world today (IAEA, 2015). The recent IPCC report suggests that climate change impacts are real and people experience it differently (IPCC, 2014). Global Climate Risk Index 2015 issued that "*Between 1995 and 2014, more than 525 000 people died worldwide and losses of more than USD 2.97 trillion (in PPP) were incurred as a direct result of over 15 000 extreme weather events*." (Kreft et al., 2016, p. 5). For example, a projected impacts of a 3°C to 4°C temperature increase will result adverse effects (e.g., severe drought and major floods) and increase stress, both to humans and ecosystems in many places (IPCC, 2014).

Following the 2011 crisis in Africa, one of the major concerns among academicians, development practitioners, and policy makers is how to build the resilience capacities of different groups at different levels in integrated ways to withstand the unpredictable hazards. For example, the 2015 or 2016 El Niño induced drought has put Ethiopia back into the spotlight with the 1980s famines being revived in the collective memories of the world media and remain the worst drought in its modern history, putting about 15 million people in precarious food insecurity (FAO, 2016). Hence, the recurrent drought and high level vulnerability to climate change impacts are due to Ethiopia's reliance on climate sensitive sectors for livelihoods, widespread environmental degradation, and very limited adaptive capacity.

Nevertheless, detailed empirical evidences that spell out the type of shocks households are vulnerable to, the context within which they operate, capacities that help households to adapt, absorb, and transform when shocks continue are not well documented. Resilience being an emerging research agenda, much of the existing knowledge is more of conceptual and theoretical debates. Therefore, the general objective of the study is to estimate households' vulnerability conditions to a changing climate and search for the resilience capacities (adaptive, absorptive, and transformative) with agro-ecological perspectives in Southern Ethiopia. Specifically, the study seeks:

1. To characterize major climate induced shocks and analyze trends of such shocks over decades in each agro-ecological Zone;
2. To analyze the historical trends of changes in climatic conditions using temperature and rainfall data and link with farmers' perception towards changes in the study area;
3. To estimate households' vulnerability situations to the changing climate in each agro-ecological Zone;
4. To measure households' adaptive, absorptive, and transformative (*resilience capacities*) to the climate induced shocks and factors that affect households level of resilience.

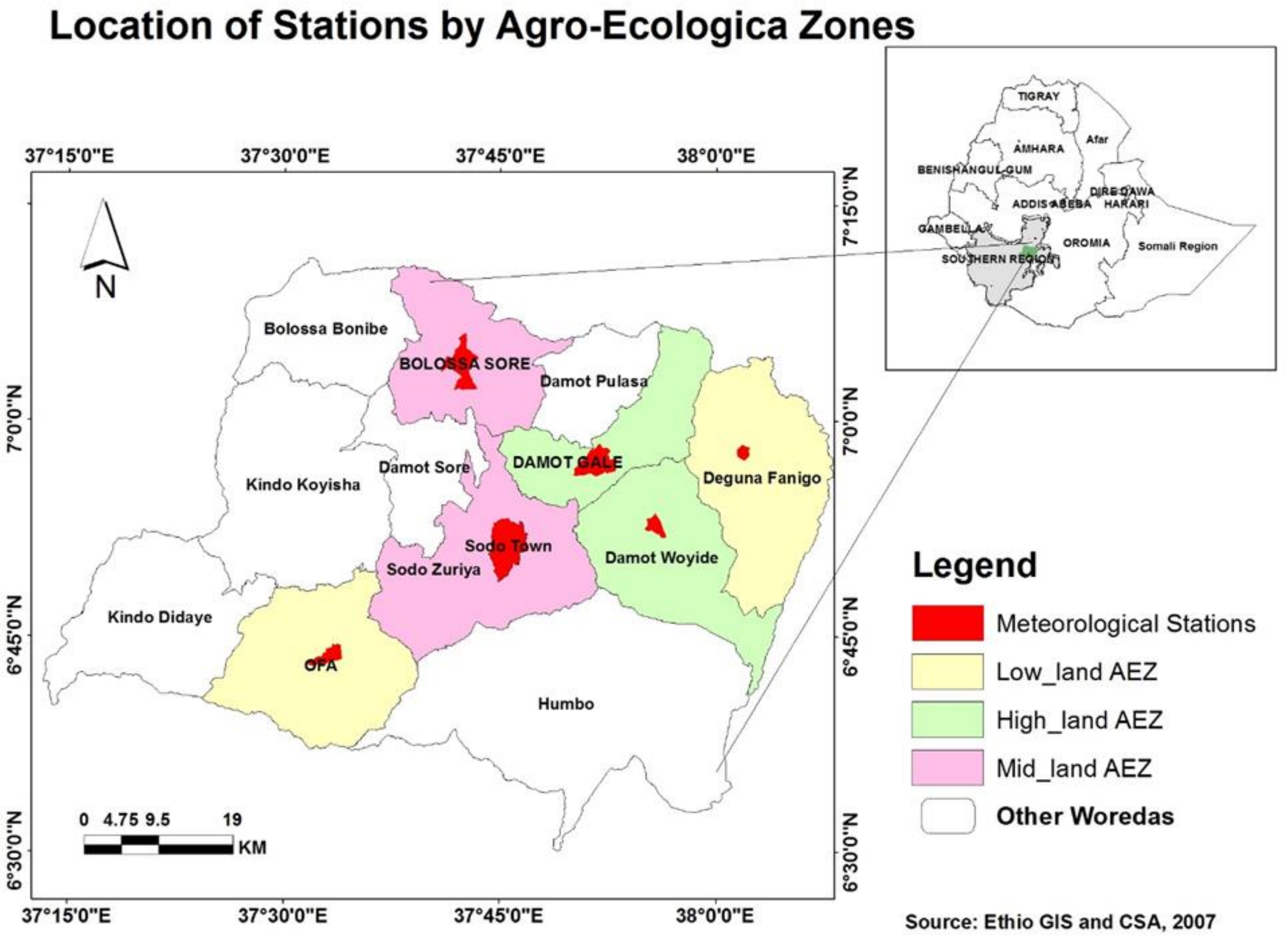
Methods

A concurrent mixed research (quantitative dominant qualitative) approach was used to generate both qualitative and quantitative data. Using a multistage sampling 428 households were surveyed by agro-ecology, applying population proportion to size (PPS), 120 households from highland, 195 from mid-land and 113 households from low-land) were randomly surveyed.

Using a pre-tested survey questionnaire, 428 households were surveyed, 15 key informants, 5 focus group discussions, 3 vulnerability and resilience mapping exercises as well as direct field observation were carried out in all agro-ecological zones.

While climate data (daily, maximum and minimum temperature; daily and monthly rainfall data from 11 stations) for the year 1980-2016 from National Meteorological Agency; Climate Induced Shocks Data (1960-2016) from National Disaster Management Commission; Agricultural Productivity Data, socio-economics and demographic data (1995-2016) from Central Statistical Authority and all other relevant data were generated from multiple sources. The trend analysis was computed using both parametric and non-parametric tests while applying principal component analysis (PCA) to construct resilience and vulnerability indices.

Location of Stations by Agro-Ecologica Zones



Results

Table 1: Summary Statistics of Maximum and Minimum Temperature by Agro-ecological Zone, Southern Ethiopia

AEZ	Record	MT	OLS Coef.	R^2	MK	S
High-Land	1981-2016	Maximum	0.047*** (.007)	0.51	0.489***	291
		Minimum	0.095 *** (.025)	0.28	0.586***	329
		RF	0.590 (4.598)	0.00	0.003	2.000
Mid-Land	1986-2016	Maximum	.024 (.008)	0.24	0.249	108
		Minimum	.041*** (.008)	0.47	0.479***	208
		RF	3.810 (6.727)	0.01	0.333*	207
Low-Land	1985-2016	Maximum	.0100(.0113)	0.02	0.026	11
		Minimum	0.135*** (.022)	0.55	0.649***	322
		RF	4.078 (3.797)	0.037	0.163	102

*Notes: Standard errors in parentheses. *p<0.05; **p<0.0; *** p<0.001; AEZ, Agro-Ecological Zone; MT, Mean Temperature, OLS, Ordinary Least Square coefficient that measures the effect of time on temperature; MK, Mann Kendal Taut; S, M-K test statistics or the Kendal Score. Trend is indicated by the coefficient of determination* (R^2).

Figure 1: Livelihood Vulnerability Index Components

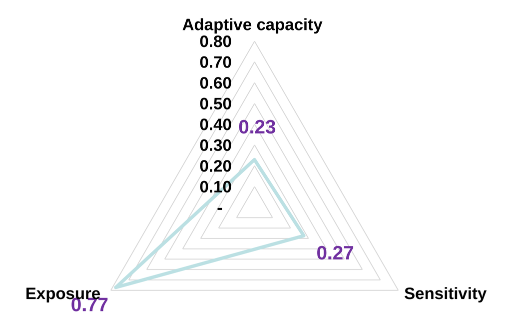


Figure 2: Livelihood Resilience Capacities

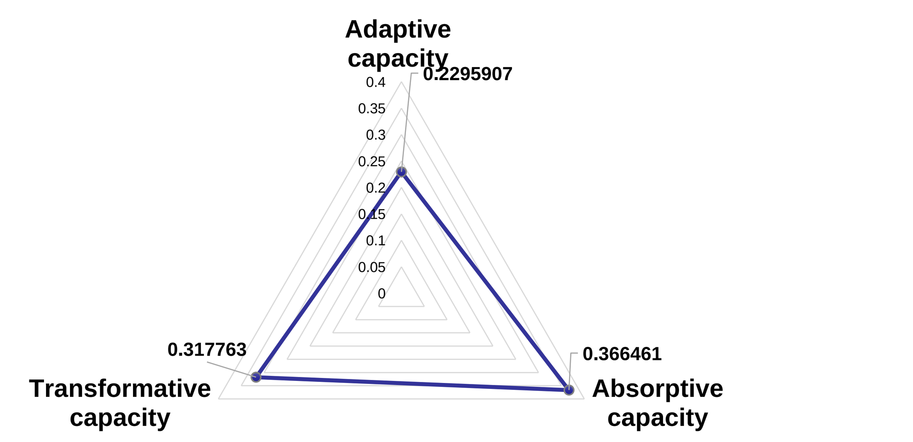


Figure 3: Resilience Capacities by AEZ

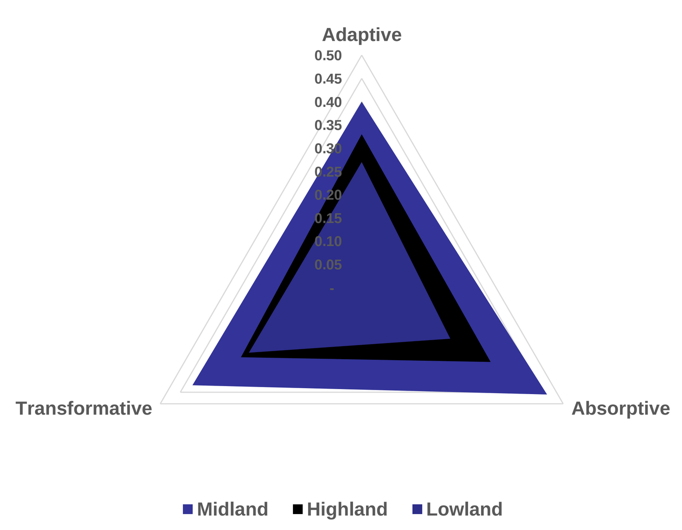
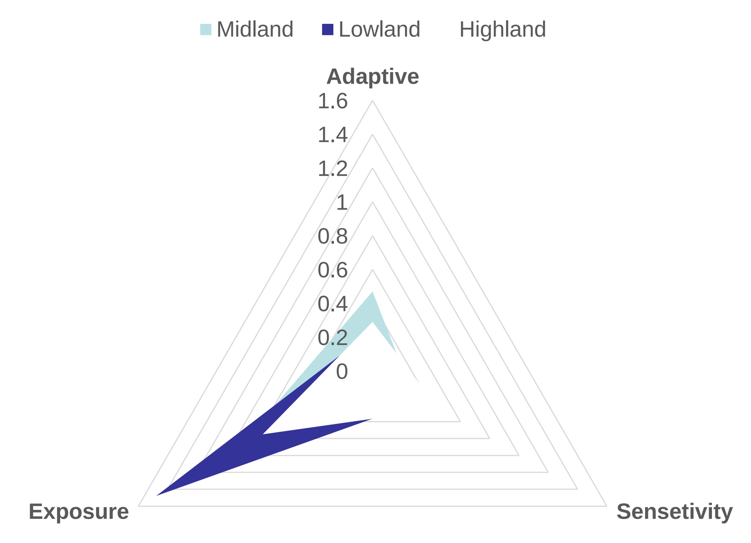


Figure 4: Vulnerability Components by AEZ



Conclusions

- Both the parametric and non- parametric trend analysis revealed that the minimum temperature has increased in all the studied agro-ecological zones over the last three decades, which is statistically significant at 99.99 % while the maximum temperature was only significantly in high-land AEZ, implying that it is getting hotter that before.
- The annual and seasonal (main and short-rains) have not shown any significant decrease or increase, except in midland AEZ, which is also consistent with the national level annual rainfall trend between 1950 and 2006 (Bewket & Conway, 2007).
- Low-land farmers are more vulnerable and less resilient to shocks, the mid-land farmers are less vulnerable and highly resilient while farmers in the high-land AEZ are moderately vulnerable and moderately resilient.
- Although adaptive capacity is a common indicator for vulnerability and resilience, it is imperative to measure the concepts concurrently than looking as the inverse of each other.

Reference

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