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Analysis of Household Food Security and Determinants in the Face of Conflict and Drought in South Wollo Zone Ethiopia

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Abstract

The study analyses the impact of conflict and drought on household food security and identifies determinant factors and coping strategies in South Wollo Zone, Ethiopia. Descriptive and quasi-experimental research designs were employed for pre-post retrospective data gathered from 422 randomly selected households. Qualitative data collected from key informants, focus group discussants, and related literature complemented the quantitative aspect of the study. Quantitative data was analyzed using regression models in Stata, while qualitative data was analyzed using thematic analysis. The study revealed that conflict and drought significantly undermine household food security. The combined exposure to conflict and drought increases food insecurity, which highlights the compounded nature of these crises. Per capita calorie availability drops from 1,789 kcal pre-conflict to 1,420 kcal post-conflict was observed, below the Ministry of Health recommendation of 2,300 kcal. This decrease was attributed to the individual and combined impacts of conflict and drought on food security, highlighting an increase in food-insecure households from 79% to 87%. In comparison, food-secure households fell from 21% to 13% using a household food balance model in the pre-post periods. The Coping Strategy Index rose as food security deteriorated, with households resorting to a combination of riskier coping mechanisms to cope with food insecurity. Some coping strategies that households consider include dietary changes, rationing, and reliance on community-based support systems like equb, edir, and debo. The regression analysis identified livestock ownership in total livestock units, agricultural index,

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work ratio, and age of the household head as positively associated with food security. In contrast, larger family size, exposure to drought, and exposure to conflict and aid were negatively associated. The study offers policy recommendations to build productive livelihood through asset building and livelihood diversification to foster self-reliance, and integrated recovery programs acknowledging the compounding nature of conflict and drought to improve food security.

Keywords: Conflict, coping strategies, drought, food security, disaster exposure, vulnerability

1. Introduction

Food security has become a global agenda that affects millions of people and is a central focus of Sustainable Development Goals (Birkmann et al., 2022). It is a multidimensional and multi-causal phenomenon that encompasses the availability, accessibility, and utilization of food to meet the nutritional needs necessary for physical and mental development. It also requires stability across these dimensions over time (Calloway et al., 2023; Guiné et al., 2021). In developing nations, food insecurity is closely associated with factors such as drought, political instability, conflict, poor governance, rapid population growth, and disease outbreaks (Delgado et al., 2023; Zhang et al., 2022; Mangaliso& Dlamini, 2018; Fyles & Madramootoo, 2016).

Climate change poses a significant threat to food security in Africa because the region's reliance on rainfed agriculture makes it highly vulnerable to climate variability and extremes (Lemma et al., 2013; Sharmake et al., 2022; Ahmed et al., 2023; Yeleliere et al., 2023). Furthermore, chronic food insecurity and poverty is exacerbated by limited adoption of improved agricultural inputs and technologies (Mohamed, 2017; Arega, 2015). Africa faces diverse conflicts, including electoral disputes, struggles over resource control, civil unrest, religious intolerance, ethnic violence, and territorial disputes (Francis & Vincent, 2021; Gluhbegovic, 2016; Pate, 2014; Christakis, 2013).

The Horn of Africa (HoA), including Ethiopia, remains entrenched in cycles of prolonged crises, resulting in widespread food insecurity (Anbes, 2020;

Mohamed, 2017). Despite investments by governments and international organizations in agricultural productivity, infrastructure, microfinance, extension services, and challenges such as recurrent droughts, conflicts, and political instability have hindered developmental progress (Yigezu, 2021).

Violent conflict exacerbates food insecurity by displacing populations, disrupting agricultural production, and damaging public and private infrastructure, including markets, roads, water facilities, and schools (UN OCHA 2018). For instance, Ethiopia has experienced its worst humanitarian crisis in 2021 since 2016, with millions of people in need of assistance. The northern Ethiopian conflict displaced over three million people, with more than 500,000 people from the Amhara region alone, significantly reducing agricultural production due to abandoned farmlands and crop damages (UNHCR, 2022; FEWS NET, 2021).

The South Wollo Zone in the Amhara region exemplifies Ethiopia's challenges as it faces recurrent drought, population pressure, fragmented farmland, pest infestations, and steep slopes prone to flooding. Known as the "famine belt," South Wollo suffered devastating famines during 1971–1974 and 1983–1984, described as Ethiopia's "worst tragedy" (Agidew& Singh, 2018; Rahmato, 1991; Mesfin, 1984). The northern Ethiopia conflict further degraded food security by disrupting the region's human, financial, physical, natural, and social capital, forcing communities to abandon crops near harvest and delaying recovery for rain-fed agriculture (FAO, 2021; Justino, 2011).

Conflict impacts food systems by constraining all aspects including production, distribution, and market access. It destroys infrastructure, disrupts institutions, and weakens resilience, creating a vicious cycle in which food insecurity exacerbates conflict, particularly in fragile contexts (Gatdet, 2021; FAO & WFP, 2018). Vulnerable groups, such as children under five, pregnant women, and lactating mothers, face heightened risks in South Wollo owing to unmet energy requirements, increased malnutrition, and exposure to diseases (IFRC & ICRC, 2021). The Productive Safety Net Program (PSNP), a lifeline for many households, was disrupted by looting and insecurity,

leaving thousands struggling even after the cessation of active conflict (GEOGLAM, 2022).

The food security situation of the South Wollo Zone experiences severe entanglement, not just because of conflict and drought, but also other factors that interplay with the socioeconomic and demographic makeup of the community. Most of the population in the zone relies on rainfed agriculture and livestock, which are highly vulnerable to climate variability and related shocks. Access to loans is limited, particularly during conflict periods, and the unaffordable collateral requirements make conventional loans and credit services inaccessible to poor and vulnerable households. In addition, limited livelihood diversification restricts the ability of the population to withstand economic and environmental shocks (Agidew& Singh, 2018). Market access was compromised due to the impact of the conflict, which affected household food security and disrupted a supply chain that increased food shortage and food prices (Muhyie et al., 2025b).

In multishock environments, addressing food insecurity requires an understanding of livelihoods, gender dynamics, social contexts, and institutional interactions. Household-level food security assessments provide critical insights into the national and community prevalence of food insecurity, informing targeted interventions (Pérez-Escamilla & Segall-Corrêa 2008).

South Wollo Zone was selected for this study due to its historical vulnerability to drought and the recent impact of the northern Ethiopia conflict, which contributed to food insecurity in the area. The zone is known for recurrent exposure to widespread drought, environmental degradation, and low agricultural productivity, contributing to food shortages (Agidew& Singh, 2018) where the northern Ethiopia conflict has exacerbated the area's vulnerability by disrupting agricultural activities, affecting supply chains, and displacement of people (Seid et al., 2024). The compounded impact of drought, conflict, and other socioeconomic vulnerabilities position the South Wollo Zone as being unique. Furthermore, the zone was relatively accessible for data collection compared to other zones affected by the northern Ethiopia conflict. Also taken into account were the researchers' prior experience,

knowledge of the zone, and familiarity with local conditions, all which would allow for a deeper food security analysis.

This study aims to assess the effects of conflict and drought on household food security in South Wollo. It examines how conflict and drought impact household food security, identifies socioeconomic and demographic determinants of household food security and explores the coping strategies employed by households to mitigate food insecurity. The research contributes to the food security literature by offering context-specific insights into the compounded effects of conflict and drought on the food security of vulnerable households in Ethiopia. These findings provide evidence for policymakers and practitioners to design interventions that can rebuild livelihoods and enhance food security in conflict- and drought-affected communities.

2. Materials and Methods

2.1. Description of the Study Area

South Wollo is one of the 11 zones in the Amhara Region of Ethiopia. It is located between 10º10′ N and 11º 41' N latitudes and 38º28′ E and 40º5′ E longitudes (Mekonen et al., 2020). The zone is bordered to the south by North Shewa, to the west by East Gojjam, to the northwest by South Gondar, to the north by North Wollo, to the northeast by the Afar Region, and to the east by the Oromia Special Zone and the Argobba Special Woreda (Seid et al., 2024).

The South Wollo zone inhabited 3,435,377 million people with 49.6% and 50.4% represents males and females, respectively. The majority of the population lives in rural areas with only 21.6% reside in urban areas. It covers an area of approximately 17,067 square kilometres with 190 inhabitants per square kilometre (ESS, 2024). The population predominantly lives in rural areas, with less than 12% residing in urban areas. The largest ethnic group reported in the 2007 census was Amhara (approximately 96%), and other ethnic groups comprised no more than 4% of the population. Muslims accounted for more than 55%, followed by Orthodox and Evangelical Christians at 39% and 5%, respectively.

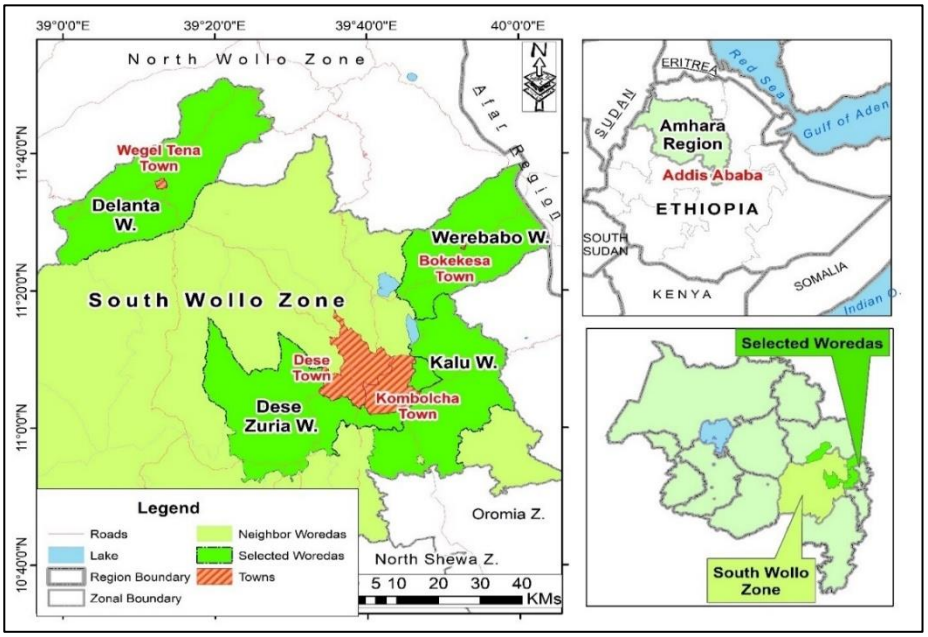

Figure 1: Map of the study area,
Source: CSA (2012) with researcher's adaptation

The population in the zone is poor in terms of resource endowment and hosts vulnerable households. The average agricultural landholding was 0.7 ha per household (Berhanu et al., 2003) which is less than the national and regional average of 1.01 ha and 0.75 ha per household. Agriculture and livestock are the major livelihoods that have been threatened by climate change in the zone (Bereket et *al*., 2022; Yifru&Miheretu, 2022) with only 10.6% of the population practicing non-farm-related jobs. The South Wollo Zone is a drought risk zone. Delanta, Dessie Zuria, Kalu, and Werebabo woredas are severely affected by the impacts of recurrent drought and devastated by the northern Ethiopian conflict. According to the National Institutes of Health (2024), the South Wollo Zone, particularly the woredas of Delanta, Dessie Zuria, Kalu, and Werebabo, has been severely affected by recurrent droughts between 1983 to 2014. According to Mindat.org (https://www.mindat.org) and tageo.com (https://www.tageo.com), Delanta, Dessie Zuria, Kalu and Worebabo woredas are located between 11° 34' 59" N and 39° 10' 0" E, 11° 10' 0" N and 39° 19' 59" E, 11° 00' 0.00" N and 39° 49' 59.99" E and 9° 07' 00" and 34° 59' 00" latitude and longitude

respectively. The northern Ethiopia conflict started on 03 November 202o in the Tigray region after the Tigray People Liberation Front (TPLF) allegedly attached the north command of the Ethiopian National Defence Force (ENDF) bases in Tigray region. The conflict has then expanded to the neighbouring regions of Afar and Amhara where its impact was extended to cover a wider geography including the South Wollo zone and caused many atrocities and damage to basic infrastructure (Arage et al., 2023).

2.2. Research Design and Approach

A combination of descriptive and pre-post-research designs defined the research methodology. Furthermore, the determinants of food security are identified by establishing causal relationships. Quantitative and qualitative data were collected for the pre-conflict (June 2019 to May 2020) and post-conflict (June 2021 to May 2022) reference periods, which includes the two major cropping seasons, *meher* and *belg*.

In this study, we employed a quasi-experimental design to evaluate the impact of conflict and drought on food security. The reference period for the study was considered the period before the Northern Ethiopia conflict as a pre-conflict reference and after the Northern Ethiopia conflict as a post-conflict reference period. These reference periods are considered for conflict and drought exposure based on respondents' perceptions of the impact of the conflict on food security. Household data was then collected for the pre-conflict reference based on recall at the post-conflict reference period. We collected recall data for similar households for the pre-conflict and post-conflict references. In the case of conflict, all respondents were unaffected in the pre-conflict period, while all were exposed to some degree of conflict in the post-conflict period. As a result, it was not possible to predefine control and treatment groups during data collection. Instead, respondents were categorized after data collection based on the self-reported intensity of conflict exposure (low vs. high), allowing for variation in treatment effects (Ravallion, 2007). Therefore, unlike randomized control trials (RCT), nonrandomized assignment of control and treatment groups was performed using appropriate statistical models due to the difficulty of random

assignment related to contextual and logistic constraints (Duflo & Banerjee, 2008).

Given these constraints and the fact that data was collected from similar respondents for the pre-conflict and post-conflict references, a Difference-in-Difference method considering a fixed effects (FE) model was chosen to control for unobservable household characteristics that remain constant over time (Wooldridge, 2010). The FE model eliminates biases caused by time-invariant factors, such as household location, cultural practices, or socioeconomic background. However, since gender and other fixed household characteristics do not change over time, they are absorbed by the FE model and thus dropped from estimation. To address the omission of these variables from the model, an interaction term with time was introduced to assess whether gender influences food security differently in the post-conflict/post-drought period.

The impact evaluation proposed in this paper assesses the impact of conflict and drought on food security as individual factors and the combined effect of conflict and drought on food security. For the sake of comparison, we recommended using the same control variables across all models (conflict, drought, and combined impact) to maintain consistency, reduce omitted variable bias, and ensure comparability of results (Imbens& Rubin, 2015). By leveraging this quasi-experimental approach, the study captures the causal effects of conflict and drought on food security despite the lack of randomized assignment.

As recall data was used for the study, the potential issue of recall bias as a result of memory decay and the potential consequence of the conflict was assessed using statistical methods called flashbulb memory test method and Common Method Bias (CMB). These tests indicates if recall bias is present in the recall data and if statistical inference is not reliable or not. A complementary question related to a well-known event was included during data collection and accuracy of recall, importance of the event and confidence of respondents in the memory recollection was gathered and statistically analysed by identifying the recall error as dependent variable.

The complementary flashbulb method used regression analysis by including conflict exposure and control variables of age, sex and education of respondents. These complementary methods to deal with recall bias indicated the absence of recall bias in the retrospective data collected for the purpose of the study confirming the reliability of the data for statistical inference. Due to its methodological contribution, the recall bias assessment is organized as a separate manuscript which is under review. The manuscript provides the detail methodology for recall bias analysis using the flashbulb memory test method and Common Method Bias (Muhyie et al., 2025a).

2.3. Methods

2.3.1. Sample Size Determination and Sampling Technique

The sample size was determined using Taherdoost (2016) with a 95% confidence interval (z value of 1.96) with a 5% margin of error (e), where p is the percentage occurrence of a state at 0.5, to maximize the variance that results in the maximum sample size (Bartlett, 2001).

$$n = \frac{p(100-p)z^2}{E^2} = \frac{0.5(1-0.5)1.96^2}{0.05^2} = 384$$

The four woredas were purposively selected in consultation with zonal experts, considering the history of conflict and drought exposure. A random sampling technique was used to select 38 villages, of which 422 households were selected proportionate to the population size, including 10% contingency. The 10% contingency was added to the required sample size to account for potential nonresponse and data loss. Since all responses were valid, the full sample of 422 was used in the analysis.

Considering the fact that the study covers four different woredas in South Wollo zone, a complete list of the sampling frame was not practical and logistically feasible (Levy &Lemeshow, 2013). As a result, we used a multi-stage sampling stratified random sampling techniques. The stratum takes the four study woredas, kebeles and villages within them. The researchers identified the list of kebeles in the four woredas and had consultation with woreda authorities to identify kebeles that were not accessible during data

collection due to ongoing conflict in the study areas. The first step in the multi-stage stratified sampling was to identify 30 – 45% of the kebeles from each woreda using simple random sampling taking into account kebeles that were identified as safe and secure for data collection. After selecting the study kebeles, a list of villages within each kebele was profiled and one village was selected using simple random sampling method from each kebele where 38 villages were identified. Based on the household data that was collected from woreda planning and development offices, the 422 samples were proportionately allocated to each village and a systematic random sampling technique was employed to identify survey participants. While the stratified sampling method helped to manage the diverse nature of the study area by breaking them into smaller stratum – kebeles and villages – the random sampling approach ensure equal chance of representation of respondents and increase generalizability of data (Lohr, 2019).

A non-random, purposeful sampling technique was utilized to select Focus Group Discussion (FGD) and Key Informant Interview (KII) participants with a focus on information-rich samples that can provide specific and specialized information (Shaheen et al., 2016; Nyimbili & Nyimbili, 2024) in the areas of food security, drought, conflict, and coping strategies of communities in the research woredas. Participants were selected purposively due to the need for expert and context-specific knowledge about food security, drought, conflict and socioeconomic situation of the study area and the study population. Individuals who could provide insightful and rich qualitative data were selected from zonal bureaus, woreda and kebele administration officials and technical expertise, elders, and selected respondents who experienced the impact of conflict and drought in the study area. This approach is relevant when maximum and in-depth information is required that assure research richness (Etikan et al., 2016; Palinkas et al., 2015; Tongco, 2007).

2.3.2. Data Sources and Collection Tools

A questionnaire-based survey was administered to 422 households affected by conflict and drought. In qualitative studies, previous research has indicated that the saturation point can be achieved at approximately 10

FGDs and 15 key informant interviews (Guest et al., 2006). Therefore, 10 FGDs and 15 KIIs were conducted with people who had an in-depth understanding of the impact of conflict and drought on household food security in the research area.

2.3.3. Techniques of Data Analysis

A Household Food Balance Model (HFBM), originally developed by FAO and further adapted by Degefa (1996) and Shishay and Gebremichael (2018), was further adapted by the researchers to compute per capita calorie availability in the pre-conflict and post-conflict reference years. Energy gains and losses from production, purchase, aid, and other transfers for major crop and animal products (maize, barley, wheat, teff, rice, oats, sorghum, cowpeas, peas, chickpeas, beans, meat, and milk) were included in the model. The kcal per kilogram of each of these products was used as described by (Tontisirin et al., 2003). The following summarizes the mathematical computation to calculate amount of calorie gained and lost through different mechanisms.

The Total Calorie Availability (TCA) is the total available amount of energy at the household level without accounting for the loss in energy in the reference period. It considers the total kcal availability from production (GP), purchase or buying (GB), food aid (FA), grin from gift (GG), and food for work (FW) accounting all grain and animal products in kilogram obtained in the reference year and multiplied by the equivalent calorie amount per kilogram of quantity (Tontisirin et al., 2003).

$$\text{KcalGP} = \sum(\text{Grain production in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGB} = \sum(\text{Grain Bought in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalFA} = \sum(\text{Grain Food Aid in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGG} = \sum(\text{Grain Gift in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalFW} = \sum(\text{Grain Food for Work in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalMP} = \sum(\text{Meat product in kilogram} * \text{Kcal per kilo } of\ meat)$$

$$\text{KcalDP} = \sum(\text{Dairy product kilogram} * \text{Kcal per kilo } of\ dairy\ product)$$

Where KcalGP is amount of calorie obtained from grain production, KcalGB is amount of calorie obtained from grain purchase, KcalFA is amount of calorie obtained from food aid, KcalGG is amount of calorie obtained from grain gift, KcalFW is amount of calorie obtained from food for work, KcalMP is amount of calorie obtained from meat from product, and KcalDP is amount of calorie obtained from dairy product.

Once the total calorie available is computed for the different components of energy gain in the reference period, Total Calorie Availability (TCA) was computed by summing up the energy obtained from different sources.

$$\text{TCA} = \text{KcalGP} + \text{KcalGB} + \text{KcalFA} + \text{KcalGG} + \text{KcalFW} + \text{KcalMP} + \text{KcalDP}$$

The Total Calorie Loss (TCL) was calculated by measuring the amount of grain used for household purposes other than consumption in the reference period multiplied by the calorie equivalent for the specified grain crops. These consisted of all the energy losses in the reference period as a result of postharvest loss (HL), grain reserved for seed (GU), grain sold (GS), grain gifted for others (GV) and grain used for social events (GSE) and converted to equivalent kcal amount using appropriate conversion.

$$\text{KcalHL} = \sum(\text{Grain Harvest loss in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGU} = \sum(\text{Grain seed reserve in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGS} = \sum(\text{Grain sold in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGV} = \sum(\text{Grain gifted to others in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

$$\text{KcalGSE} = \sum(\text{Grain for social event in kilogram of X grain} * \text{Kcal per kilo } of\ X\ grain)$$

Where KcalHL is amount of calorie loss due to postharvest loss, KcalGU is amount of calorie loss due to grain reserve for seed, KcalGS is amount of calorie loss due to sale of grain, KcalGV is amount of calorie loss due to gift to others and KcalGSE is amount of calorie loss due to grain used for social events.

After computing the energy amount for each category of loss in the reference period, the total calorie loss was computed by summing up the energy losses through different mechanisms.

$$\text{TCL} = \text{KcalHL} + \text{KcalGU} + \text{KcalGS} + \text{KcalGV} + \text{KcalGSE}$$

Once the total kcal availability and total kcal loss is computed, the net calorie availability was computed using the below formula.

$$\text{NCA} = \text{TCA} - \text{TCL}$$

Using the NCA, the daily per capita calorie availability for the members of the household was computed by dividing the NCA by the number of members of the household and 365 days as indicated below.

$$\text{Per Capita Calorie Availability} = \left(\frac{\text{Net Calorie Avaialbaility (NCA)}}{Household\ size}\right)/365$$

The Difference-in-Difference model was computed for the impact of conflict, drought and combined impact on food security using the following mathematical formula and the analysis was conducted in Stata software.

The following mathematical computation provides the formula to compute the impact of conflict on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2 (Conflict\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

Y_{it} = Food security outcome which is per capita calorie availability for household i at time t

α = constant term

Post_t = 1 for post-conflict, 0 for pre-conflict period

$\text{Conflict Exposure}_{it}$ = level of conflict exposure (0 for low, 1 for high)

$\text{Conflict Exposure}_{it} * \text{Post}_t$ = interaction term capturing the differential impact of conflict in the post-conflict period

X_{it} = control variables (age, sex, education, family size etc.)

μ_i = household fixed effects (capturing time-invariant characteristics)

ε_{it} = error term

The following mathematical computation provides the formula to compute the impact of drought on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2 (Drought\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

$\text{Drought Exposure}_{it}$ = level of drought exposure (0 for low, 1 for high)

$\text{Conflict Exposure}_{it} * \text{Post}_t$ = interaction term capturing the differential impact of drought in the post-conflict period

The following mathematical computation provides the formula to compute the combined effect of conflict and drought on household food security.

$$Y_{it} = \alpha + \beta_1 Post_t + \beta_2(Conflict\ Exposure_{it} * Post_t) + \beta_3(Drought\ Exposure_{it} * Post_t) + \beta_4(Conflict\ Exposure_{it} * Drought\ Exposure_{it} * Post_t) + \gamma X_{it} + \mu_i + \varepsilon_{it}$$

Where:

$Conflict\ Exposure_{it} * Drought\ Exposure_{it} * Post_t$ = interaction term capturing the combined impact of conflict and drought in the post-period

Determinant factors of per capita calorie availability were identified by running multiple linear regression.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots \beta_n X_n + e$$

Where Y is the dependent variable, which is per capita kcal available; X is the independent variable; β_0 is the y-intercept; Bs are the regression coefficients; and e is the model's random error (residual) term.

A thematic analysis method was utilized to thematically organize and analyse secondary data from related literature reviews, FGD, and KII. Food security, coping strategies, and drought- and conflict-related themes were thematically organized according to research themes (Naeem et al., 2023) to assist in the interpretation, conceptualization, and understanding of the perspectives of respondents.

3. Results and Discussion

3.1.Demographic Information and Socioeconomic Characteristics

Data were collected from 422 households in Delanta, Dessie Zuria, Kalu, and Werebabo Woredas. The average household size in the research woredas was 5.1 person per household. The below table summarizes the per capita calorie availability for the research woredas. A two-way ANOVA test demonstrated that there was significant difference in the per capital calorie availability across the research woredas with a p-value of 0.0000. in addition, there was significant difference in calorie availability at household level over the pre-conflict and post-conflict reference periods with p-value 0.0002. However, the interaction between woreda and time was found not

significant determining that the change in per-capita calorie availability does not vary over time for the different groups – woredas.

Table 1: List of research woredas, number of respondents and per capita calorie availability

Name of woredas	Number of Respondents	Per capita calorie availability	
		Pre-conflict	Post-conflict
Delanta	89	1,663	1,504
Dessie Zuria	138	2,505	2,023
Kalu	88	1,507	1,309
Worebabo	107	1,204	664
Total/Average	422	1,789	1,420

Source: Survey data by authors

Among the respondents, 64 were female heads and 358 were male-headed. The gender of the household head was found to be an important socioeconomic characteristic that provides a gender differential aspect of household food security. It was found out that the calorie availability for both male and female headed households reduced at post-conflict compared to the pre-conflict reference period. However, there was no statistically significant difference in the mean per capita calorie availability concerning gender of the household head.

Table 2: Gender of household head and per capita calorie availability

Gender of Household Head	Number of Respondents	Per capita calorie availability	
		Pre-conflict	Post-conflict
Male	358	1,809	1,436
Female	64	1,678	1,328
Total/Average	422	1,789	1,420

Source: Survey data by authors

The age of the respondents ranged from 22 to 79 years, with a mean age of 46 years. The below table provides a summary of the average per capita calories available for each age group. A two-way Anova test indicated that there is significant difference in per capita calorie availability between the different age categories with p-value of 0.0003. in addition, there is also

statistically significant difference in the per capita calorie availability of the different age categories across the pre-conflict and post-conflict reference periods. However, there was no statistically significant variation between per capita calorie availability and age categories over a course of time (p-value of 0.9935).

Table 3: Age category of household heads and per capita calorie availability

Age categories for household heads	Proportion of respondents in percent	Corresponding per capita calorie available	
		pre-conflict	post-conflict
20 - 29 years	3.1	2,326	2,269
30 - 39 years	24.2	1,677	1,266
40 - 49 years	37.4	1,685	1,304
50 - 59 years	22.5	1,757	1,424
60 - 69 years	10.4	2,120	1,745
70 - 79 years	2.4	2,743	2,246
Total/Average	100	1,789	1,420

Source: Survey data by authors

In the post-conflict reference, a notable reduction in per capita calorie availability was recorded for all marital statuses except for separated households. Separated households demonstrated increased per capita calorie availability, despite the immense impact of conflict and drought. It was indicated during focus group discussions and from the household survey that separated households has relatively higher work ratio than the other groups. Even though, it was not strongly substantiated in this research, the higher work ration could be attributed to increased workforce that contribute to more income sources which could have a positive outcome of household food security.

Furthermore, statistically significant variations between per capita calorie availability and the different groups of marital status were observed on Anova test. However, these differences do not vary between pre-conflict and post-conflict reference periods nor they interact with time over a period of time as the interaction term between marital status and the food security outcome was not statistically significant.

Table 4: Marital status and per capita calorie availability

Marital status	Number of respondents	Mean work ratio	Corresponding per capita calorie available	
			pre-conflict	post-conflict
Single	27	0.60	2,092	1,959
Married	327	0.57	1,728	1,367
Divorced	22	0.67	2,620	1,578
Separated	4	0.75	2,618	2,948
Widow	42	0.69	1,556	1,256
Total/average	422	0.59	1,789	1,420

Source: Survey data by authors

The education status of the household heads ranges from zero to 13 years with an average of 3.6 years of education. Among the surveyed communities, 38% of household heads do not have any formal education while 20% attended education between grade 1 – 4, 31% between 5 – 8 and 11% attended high school and above. Even though the per capita calorie availability decreased for all education categories during post-conflict, there was no statistically significant difference in the mean calorie availability between education status in the pre-post reference periods.

3.2.Off-farm Participation

There was evidence of the diversification of livelihoods through off-farm income-generating activities, where 30% of households reported off-farm participation in the pre-conflict reference period. The off-farm livelihood activities practiced in the research areas include tailoring, hairdressing, carpentry, painting, and daily labour activities.

Table 5: Education status and per capita calorie availability

Education status	Number of respondents	Corresponding per capita calorie available	
		pre-conflict	post-conflict
No formal education	162	1742.699	1384.586
Lower elementary (grade 1 to 4)	83	1753.299	1369.983
Upper elementary (grade 5	132	1835.513	1454.672

to 8)			
High school and above (grade 9 and above)	45	1886.725	1534.943
Total/average	422	1,789	1,420

Source: Survey data by authors

The per capita calorie availability for households who participated in off-farm activities (1,899 kcal) was higher than for those who did not participate in off-farm activities (1,742 kcal), during the pre-conflict references periods. Households who participated in off farm activity had higher per capita calorie availability which was also higher than the overall average in pre-conflict (1,789 kcal). This demonstrates the contribution of off-farm participation to household food security. Similar studies (Tesfaye & Nayak, 2022; Zelalem & Abate, 2014; Meskerem &Degefa, 2015) have also argued that households that participate in non-farm activities are more food secure. They argued that household's participation in off-farm activities enhance household food security.

Table 6: Off farm participation and per capita calorie availability

Off farm participation	**Number of respondents**	**Corresponding per capita calorie available**	
		pre-conflict	post-conflict
No	296	1,742	1,440
Yes	126	1,899	1,371
Total/average	422	1,789	1,420

Source: Survey data by authors

However, the situation in the post-conflict scenario was different. Households who participated in off-farm activities during and early after the cessation of the northern Ethiopian conflict were reduced (1,371 kcal) compared to those who did not engage in off-farm activities (1,440 kcal). This is a result of the disruption of business activities and the loss of opportunities as a result of conflict. This was also reported by other studies which was attributed to the impact of conflict on market disruptions, displacement affecting people participation in off farm activities, damage to infrastructure and markets disruption due to the conflict that led to

diminishing income from non-agricultural activities (UN OCHA, 2023; World Bank, 2023; FAO, 2023).

Labor work was identified as a major alternative livelihood that supports household food security. FGD participants indicated that the major source of labour activity is related to agricultural activities of planting, weeding, and harvesting periods during *meher* and *belg* seasons. Mining (particularly opal mining in Delanta woreda) and construction sectors are also major contributors to labour opportunities.

3.3.Exposure to Climate-induced Disasters: a perception assessment

Exposure to disasters is defined as exposure to climate-related calamities, such as drought floods, snow, and pests. 75% of respondents were exposed to at least one of the climate-related impacts during the pre-conflict period, while 74% reported similar exposure during the post-conflict reference period. A Pearson's chi-square test shows that there was no significant difference in the exposure of respondents between the pre-conflict and post-conflict reference periods. However, agroecology has been found to play a significant role in disaster exposure. More than 60% of the respondents indicated that the impact of climate-related disasters on food systems was medium and high during both reference periods.

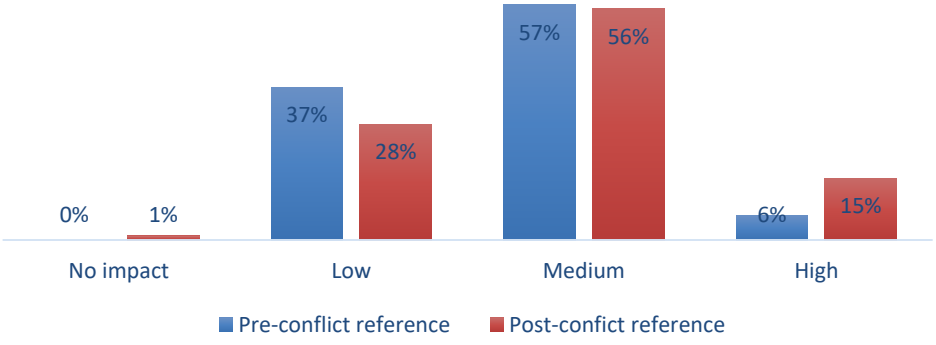

Figure 2: Perception of respondents on level of climate change impact on food systems; Source: Survey data by authors

3.4.Household Food Security

3.4.1. Household Food Balance Model (HFBM)

The mean per capita energy availability (average kcal/person/day) during the pre-conflict reference period was 1,789 Kcal while the per capita energy availability during the post conflict reference period was 1,420 Kcal/person/day.

Table 7: Two-sample t-test for calorie available for pre-conflict and post-conflict reference periods

Group	N	Mean per capita calorie availability	Standard Deviation (SD)	t	df	p-value
Pre-conflict	422	1789	1523	3.85	842	0.0001
Post-conflict	422	1420	1253			

Source: Survey data by authors

Based on a two-sample t-test with equal variance, there was a significant difference in the mean per capita calorie availability for the pre-conflict reference (M=1,789, SD=1,523) and post-conflict reference (M=1,420, SD=1,253) with conditions of t=3.85 and p = 0. 0001. The conflict increased household food insecurity by limiting calorie availability. The multifaceted impact of conflict on food systems has contributed to the reduction of household food security. Other studies (George et al., 2020; George &Adelaja, 2022; Kafando & Sakurai, 2024) have also argued that conflict, through its widespread impact, negatively affects household food security.

Considering the MoH (2022) cut-off of 2,300 kcal/person/day, 79% of households were food insecure, while food secure households accounted for only 21% of households before the conflict. Food insecure households increased to 87%, while the proportion of food secure households decreased to 13% after the conflict.

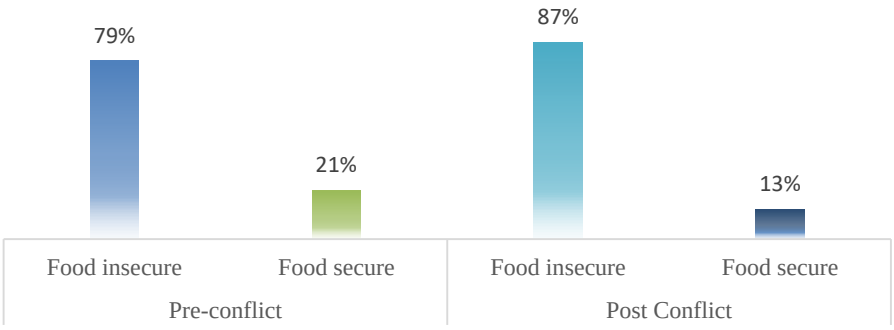

Figure 3: Categories of food security status on the basis of HFBM, Source: Survey data by authors

The study analysed the impact of conflict and drought on household food security using Fixed Effect (FE) Difference-in-Difference statistical model. Treatment variables were intensity of exposure to conflict and drought described as low and high based on self-reported household data. The time considers the reference period which is a year before the northern Ethiopia conflict and a year after the northern Ethiopia conflict pertaining the research zone. Interaction variables were set up and relevant statistical tests like presence of multicollinearity was checked using the Variance Inflation Factor (VIF) which shows less than 10 determining absence of multicollinearity problem. In addition, model appropriateness was tested using Hausman test to determine whether Fixed Effect (FE) or Random Effect (RE) was the most appropriate model. The test indicated that FE was the best with significant probability. Furthermore, the pre-post data was collected from similar respondents which also necessitates the use of FE due to the inconsistency of RE models in such scenarios.

The determinant factors of household food security were identified using multiple linear regression model for per capita calorie availability. The data were tested for the regression assumptions of linearity of the relationship between the dependent variable and each independent variable, no multicollinearity, normality of the error term, and no heteroscedasticity. Moreover, the necessary data adjustment and model specification tests were conducted for omitted variables. All tests confirmed the fulfilment of the assumptions of linear regression, and relevant inferential statistics were assessed.

3.4.2. Impact of Conflict and Drought on Household Food Security

A DiD model run to identify the impact of conflict on household food security expressed as per capita calorie availability. In the pre-conflict reference period, all respondents were not affected by conflict. The DiD model indicated that there was an overall negative impact of conflict on household food security which is expressed in terms of per capita calorie availability. The DiD analysis revealed that there was no evidence of differential impact of conflict between households exposed to different intensity of conflict. We found out that conflict reduces significantly household food security between the pre-post reference despite intensity of conflict exposure. Conflict reduced per capital calorie availability by 229.99 units during post-conflict reference.

Table 8: Estimates of the Overall Impact of conflict (Pre vs. Post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Postconflict (post=1)	-229.99	75.95	0.003	-379.28	-80.70
Total livestock unit	169.56	74.95	0.024	22.23	316.89
Age	13.37	4.96	0.007	3.63	23.12
Total off farm income	0.01	0.004	0.045	0.002	0.171
Agriculture index	263.05	100.63	0.009	65.26	460.84
Wealth index	-163.25	413.11	0.693	-975.267	648.76
Constant	579.21	299.13	0.054	-8.77	1167.19
Individual FE	Yes				
Time FE	Yes				
Observations	844				
R-squared	0.13				

Other researches confirm that conflict reduces household food security. Evidence from Ethiopia and Malawi (Muriuki et al., 2023) reported that conflict reduced food consumption score by more than six units while Mekonnen and Mitiku revealed that conflict significantly reduce household

food security where about 85% of household experienced food insecurity (Weldegiargis et al., 2023). These studies complement and support our finding that conflict reduces household food security significantly. The overall impact of drought was estimated using the DiD model. The impact analysis highlighted that drought reduced per capital calorie availability by 268 units in the post-conflict reference period based on self-reported drought exposure data. Similar to the conflict exposure, there was no evidence of differential impact of conflict among different intensity of drought the study area.

Table 9: Estimates of the Overall Impact of Drought (Pre vs. Post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Postdrought (post=1)	-268.24	75.13	0.000	-415.92	-120.57
Total livestock unit	155.82	77.64	0.045	3.20	308.43
Age	13.02	4.97	0.009	3.25	22.78
Total off farm income	0.01	0.004	0.050	0.000	0.016
Agriculture index	192.89	104.45	0.066	-12.43	398.20
Wealth index	156.86	385.92	0.685	-601.71	915.42
Constant	677.49	317.6	0.033	53.21	1301.77
Individual FE	Yes				
Time FE	Yes				
Observations	844				
R-squared	0.15				

Source: Survey data

In order to analyse the combined impact of conflict and drought, we created a modified variable that shows the combination of post-conflict and post-drought exposures. This was due to multicollinearity issue where the combined effect was not possible to run using the DiD model. The problem arose due to the fact that all respondents were not affected by conflict during

pre-conflict and most of drought affected households were also affected by conflict during the post-conflict period that resulted in collinearity issue. In order to mitigate this challenge and to provide an understanding of how the combined effect of conflict and drought is analysed using DiD, we created a variable that combines post-conflict and post-drought interaction terms. The new variable is categorized to have 3 groups: the first group is for those households who reported post-conflict exposure but not post-drought exposure, the second group are those who reported post-drought exposure but not post-conflict exposure and the third group is for those who reported both post-conflict and post-drought exposure. Once the categorical variable was created, we run the DiD model to understand the combined effect of conflict and drought on household food security.

Table 10: Estimates of the Overall Combined Impact of Conflict and Drought (Pre vs. Post) on per capita calorie availability

Variable	Coefficient	Std. Error	p-value	95% Confidence Interval	
Postcombined (post=1)					
Post-conflict only	-229.18	216.44	0.290	-654.62	196.25
Post-drought only	-288.87	102.65	0.005	-490.64	-87.10
Post-conflict_drought (both)	-269.47	86.13	0.002	-438.76	-100.18
Total livestock unit	140.79	74.79	0.060	-6.21	287.81
Age	12.59	4.96	0.012	2.84	22.34
Total off farm income	0.01	0.003	0.041	0.000	0.016
Agriculture index	182.99	102.99	0.071	-19.46	385.44
Wealth index	161.46	383.53	0.674	-592.42	915.33
Constant	743.87	307.01	0.016	140.40	1347.34
Individual FE	Yes				
Time FE	Yes				
Observations	844				

R-squared	0.15

Source: Survey data

As indicated in the above table, the interaction between exposure in conflict and drought provides an understanding of the combined effect of conflict and drought on household food security. It is noted that this interaction was generated through modification of variable and interpretation should be made with caution. While the individual impact of conflict and drought are provided in the previous sections, the interaction between the two could provide a different result and interpretation may not be taken directly.

The first group of respondents who were exposed to conflict but not to drought in the post-conflict reference, the interaction between conflict and drought exposure was found to be not significant. This interaction does not have significant influence on household food security. Whereas, households who were exposed to drought but not conflict in the post-conflict exposure, the interaction between conflict and drought exposure resulted in reduction in per capita calorie availability by about 288.87 units which is higher than both the individual overall impact of conflict (229.99) and the individual overall impact of drought (268.24).

Furthermore, households who were exposed to both conflict and drought in the post-conflict reference period demonstrated a significant reduction in household food security. The interaction between conflict and drought for these groups of respondents resulted in a reduction per capita calorie availability by 269.47 units which is higher than the individual impact of both conflict and drought. Looking at the interaction of conflict and drought, it is generally indicated that drought exposure resulted in higher reduction in household food security than conflict exposure in both individual impact analysis and considering the interaction between the two.

3.4.3. Determinants of Food Security: Multiple linear regression analysis

The following table indicates the names and description of variables that have been used in the regression analysis alongside with the type and

direction of expected change in regards to the outcome variable which is the per capita calorie availability.

Table 11: Description of variables and expected direction of change against the dependent variable

Variables	Description of variables	Type of variable	Expected direction of change
outcome	Per capita calorie availability	Continuous dependent	Not applicable
ast_tlu	Total livestock unit	Continuous independent	Positive
age	Age of the household head	Continuous independent	Negative
offincom_tot	Amount of total off farm income in birr	Continuous independent	Positive
ast_agrindex	Agriculture index	Continuous independent	Positive
ast_wealthindex	Wealth index	Continuous independent	Positive
time	Pre=post reference (0 for pre-conflict and 1 for post-conflict)	Binary independent	Negative
loan_yn	Access to loan	Binary independent	Positive
aid	Amount of aid received	Continuous independent	Positive
edu_head	Education of the household in years	Continuous independent	Positive
sex_head	Gender of the household head (1 for male headed and 2 for female headed households)	Binary independent	Negative
fam_size	Total family size	Continuous independent	Negative
work_ratio	Work ration expressed as ration of working force in the household	Continuous independent	Positive
liv_mark	Distance to livestock	Continuous	Negative

	market	independent	
marital	Marital status of the household head	Categorical independent	Negative
disaster	Exposure to disaster (drought)	Binary independent	Negative

A linear regression model was used to identify the interaction between independent variables to determine the outcome variable which is per capita calorie availability. Considering that the data is a pre-post data, a dummy variable showing the pre-conflict and post-conflict reference has been included as independent variable and a joint regression for the pre-post data was undertaken to identify determinant factors using multiple linear regression model.

The multiple linear regression indicates that total livestock unit (ast_tlu), agriculture index (ast_agrindex), time (pre-post reference), family size (fam_size), work ratio (work_ratio), and exposure to disaster like drought were found to be significant determinant of household food security expressed in terms of per capita calorie availability at p-value less than 0.005. In addition, age of the household head (age) and amount of humanitarian aid (aid) were significant at p-value of 0.1.

These determinant factors and the association more broadly with household food security and in particular with per capita calorie availability are discussed in the below sections. We grouped the significant variables into impact of livelihoods assets, demographic characteristics and effect of shocks and external assistance.

Total livestock unit, a crucial livelihood asset played significant role in determining household food security expressed as per capita calorie availability. The TLU was found to have a positive and statistically significant effect on household food security ($p < 0.05$). with a unit increase in TLU, per capita available calorie increases. This result aligns with existing literature emphasizing the central key of livestock as both a source of income and a coping mechanism during crises (Little et al., 2006; Gebreegziabher et al., 2012). In South Wollo, key informants and focus group participants reported that the conflict severely disrupted livestock-

based livelihoods through theft, displacement, and market closures (FAO, 2022). However, despite the challenge that the livestock sector faced during the conflict period, households that retained their livestock were more resilient, using animals for food, labour, or emergency cash through distress sales. Awoke et al. (2022) argued that in addition to other predictors, tropical livestock units, livelihood diversification, agricultural income, and farm size determine household food security status.

Table 12: Determinant factors of household food security using multiple linear regression

Variables	Betas	Standard Error	t	P>|t|	Confidence Interval (95%)	
					Lower	Upper
ast_tlu	310.079	50.215	6.170	0.000*	211.514	408.643
age	7.920	4.530	1.750	0.081**	-0.972	16.811
offincom_tot	-0.001	0.003	-0.320	0.746	-0.008	0.006
ast_agrindex	252.440	108.018	2.340	0.020*	40.419	464.460
ast_wealthindex	343.855	431.977	0.800	0.426	-504.043	1191.753
time	-180.790	90.268	-2.000	0.046*	-357.971	-3.608
loan_yn	-118.891	86.069	-1.380	0.168	-287.830	50.049
aid	-167.948	86.189	-1.950	0.052**	-337.121	1.226
edu_head	12.543	12.888	0.970	0.331	-12.754	37.840
sex_head	4.199	211.856	0.020	0.984	-411.638	420.036
fam_size	-271.864	37.347	-7.280	0.000*	-345.169	-198.559
work_ratio	893.092	258.490	3.460	0.001*	385.720	1400.464
liv_mark	0.071	0.746	0.090	0.925	-1.394	1.536
marital	-96.949	74.422	-1.300	0.193	-243.028	49.129
disaster	-215.854	104.258	-2.070	0.039*	-420.494	-11.213
constant	1853.850	378.407	4.900	0.000*	1111.100	2596.600

* Significant predictors at 95% confidence interval, ** significant predictors at 90% confidence interval; Source: Survey data by authors

Similarly, the agriculture index, a proxy for agricultural performance and diversification through the use of improved fertilizer, pesticide and agronomic practices, was positively associated with food security ($p < 0.05$). During the conflict, agricultural activities were significantly hampered by violence, the destruction of farming inputs, and the displacement of labour

(UN OCHA, 2022). Nonetheless, households that managed to sustain agricultural practices—either due to relative safety or access to early recovery support—experienced improved food security, underscoring the critical role of local food production in post-conflict recovery (WFP, 2021).

The work ratio, defined as the proportion of working-age individuals in the household, was also positively associated with food security ($p < 0.05$). In the aftermath of conflict, labour availability became a key determinant of household resilience, with working-age members enabling income diversification through casual labour. This finding is consistent with Headey and Taffesse (2014), who highlighted the role of labour capacity in rural household welfare under crisis conditions.

The age of the household head was positively associated with food security at a 10% significance level. This may reflect the cumulative benefits of experience, social capital, and better adaptation strategies among older heads. In Ethiopian rural settings, older household heads often have stronger community networks and more diversified livelihood strategies, enabling them to better navigate crises (Berhane et al., 2014). In addition, according to focus group discussants, the younger community category was directly involved in the conflict more than the aged groups. This might also one reason for this interpretation.

Conversely, family size was negatively associated with food security ($p < 0.05$), indicating that larger households faced greater food insecurity. During the conflict, larger families were more likely to experience resource strain. The conflict affected households by limiting their participation in agricultural activities, loss of businesses and due to displacement. Due to the general impact of the conflict in the research woredas, with limited availability of livelihood options, larger families faced higher level of food insecurity. This finding echoes earlier research by Tafere and Taffesse (2010), which found that household food resources decline on a per capita basis as family size increases, particularly in rural Ethiopia.

A key finding of this study is that the post-treatment time period—capturing the conflict-affected phase—was significantly associated with a decline in

per capita calorie availability at household level ($p < 0.05$). This reinforces reports from humanitarian agencies that the Northern Ethiopia conflict had devastating impacts on household welfare, particularly in South Wollo Zone, where markets were disrupted, farms abandoned, and humanitarian access restricted (FSIN, 2023; WFP, 2022).

Paradoxically, aid was found to be negatively associated with food security ($p < 0.1$). This may reflect the fact that aid is targeted to the most food-insecure households, creating a selection effect. Additionally, during the height of the conflict, aid distribution was inconsistent due to insecurity, looting, and logistical breakdowns. As Maxwell et al. (2012) argue, humanitarian aid in protracted crises can have limited impact when delivery mechanisms are compromised or delayed.

Finally, exposure to drought was significantly associated with lower food security ($p < 0.05$). South Wollo is a drought-prone area, and the recent conflict overlapped with below-average rainfall years, creating a compound crisis. As reported by FEWS NET (2021), the combined impact of conflict and drought severely undermined local coping mechanisms, resulting in widespread food shortages. This finding reinforces the importance of understanding food insecurity as the result of intersecting shocks rather than isolated events.

3.5.Major Constraints to Food Security: A Perception-based Review

Violent conflict, drought, flood, frost, crop, and animal diseases are the major challenges that constrain food security in the research areas. A key informant from Delanta woreda food security coordination office noted that, “non-conflict disasters affect some of the food systems depending on the vulnerability of different sectors within the food system. However, violent conflict has been identified as a complex disaster that affects the entire food system.”

This was coupled with a lack of sufficient agricultural land and the complete absence of land for young people, limited access to irrigation, population growth resulting in fragmentation of farmland, and traditional agricultural practices limiting the availability of food. In addition, there are cultural and

traditional factors that compromise food security. Unnecessary and extravagant spending during social and cultural events such as weddings, mourning for the dead, birth, and other events leads to debt burdens that affect food security and livelihoods.

Focus group participants reported that the lack of appropriate toilets and poor hygiene practices that lead to open defecation contribute to hygiene-related diseases that directly contribute to malnutrition, a manifestation of food insecurity. Lack of proper utilization of natural resources, poor distribution and timing of rain, crop and livestock disease, and other climate-induced disasters jeopardize production ability.

3.6. Coping Strategies and Community Support Mechanisms

The CSI score was calculated by multiplying the frequency of occurrence of the 12-coping strategy-related questions by the weight assigned to each behaviour, as in Maxwell et al. (2003). Accordingly, the mean CSI of the respondents was approximately 22.4.

Table 13: Affirmative responses to the coping strategy index questions

Coping strategies	Number of affirmative responses	(% yes) *
1. Dietary change		
a. Rely on less preferred and less expensive foods	375	89%
2. Short-term measures to increase household food availability		
b. Borrow food, or rely on help from others	222	53%
c. Purchase food on credit	173	41%
d. Gather food from garbage or collect from leftovers	22	5%
e. Do labour work for friends, relatives, neighbours in exchange for food	102	24%
3. Decrease Numbers of People		
f. Send household members to eat elsewhere	52	12%

g.	Send household members to beg	27	6%
4.	**Rationing Strategies**		
h.	Limit portion size at mealtimes	275	65%
i.	Restrict consumption by adults for children to eat	185	44%
j.	Feed working members at the expense of non-working members	67	16%
k.	Reduce number of meals eaten in a day	282	67%
l.	Skip entire days without eating	73	17%

** % yes, was calculated against the total number of observation (422) who affirmatively answered the CS; Source: Survey data by authors*

As indicated in the above table, 'severely food insecure' households have the highest mean CSI, which is even more than the overall average. This indicates that the higher the household food insecurity, the higher the chances of the household considering severe and negative coping strategies.

Table 14: Food security categorization on the HFBM categories and corresponding CSI scores

HFIAS Prevalence (Categories)	Summary of mean CSI	Standard deviation of CSI scores	Frequency of respondents
Food insecure	22.893	19.129	366
Food secure	18.911	15.648	56
Total	22.365	18.737	422

Source: Survey data by authors

The food insecure households often lack the asset and resources to cope up with adversities like conflict and drought and their compounded consequences. This increases their vulnerability and force them to exercise dangerous and often negative coping strategies. The below table summarizes key socioeconomic and demographic factors and provide comparative analysis which shows food insecure households have less livestock ownership, agriculture index, work ratio, agricultural landholding and received less amount of money from off farm activities. Conversely, food insecure households have higher family size and more dependent on external assistance.

Table 15: Key household characteristics for food insecure and food secure households

Socioeconomic and demographic factors	Mean value of socioeconomic and demographic factors per food security status	
	Food insecure	Food secure
Total livestock unit	1.68	2.35
Agriculture index	0.56	0.66
aid	0.31	0.19
Family size	5.26	4.23
Work ratio	0.58	0.69
Agricultural landholding	3.04	4.03
Amount of off farm income	2455.00	3977.00

Source: Survey data by authors

The coping strategies were classified into four important categories: dietary change (#1), short-term measures to increase household food availability (#2, #3, #4, and #5), a decrease in the number of people (#6 and #7), and Rationing (#8, #9, #10, #11, and #12). Some households deployed a combination of strategies to respond to food insecurity situations, as reflected in the figure below.

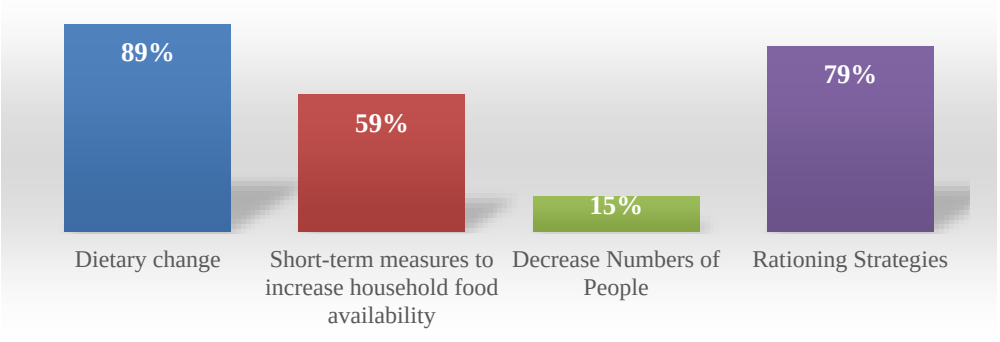

Figure 4: Proportion of households deploying different coping strategies; Source: Survey data by authors

According to the KII and FGDs, communities consider different coping strategies during shortfalls of food stock or lack of financial means to buy it. These include selling valuable household items and productive assets,

sending children to engage in labour activities, taking loans to bridge gaps in household food security, and begging in the worst-case scenario for some households. Furthermore, the migration of young people to other parts of the country and the Middle East for labour was identified as a very important strategy. Mohamed (2017) found similar coping strategies deployed by households to cope with adversities that constrain household food security.

Prior to the northern conflict, some of the coping mechanisms at times of disasters for the community included going to another area for labour, selling valuable assets including livestock, collecting firewood and charcoal, eating inexpensive food, and borrowing from relatives and friends. However, during conflict, coping mechanisms have changed significantly. People have demonstrated more severe and dangerous comping strategies to cope with the compounded impacts of conflict and drought. The conflict also restricted the movement of people from place to place, in fear of their lives.

Among the different community structures, *equb*, *edir*, and *debo* were the most important. These structures helped the community facilitating borrowing of money, weddings, and mourning events and pull labour resources to each other. In addition to the aforementioned local structures, kebele-level multipurpose service cooperatives provide basic items on a credit basis to poor people.

KIs indicated different opinions regarding the contribution of assets and livestock in mitigating conflict impacts. Fixed assets and livestock play an important role in mitigating the impact of conflict by providing a source of income and guaranteeing access to family loans. However, some studies have reported that livestock and fixed assets play a negative role, as it led to deliberate targeting during the conflict. As a result, assets and livestock are considered liabilities. However, they played an undeniable role in reducing the extra suffering of households despite the parties involved in the conflict targeting assets and livestock.

4. Conclusion and Recommendations

This study investigated the impact of conflict and drought on household food security using a difference-in-differences (DiD) approach, complemented by multiple linear regression analysis to identify key socioeconomic and demographic determinants of household food security. It also assesses the different consumption-related coping strategies that households employ to cope with food shortage during crisis periods. The results reveal that both conflict and drought significantly reduced household food security which is expressed in terms of per capita calorie availability. Furthermore, the combined exposure to both shocks in the post-conflict period had the most severe impact, suggesting a compounding and mutually reinforcing relationship between these crises.

The multiple linear regression analysis indicated that livestock ownership expressed in terms of total livestock unit (TLU), agriculture index expressed in participation in agriculture activities with a focus on improved agronomic practices, work ratio, and the age of the household head positively influenced household food security. In contrast, larger family size, disaster exposure, and aid was negatively associated with food security. The negative relationship between aid and food security suggests that while aid targets vulnerable populations, its structure and delivery may not be sufficient to improve resilience or ensure long-term food access. Besides, during the conflict, humanitarian aid including the productive safety net programme was interrupted, untimely and insufficient which could have reduced the effectiveness of aid for the particular context of the study.

In general, the multiple linear regression results highlight the important interaction between household assets, demographic characteristics, and exposure to shocks in determining per capita calorie availability in conflict-affected settings. Households with stronger asset bases—such as livestock and agricultural productivity—managed better, while those exposed to large-scale shocks like conflict and drought experienced heightened vulnerability. A post-conflict recovery strategy that prioritizes support for rebuilding agricultural and livestock sectors, restoring market functionality, and expanding livelihood opportunities for working-age members to enhance household food security are required in South Wollo zone.

Additionally, humanitarian assistance must be more predictable, equitable, and responsive to compounding crises like conflict and drought. Strengthening resilience to both conflict and climate shocks is essential for sustainable food security in this and similar fragile regions of Ethiopia.

In response to the conflict and drought shocks, households adopted a wide range of coping strategies to manage food insecurity, often using multiple strategies simultaneously. These strategies included dietary changes, reducing meal frequency and portion sizes, rationing food among family members, and short-term actions aimed at increasing food availability. As food insecurity worsened, households increasingly resorted to more extreme and potentially harmful coping mechanisms, as reflected in rising Coping Strategy Index (CSI) scores. Food insecure households had the highest CSI demonstrating that they resort to dangerous coping strategies due to deteriorated food security. Social institutions and informal networks, such as *equb*, *edir*, and *debo*, emerged as critical community-based mechanisms for managing crises as described by focus group participants. These traditional systems provided a foundation for mutual aid and resource mobilization, particularly during the generalized impacts of conflict and drought though the scope and effectiveness has reduced due to the conflict which had caused immense livelihood challenges for everybody. Even when the entire community was affected, these structures played a pivotal role in supporting the most vulnerable, though their capacity was often constrained under widespread distress.

This study contributes to the growing body of evidence on the intersection of conflict, drought, and household food security, particularly in fragile context. By combining a difference-in-differences (DiD) impact evaluation with a determinants-based regression framework, it provides a very good understanding of both the causal impacts of shocks and the underlying household-level factors shaping food security outcomes. Moreover, the inclusion of coping strategies offers important insights into the behavioural and social responses to compound crises—an area often overlooked in quantitative food security research. The findings enrich the scientific dialogue on resilience and vulnerability by emphasizing the compounded

effects of conflict and drought, the limitations of current aid modalities, and the critical role of local institutions. These insights are intended to inform not only academic discourse but also the design of more responsive, context-sensitive policy and programming in humanitarian and development settings. This research also provides an understanding of different methods to the use of retrospective data in post-conflict food security study by highlighting key steps in dealing with recall bias.

In light of these findings, several key recommendations are proposed. First, it is essential to strengthen both individual and community-level coping mechanisms. Policymakers and development actors should invest in transforming short-term, erosive strategies into adaptive practices that build resilience over time. This includes expanding access to livelihood assets, supporting livelihood diversification, and reinforcing traditional support systems like *equb* and *edir*, which play a vital role in mobilizing community resources. Second, recovery and resilience programs should integrate responses to both conflict and drought, acknowledging the compound nature of these shocks. Targeted support to livestock and agricultural sectors will be crucial in improving household food access and stability.

Aid interventions must also be re-evaluated to ensure they are timely, appropriately targeted, and linked to sustainable development outcomes. Effective aid programs that foster self-reliance and build productive capacity may be more effective than traditional handouts. Furthermore, promoting labour participation and creating employment opportunities, especially for youth and women, can reduce vulnerability and enhance household food security. Investment in early warning systems and crisis preparedness is also necessary to help communities anticipate and mitigate future shocks.

Finally, future research should investigate the long-term impacts of different coping strategies, distinguishing between those that are adaptive and those that may further exacerbate existing vulnerability. A further exploration into the structure, delivery mechanisms, and outcomes of aid programs, particularly in the context of violent conflict, will provide valuable insights

for designing more effective food security interventions in complex emergency contexts.

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Public-Private Partnership Financing Framework for Housing Development in Addis Ababa: Evidence from Planning and Implementation Phase

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Abstract

Housing development financing faces significant challenges in Addis Ababa City Administration. Among others, inadequate planning, insufficient risk management, and lack of transparency in procurement constituted the gaps. These challenges undermine the effective implementation of Public-Private Partnership as a viable financing approach. This study employed a mixed methods design to investigate the planning phases of Public Private Partnership housing development of the city. Results indicated that planning dimensions such as integration of various components, defining the scope, and resource allocation demonstrated remarkable successes so far. However, inadequacy of institutional capacity, limited stakeholder engagement, and imbalanced risk identification and allocation comprise dimensions that seek further attention. The values for the path coefficients of procurement and resource allocation were found to be 0.99 and 0.66, respectively, highlighting the presence of correlation with institutional capacity. The findings further suggest the need to balance private sector incentives with deliverables, affordability, and transparency.

Keywords: Public-Private Partnership, Housing Development, Procurement, Planning Phase, Addis Ababa, Ethiopia.

1. Introduction

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Rapid pace of urbanization added to the population growth are aggravating the housing crisis in urban centers globally, resulting in a critical imbalance between housing demand and supply (Turok et al., 2023). This disparity often exceeds the financial capabilities of public sector i.e., the government to address gaps between demands and supply (Akomea-Frimpong et al., 2023). In response, the PPP framework has emerged as a financing strategy, leveraging the resources and the expertise from the private sector to complement the efforts by the government in the housing development initiatives (Ugonabo, 2023).

Global projections estimated that nearly 3 billion middle-class residents would lack access to affordable housing by 2050 (UN-Habitat, 2020). In Africa, a significant demand-supply gap of approximately 50.5 million housing units was reported in 2018 (ADB, 2022). Ethiopia mirrors this trend, with a 5.4% annual urbanization rate causing substantial challenges to housing supply and development (World Bank Group, 2015). The Ethiopian Economic Association (EEA) projects that rapid urbanization and population growth would necessitate 471,000 housing units annually until 2035 (EEA, 2021). Despite government efforts since 2005 in providing affordable housing through the Integrated Housing Development Program (IHDP), a persistent shortage remains in Addis Ababa City Administration, where over 700,000 residents have been still on waiting lists for condominiums (Charitonidou, 2022). Only 400,000 units were constructed over thirteen years, exhibiting a significant disparity between demand and supply attributed to insufficient housing finance and drawbacks in institutional capacity (Alemu, 2021).

Consequently, the Ethiopian government has been increasingly seeking alternative financing options from the private sector to address housing shortages and gaps (Getachew, 2021). This shift has led to the implementation of PPP, with successful initiatives observed in countries such as the UK, Ireland, Argentina, Nigeria, and South Africa (Batra, 2022 and Arimoro, 2020). These nations demonstrate the importance of collaborative efforts to create sustainable housing solutions to their citizens (Mansilla & Vassallo, 2020). The planning and implementation schemes

such as PPPs in the housing sector facilitate the mobilization of private capital, promote efficient resource allocation, enhances project management capabilities, and encourage innovation in housing design and construction (Rahman et al., 2025). This study aimed to assess the implementation of the planning phase of PPP in the housing development of Addis Ababa City Administration. The study covered examining the initiation of PPP projects procurement, and risk identification at the planning phases of its implementation (Batjargal & Zhang, 2021).

2. Literature Review

The literature review provides the conceptualization of PPP and discusses relevant theories that guide in comprehending the framework and how it applies into the context of the study The arguments of Principal-Agent and Institutional Theories were found to be relevant to analyze the planning phases the PPP framework in the housing development of Addis Ababa City Administration.

2.1. Theoretical Framework

PPP is characterized as a long-term contract between a public sector and a private company for delivering public infrastructure and services, with risks allocated according to each party's capacity to manage them African Development Bank, 2021). According to UNECA, a PPP epitomizes as a mutually binding contract stipulating the terms and conditions for implementing a PPP project (United Nations, 2023).

Risk is described as the probability of an adverse event occurring during a specified timeframe being attributed to challenges (Tallaki& Bracci, 2021). In many developing countries, public institutions encourage and solicit private sector partnerships to secure financing for projects (Cambra-Fierro et al., 2025; Fernando et al., 2025; Wu et al., 2025). Ako and Shey (2025) indicate that PPP facilitates private financing of infrastructure and services guided by public sector policies, regulations and procedures.

Institutional Theory: suggests that business decisions are significantly influenced by institutional norms, values, and practices, which are crucial

for achieving legal body and mobilizing resources (Franco & Franco, 2021). Pioneers of institutional theory, such as Meyer and Rowan, established a foundation for examining systems to enhance our understanding of how institutions impact partnership effectiveness (Drori, 2020; Koster et al., 2019; Scott, 1987). This theory emphasizes both technical prerequisites and the significance of building institutional elements (Coates et al., 2023; Risi et al., 2023).

Principal-Agent Theory: centers on the contractual relationship between companies and contracting bodies, highlighting the separation of ownership and execution duties (Huang, 2025). Founded in the 1970s, this theory addresses the misalignment of interests, where agents may not act in optimal ways, leading to risks (Zogning, 2022; Mitnick, 2011). Jensen and Meckling (1976) expanded on this by highlighting the costs associated with agency relationships, emphasizing the need for principals to oversee agents' responsibilities. This theory is instrumental in supervising agreements between public institutions (principals) and private enterprises (agents) (Musawir, 2025).

The core thesis of both theories was found to be instrumental for analyzing the dynamics between public institutions and private partners while engaging in contractual activities for the delivery of housing. However, as the study focused more on the implementation of the planning phases of PPP in the housing development. It hugely investigates the legal and institutional capacities of the private and public sectors, deploying the essence of institutional theory as a framework.

2.2. Conceptual Frameworks

One of the major challenges in the housing sector of Ethiopia is the insufficient availability of mortgage financing, exacerbated by the limited lending capacity of commercial banks in Ethiopia (Misrak& Kaur, 2023). These deficiencies constrict the endeavors by the government to provide mass housing. Similarly, real estate developers have also been challenged due to lack of schemes and land supplies (Mekuria, 2022). Moreover, stringent collateral requirements and high-interest rates escalated housing finance and often discouraged the private (Asnakew&Amogne, 2022).

Given the inadequacy of customary financing techniques in addressing housing finance requirements, opting PPP becomes essential (Ugonabo, 2023). The involvement of private sector in public housing provisions remains crucial in meeting the housing demands driven by rapid urbanization (Adedeji, 2023). Consequently, policymakers are increasingly occupied with creating an enabling environment for private sector partnerships engagement into PPP (Wang & Ma, 2021a).

However, private sector engagement in housing provision through PPPs requires strong institutional capacity, a supportive legal framework, transparency, and accountability (Alshahrani et al., 2023, Anbumozhi et al., 2023 and Fell & Mattsson, 2021). Hence, the successful initiation of Public-Private Partnership (PPP) projects in Addis Ababa City Administration requires transparent procurement processes, risk identification, effective resource allocation, and leadership, all guided by meticulous planning and execution (Chileshe et al., 2022). Inadequate procurement procedures would create conflicts and inefficiencies among participating parties, undermining project outcomes and quality as well (Ahmad et al., 2022; Lam & Yang, 2020).

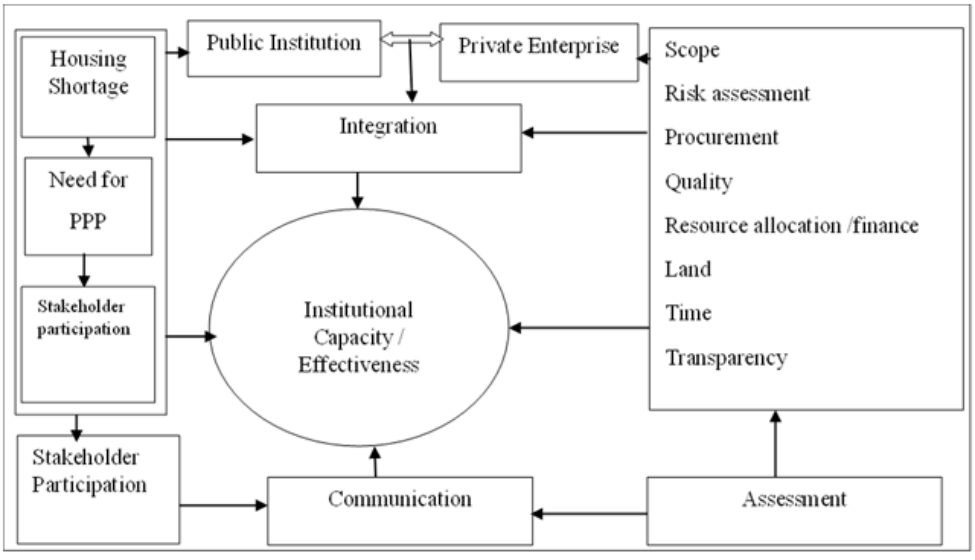


Figure1*: Conceptual Framework*
Source*: Adapted from Kavishe (2019)*

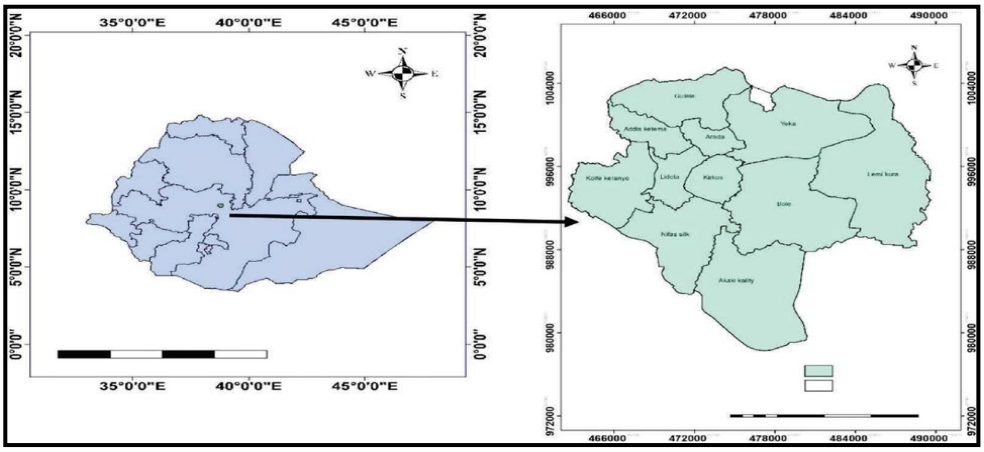
Furthermore, insufficient planning, particularly when combined with limited stakeholder engagement during both the planning and implementation stages significantly undermines the ambitions of innovative financing through PPPs (Miranda-Poggys& Morena, 2023). Such deficiencies not only jeopardize project success but also lead to substantial financial losses and increased public debt, eventually imposing burdens on beneficiaries of housing development who actually suffers the failures of the projects (Boiarko et al., 2021; Godt, 2023). Therefore, for the conceptual framework stated below demonstrates the PPP initiatives, planning and stakeholder involvement to ensure their overall efficacy and sustainability of PPP frameworks in housing sector of Addis Ababa City Administration.

3. Material and Methods

3.1. Description of Study Setting

This study was conducted in Addis Ababa, the capital city of Ethiopia. Geographically, the city is located at approximately 9°0' 019.4436" North latitude and 38°44' 24" East longitude (CSA, 2013).

Figure 2: *Map of Addis Ababa City Administration*



Source: *Modelling Urban Land Use in Addis Ababa, Ethiopia (Berta & Emagnu, 2024).*

Spanning an area of 527.4 square kilometres, Addis Ababa features a predominantly mountainous landscape, particularly in its northern escarpments (Ethiopian Institute of Architecture, Building Construction and City Development,

2017). With its relatively better developed infrastructure, Addis Ababa serves as the hub of Ethiopia's economic transactions, driving regional development.

3.2. Study Design and Methods

This research employed a mixed explanatory design, incorporating Confirmatory Factor Analysis to ensure comprehensive analysis. According to Maqbool and Sridhar (2024), using a survey strategy for quantitative data strengthens the understanding of PPP implementation within a study setting in this case, the Addis Ababa City Administration. Quantitative data was collected from 203 participants, while qualitative data was gathered from five (5) interviewees and supplemented by a review of legal and official documents. The qualitative data provided combinations and support in components such as planning and implementation, risk identification, procurement, and housing development.

3.3. Sampling Design

A simple random sampling method was used to select eight private-sector partners out of the 22 who are currently engaged in PPP projects. All relevant government offices involved in PPP initiatives were also included, such as the Addis Ababa PPP Office, the PPP Contracting Administration Team of the Addis Ababa Housing Development Bureau, and the PPP Directorate General of the Ministry of Finance. The eight selected private partners elected because they commenced the construction process were OVID Real Estate, Gift Real Estate, Africa Holdings, Irre General Trading, Jambo Star Trading, KH Engineering Group, Oromiya Construction Corporation, and East African Real Estate Development Plc. From these private real estate companies and public institutions, a total of 203 sample employees were chosen: 170 individual respondents from the private companies and 33 experts from the government offices.

The sample size was determined using Yamane’s sample size determination formula:

Where: $n=N/ [1+N (e^2)]$, (Uakarn et al., 2021).

n= sample size, N= population = 412, e= level of precision=0.05,

Calculating this, we have "n" equals to:

Sample size $n=N/ (1+N (0.05)^2)$, $n=412/ [1+412(0.05)^2]$

n=412/(1 + 1.03]) n=412/2.03

Sample size n =203.

3.4. Method of Data Collection

The data for this study were collected through self-administered survey questionnaires and an interactive interview guide, with primary data obtained from multiple key stakeholders. Additionally, secondary data sources were reviewed including signed PPP contracts, PPP proclamations, and directives.

A total of 216 questionnaires were distributed, resulting in 203 valid responses, which represents a response rate of 94%. This high response rate reflects strong engagement by the experts from both sectors and provides a robust dataset for analyzing the planning and implementation phases of PPP in the housing development of Addis Ababa City Administration. The Cronbach alpha test result was 0.9617 indicating the data is reliable in measuring the variables under study.

3.5. Analytical Techniques

The analysis utilized Confirmatory Factor Analysis (CFA) for quantitative data and analyzed using R-Studio software and thematic analysis applied for qualitative data. Ten key performance indicators were identified to examine PPP institutions within the Addis Ababa City Administration, focusing on the initiation, planning, and execution of PPP projects. The model emphasized examining the planning phases, particularly in terms of institutional capacity.

The data analysis utilized descriptive and inferential statistical techniques, including path coefficients, factor loadings, and R-square values. Confirmatory Factor Analysis (CFA) was conducted using R Studio (version R4.4.2; R Core Team, 2021), a statistical technique to test

relationships between measured constructs (observed variables) and institutional capacity (latent variables) (Yamani et al., 2024; Goretzko et al., 2024).

General Equation:

EFF = 0.99 PRO + 0.54 INT + 0.6 TIM + 0.39 COS + 0.65 RAL + 0.66 PL + 0.58 RSP

Where:

- EFF = Effectiveness of planning
- INT = Integration, - TIM = Time
- COS = Cost, RAL = Resource allocation
- PRO = Procurement, - SPL = Stakeholder participation
- RSP = Risk planning

The fitness of the model for measuring the variables was approved by Comparative Fit Index (CFI) = 0.971, and for Tucker-Lewis Index (TLI) = 0.91. In addition, the model fitness test for the second order latent variable focusing on effectiveness of institutional capacity demonstrated the CFI value equals to 0.82 and considered as it approaches the acceptable level.

4. Data Analysis and Discussions

Since 2023, as indicated in the signed PPP contracts, the Addis Ababa City Administration has collaborated with the private sector to provide affordable housing under a 70/30 agreement. In this partnership, the private sector covers the financial costs of housing development, while the public sector allocates land for construction. Upon completion of the agreed number of houses, the private sector delivers 30% of the houses to the Addis Ababa Housing Corporation and retains 70% to recover costs by selling them at market value, as revealed by interviews. To address the challenges stated in the foregone arguments, the city administration enacted PPP Regulation 128/2022 and accompanying directives. This regulation invites private

partners to participate in housing development through the 70/30 PPP model, as outlined in Article 6 of the contractual agreement (the 2023 signed PPP Contract Document). Under this model, private partners design, finance, and build housing, transferring 30% of the constructed houses to the public sector in exchange for land provided by the city government.

Demographic analysis revealed that 37.44% of participants were female, representing various levels of expertise in the construction sector. Furthermore, 67.98% of participants were under the age of 39, with the same percentage holding at least a bachelor's degree. Occupational distribution showed 29.56% of respondents were from government offices, 48.28% from private partners, 16.75% as consultants, and 5% from other departments. The diversity in respondents' age, education, and experience levels would help to fetch diverse insights from professionals with varying perspectives, contributing to a clearer understanding of the in the initiations, planning and procumbent of PPP implementation in the housing sector of Addis Ababa City Administration.

4.1. Results and Discussion

In this section, the survey data analyzed using the Confirmatory Factor Analysis using R-Studio statistical analysis tool and a qualitative data obtained through interview guide from experts and PPP officials presented and discussed.

4.1.1. Integration of the Planning Phases

The analysis revealed a strong positive correlation between integrated planning and the effectiveness of PPP institutions, with a path coefficient of 0.693. This finding underscores the importance of effective integration, of the initiation, preparing the plan and the contract document, resource allocation, and signing the contract, within planning processes and organizations in enhancing the outcomes of PPP implementation.

Regarding the PPP framework, secondary data indicated that contracts were meticulously prepared, signed, and documented to ensure clarity and accountability (the 2023 signed contract). Private partners played a pivotal role by providing financial and technical resources, while the Addis Ababa City Administration took responsibility for land preparation. Per the agreements, private partners were tasked with constructing housing units and delivering 30% of these completed units to the city administration. However, the mean response to the question on adherence to the agreed implementation plan yielded a score of 0.227. This result indicates that the execution of contracts has not fully aligned with the stipulated agreements, pointing to a need for a thorough review and adjustment of the implementation process. Interviews with city administration officials revealed frequent delays in land delivery due to unresolved land clearance issues, which occasionally escalated into legal disputes, further hindering progress. This aligns with the findings of Casady and Peci (2021) in their study on “institutional challenges of PPP” conducted in Kosovo, highlighting similar challenges in PPP execution. The graph below depicts first ordered latent variables.

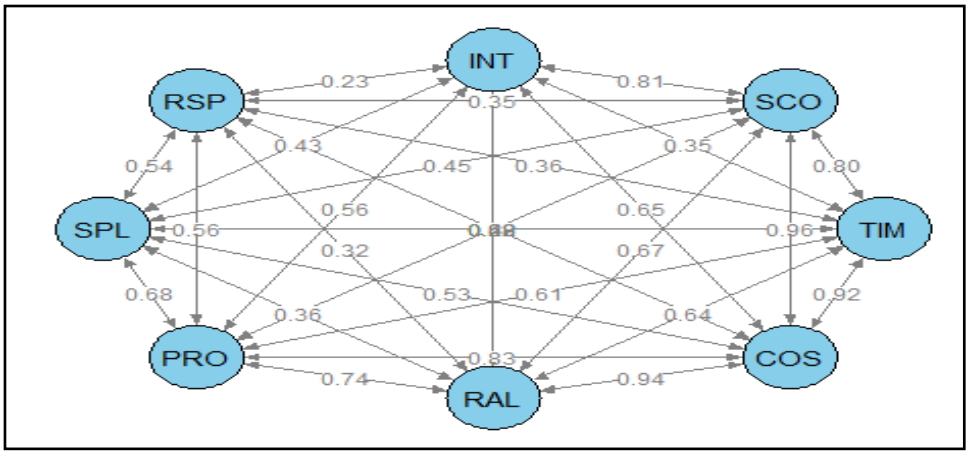


Fig 1. Effectiveness
***Source**: Survey December (2024)*

The graph illustrates the first-order latent variables derived from the data analysis conducted using R Studio software. It visualizes the relationships and path coefficients between different latent variables, which serve as indicators for assessing the effectiveness of Public-Private Partnership (PPP) institutions in Addis Ababa City Administration. The latent variables are represented by Integration (INT), Stakeholder Participation (RSP and SPL), Procurement (PRO), Resource Allocation (RAL), Stakeholder Coordination (SCO), Time (TIM), and Cost (COS).

As shown in Figure 3, the connecting lines represent path coefficients, indicating the strength and direction of the relationships between the variables. The numerical values along the lines are standardized path coefficients, ranging from -1 to 1, with higher values denoting stronger relationships. The analysis of the first-order latent variables revealed positive correlations among dimensions such as procurement, resource allocation, cost, scope, risk identification and sharing, time, and integration. These robust positive correlations collectively demonstrate the steady progression of institutional capacity among the Addis Ababa City Administration PPP implementing offices. This aligns with the findings of Calugareanu and Bulat (2022) in their study titled *"World practice in the evolution of PPP,"* which states that PPP effectiveness is influenced by an

efficient administrative structure, private sector development, and investment potential.

Equation 1: INT =~ 0.71iwas + 0.61ikas + 0.23iipp + 0.6ikpd + 0.58ihid

- Comparative Fit Index (CFI) 0.988
- Tucker-Lewis Index (TLI) 0.969

The result of the model fit was acceptable in which the model measures the dimension effectively.

***Table 1**: Integration*

Latent Variables: INT(Integration)								
Measured variables	Estimate	Std. Err	z-value	P(>|z|)	ci. lower	ci. upper	Std.lv	Std. all
Project plan preparation (ikpd)	0.815	0.131	6.241	0.000	0.559	1.071	0.687	0.603
Plan implementation (ikpia)	0.348	0.133	2.623	0.009	0.088	0.607	0.293	0.227
Contract document well prepared (iwas)	1.000	1.000	1.000				0.842	0.707
Contract signed (ikas)	0.870	0.138	6.282	0.000	0.599	1.141	0.733	0.610
Supporting project document prepared (ihid)	0.779	0.128	6.086	0.000	0.528	1.030	0.656	0.577

***Source:** Survey December (2024)*

Factor loadings depicted in the graph validated these findings. For instance, the outer loading weight for the variable "*signing of the partnership document*" was 0.71, indicating its strong connection to the latent variable of integration. Conversely, outer loading factors for variables like "*detailed plan preparation*" were below 0.7, suggesting a weaker association between these indicator variables and the implementation of signed agreements.

Table 1 presents the standardized factor loadings for the latent variable "INT" (Integration) derived from a survey analysis. The Comparative Fit Index (CFI) of 0.988 and Tucker-Lewis Index (TLI) of 0.969 indicate an excellent model fit, exceeding the recommended threshold of 0.90. The factor loadings range from 0.348 for *participatory planning* to 1.000 for *signing of the contract document*, reflecting varying degrees of association between the measured variables and the latent construct of Integration. The statistical significance of the factor loadings was confirmed through standard errors, z-values, and p-values. Most of the factor loadings were

significant at the *p >0.001* level, underscoring a strong relationship between the measured variables and the latent construct.

The integration of the planning process emerges as a key indicator in examining the effectiveness of the Addis Ababa PPP Office in financing affordable housing projects. In this framework, the Addis Ababa Housing Construction Corporation assumes responsibility for planning and monitoring the execution of action plans derived from PPP contracts. A dedicated team within the Housing Corporation is tasked with developing these plans, engaging in with the private partner's entity, known as the Special Purpose Vehicle (SPV), and conducting regular assessments of project progresses. This team is also responsible for addressing deviations from the agreed plans to ensure alignment with overarching objectives of the contracting parties.

***Table 2**: Analysis Result of Qualitative Data*

Theme	Description	Qualitative data
Integration	The capacity of the PPP institutions to integrate the initiation, planning, and implementation process	In the planning (initiation, resource allocation, and contract signing) phase are relatively well integrated. In the implementation phase there were delays in the transfer of land handing over, SPV establishment, commencement of construction (8 out of the 22 partners signed the contract and commenced the construction)
Initiation and planning	Initiating the idea, preparing the feasibility study, preparing PPP plan document	The planning phase of this dimension were properly accomplished

Contract document preparation and signing	Preparing a contract document having clear goal, resource contribution, risk explicitly put, deliverables identified in terms of number, size, quality, and singing the contract	-The document clearly identified the capital of the private partners, design, and construction. It also identified transfer of land prepared by the city having access to water and electric - 30% of the constructed houses delivered to the public institutions -Room numbers, quality and size of the 30% of the houses not clearly stated in the contract agreement
Transparent procurement	Whether the process of private partners engagement in to PPP was on competition base so that best bidder obtained	Not competitive rather it is invitation based
Plan implementation	Implementing the plan as per the agreement in time	Delays observed commencing the construction out of the 22 partners signed the contract only 8 were started, few partners faced delay in land delivery, SPV establishment to longer time affecting the overall schedule

***Source**: Analysis of extracts from interviews, 2024*

The above table provides the description of the qualitative data on the themes of integration, planning, and preparation of contract documents. Qualitative analysis also adopts the procumbent processes and institutional capacity of the PPP implementing partners. Themes and qualitative descriptions of the data are provided to complement to cross-verify and quantitative findings.

As presented in Table 2, qualitative data obtained through interviews with the Addis Ababa PPP Office, Addis Ababa PPP Contracting Office, Addis Ababa Housing Corporation, and the PPP Directorate General under the Ethiopian Ministry of Finance revealed that the integration of the planning

process was effective in the initiation stage, resource allocation, and in terms of inviting private partners into the partnership arrangement. However, challenges arose in establishing a Special Purpose Vehicle (SPV) Office. This office, designated to administer PPP contracts and act as the project owner on behalf of the private partner, plays a crucial role. Its absence and malfunctioning significantly deterred the overall effectiveness of the projects, as it hindered the timely commencement of construction activities. In this regard, data collection revealed that, out of the 22 private partners who signed PPP contracts, only eight had initiated construction. Additionally, some private partners had not finalized negotiations on the contractual agreements, despite the general contractual framework being already signed. This situation definitely hinders the success of the projects.

Moreover, quantitative data demonstrated the effectiveness of the planning phase's dimensions such as initiation, resource contribution by each party, and contract signing. However, both quantitative and qualitative datasets demonstrated delays in establishing the SPV, finalizing detailed negotiations particularly regarding risks associated with macroeconomic conditions and clarifying how 70% of the constructed houses would be sold to end users. The triangulation of this findings revealed that of the partnership agreement documents revealed that it was not clearly articulated, leaving expectations and responsibilities of public and private partners insufficiently defined.

The work of authors such as Akomea-Frempong et al. (2023) in Ghana also complemented the study findings. The authors reported delays alongside positive performance in the planning and implementation phases of PPP in the housing sector. While problem identification, partner consultation, and appropriate contract document preparation were effectively completed, the implementation phase faced unexpected delays. Challenges such as third-party claims on land and resource mobilization resources had imposed hindrance to the anticipated progresses, with several private partners unable to initiate construction work due to these difficulties (Akomea-Frempong et al., 2023).

4.1.2. Scope, Time and Cost of the PPP for Housing Development in Addis Ababa

The survey results analyzed the scope of assigning the partners' responsibilities, the timely implementation of the plan, and the redistribution of project implementation costs among the partners. These aspects were thoroughly discussed to assess their interventions on the overall effectiveness of the PPP initiatives. The equation below shall demonstrate the measurements of these dimensions.

Equation 2: SCO =~ 0.78ids + 0.65irw + 0.67iks + 0.45ikr + 0.35ibr + 0.53ist

Comparative Fit Index (CFI) 0.945, this result indicates the model was a good fit and the result is dependable.

Tucker-Lewis Index (TLI) 0.881

Whereas:

- iks= scope base line preparation
- ist= requirement traceability matrix
- irw= preparation of work breakdown
- ibr= require elements for implementation
- ikr= requirements for planning met
- ids=scope statement prepared.

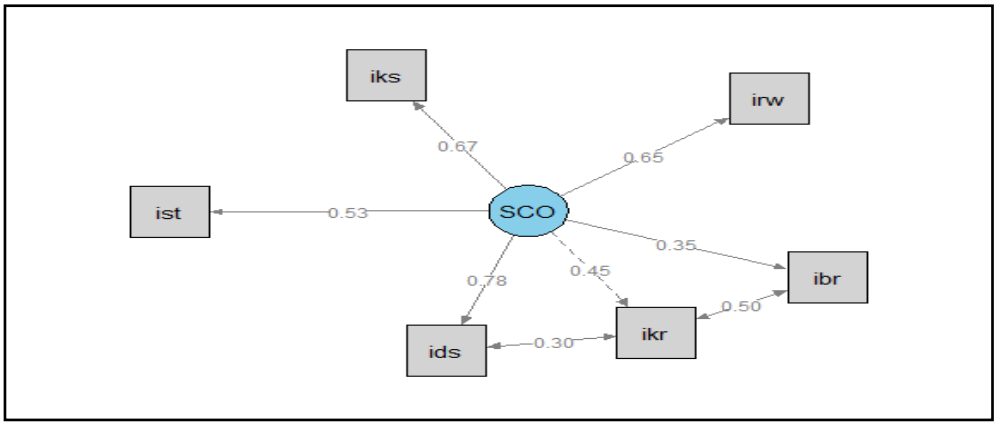


Fig 2: Loading factors of scope

***Source**: Survey December (2024)*

Figure 2 illustrates the outer loading factors of the latent variable "SCO" (Scope), derived from the survey analysis conducted in 2024. The

Comparative Fit Index (CFI) of 0.945 and the Tucker-Lewis Index (TLI) of 0.881 suggest that the overall model fits the data well, with the CFI value nearing the recommended threshold of 0.95.

The highest loading factor, 0.67, corresponds to the measured variable "iks," indicating that the scope of the baseline preparation variable is strongly and positively associated with the latent construct of Scope. Meanwhile, preparation of the detailed action plan and work traceability matrix has lower loading factors, ranging from 0.30 to 0.65. These values signify relatively weaker relationships between these measured variables and the latent Scope construct. The table below provides a qualitative data that would complement the quantitative findings.

Table 3: *Extraction of qualitative data on scope, time and cost*

Theme	Description	Qualitative data
Scope	Identified what is expected from both parties Private partner design, finance, and build, quality, number. Public institutions availing plots of land having water and electric access	The interviews helped to identify that the finance of private partners, design, and build clearly stipulated in the contract. Public institutions prepare plots of land with access to water and electric supplies. The quality and room sizes of 30% of the houses to be delivered were not clearly identified.
Time	Preparation of schedule for each activity, delivering as per the schedule	Schedule was prepared, but delays in land delivery due to third party claim, delay in SPV establishment in some partners, 14 out of the 22 private partners did not start construction on time
Cost	Clearly allocating budget for the project finance, and land	The allocation of cost was well done but, staggered to timely transfer land and some of the private partners took longer time to show 30% of the cost in time and

		lagged the commencement of the construction
Stakeholders' engagement	Involving the private partners, consulting end users	Private partners participated in the consultative activities and decisions Private partners not engaged in risk identification; and the beneficiaries of the housing units have not been consulted

***Source**: Analysis of extracts from interviews, 2024*

As indicated in Table 3 above, qualitative data revealed that the PPP contract clearly defined the responsibilities of the private partners. In a PPP contract agreement, the contracting authority is tasked with providing land to the private partner. Additionally, it is crucial to ensure the signed contract includes detailed specifications such as the number of rooms, room sizes, material quality, and finishing standards for the houses to be constructed by the private partner.

Moreover, secondary data analysis supported these findings, demonstrating that the signed PPP contracts outlined the scope of the project, including private developers' roles in design, financing, construction, and delivering the agreed-upon buildings, green areas, and playgrounds. Qualitative and quantitative data consistently demonstrated that the scope was clearly delimited and that both parties fulfilled their respective responsibilities. However, delays were noted, primarily due to some private partners taking longer time to allocate the 30% share and commence construction. This finding clearly proved the shallow nature of PPP market maturity(Casady, 2023:17; Song et al.).

4.1.3. Institutional Capacity of Addis Ababa PPP Offices

This section addresses the institutional capacity of the Addis Ababa PPP Office and the Addis Ababa Housing Corporation, particularly regarding the operation of systems, rules, regulations, and trained experts capable of managing the complexities of PPP contracts and cases. With the underlying

aspirations to undertake the institutional capacity, both the survey data and qualitative data have been reported in the forthcoming paragraphs.

Figure 3 presents a Confirmatory Factor Analysis (CFA) diagram prepared using R-Studio, which depicts the institutional capacity of the PPP institution. The equation at the bottom of the graph defines the relationship between the latent variable "Institutional Capacity" (EFF) and its predictors:

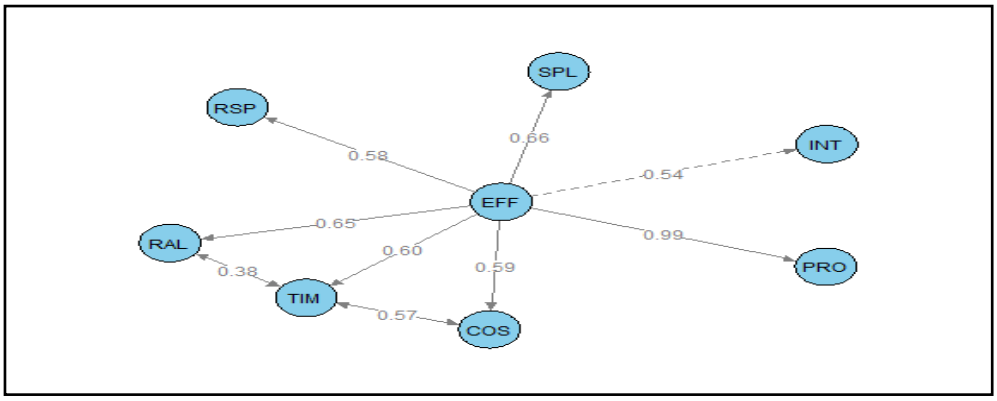


Fig 3: Institutional capacity of PPP institution.

Equation 3: Equation 3: EFF = 0.99 PRO + 0.54 INT + 0.6 TIM + 0.39 COS + 0.65 RAL + 0.66 PL + 0.58 RSP.

This equation indicates that the Institutional Capacity (EFF) of the PPP institution is positively influenced by several factors: including Procurement (PRO), Integration (INT), Time (TIM), Cost (COS), Resource Allocation (RAL), Planning (PL), and Stakeholder Participation (RSP). The diagram visualizes relationships between first-order latent variables and their corresponding second-order latent variables, with "EFF" as the central latent variable representing Institutional Capacity. Path coefficients in the analysis show that institutional capacity is directly influenced by outer latent variables such as integration, risk identification, and transparency in bidding. The institutional capacity of the PPP institutions of Addis Ababa City was assessed based on seven latent variables, with a statistically significant P-value of 0.000 for all variables. This underscores the presence of gap in execution capacity in the institutions.

As shown in Graph 3, the path coefficient between procurement (PRO) and institutional capacity (EFF) was 0.99, indicating a strong relationship between the two. This result was supported by qualitative data, particularly in attracting financing from the eight private partners. Additionally, division of resource contribution of among partners contributed positively to institutional performance. One of the major observations was that the entire process lacked transparency and was not competitively structured. The city administration determined the price under the 70/30 modality, where private partners acted as price takers, and a deviation from international practices. This study focused on the planning process, and further research is needed to assess the effect after the construction phase concludes and houses are delivered to the city and the beneficiaries

Table 4: *Extracts of qualitative data on Institutional Capacity*

Theme	Description	Qualitative data
Capacity	Institutional capacity to coordinate, responsiveness	- Encouraging practices in planning, contract document preparation, contract administration experience, -There is gap in timely engaging all private partners to the construction process, detailed follow up plans not prepared, contract
Expertise	Expertise of managing the complex nature partnership,	-Have project coordinating and supporting staffs -the contracting office Addis Ababa Housing Corporation have engineers, and management staffs
Knowledge	Training on contract administration, project management, PPP knowhow	Trained staffs in engineering and management related lacks training on public private partnership
System	Established system which handles PPP process of engaging	-PPP office is responsible for document preparation to the partner selection; the housing corporation is

	private partners, responsiveness, rules,	a contracting office and responsible for the contract administration
Laws	Presence of directives, regulations	Have PPP directive, procurement directive specially designed for PPP, Have regulation 128/22

***Source**:* Analysis of extracts from interviews, 2024

The interviews revealed that, Table 4, as of data collection, only seven out of 22 private partners had initiated construction activities. Though, delays were attributed to both parties: some private partners lacked experience, financial resources, and technical capacity to meet contractual requirements within the agreed timeline. The empirical findings align with a study conducted in Kenya, which indicates that failing to adhere to timelines and inabilities in handling institutional capacities negatively affect the effectiveness of PPP implementation (Giti, 2023). Additionally, factor loading results indicated that specific timelines defined in contracts, such as the three-month period for depositing 30% of the total project cost, had a moderate relationship with institutional effectiveness, with a path coefficient of 0.6.

The interview data revealed that the Addis Ababa PPP system is well-established, beginning with board committees that provide strategic direction. A PPP Office, directly accountable to the Mayor's Office and the board, oversees the preparation of PPP documents, the selection of private partners, and overall supervision. In terms of regulatory frameworks, the city has a PPP regulation aligned with Federal PPP Proclamation 1076/2018, supplemented by a procurement directive tailored to the unique nature of PPP projects.

Despite these established systems and frameworks, challenges remain in effectively integrating and coordinating PPP projects. This is evidenced by the fact that 63.6% of private partners failed to commence construction on time, largely due to gaps in private partner selection stemming from institutional capacity deficiencies. Additionally, issues such as insufficient detail on room size and quality in contract documents further highlight weaknesses in institutional capacity.

These findings are consistent with Sue Godt's assertion that inefficiency within public institutions and states inevitably leads to poor delivery of services (Godt, 2023). Addressing these gaps in institutional capacity, especially in project coordination and partner selection, is critical to ensuring the successful implementation of PPP initiatives and planning.

4.1.4. Resource Allocation, Risk Sharing and Quality

This section examines the agreements outlined in the contractual document regarding the allocation of resources required for executing the housing construction project. It also investigates whether the risk-sharing processes were systematically implemented to mitigate potential project failures. Additionally, it states how quality assurance measures for the houses under construction were incorporated into both the contractual document and the planning phase.

The quality assurance mechanism of these projects are critical for safeguarding public interest and ensuring compliance with minimum housing standards (Batra, 2022). As indicated in Table 5, one of the interviewees from the private partners noted that key quality indicators—such as material specifications, the number of rooms per house, and room sizes—were not clearly defined in the contractual documents. In a nutshell, the gaps in practice the improvement required to better integrate quality assurance into the agreements and planning processes.

These unresolved issues were anticipated to be addressed during subsequent renegotiations. As the literature suggests, the private sector cannot be held accountable for matters that were not negotiated and signed within the scope of the contractual agreements. This falls in tandem with the findings of Oksana et al. (2020), which emphasize that for PPPs to be effective and successful, risks, responsibilities, and obligations must be allocated among the partners through institutional mechanisms and based on binding frameworks.

Equation 4: RAL =~ 0.7 wrmpp + 0.5 iirmp + 0.74 iktca + 0.49 ikrbsc

Whereas: wrmpp = I participated in resource management plan that was prepared, iirmp = I have information that resource management plan

prepared, iktca= team charter was prepared, ikrbsc = resource breakdown structure prepared. The factor loading for the resource management plan was 0.7, and for the signing of the team charter between contracting parties were 0.74. Both measured variables demonstrated a strong relationship with resource allocation. However, qualitative findings revealed that delays in signing the team charter and preparing the resource breakdown significantly deterred project schedules. Consequently, only 8 out of the 19 private partners had commenced actual construction work, representing a 42% engagement rate in the construction process at a time when the data fieldwork was conducted

Table 5: *Extracts of the interview on resource allocation, risk, and quality*

Theme	Description	Qualitative data
Finance	The budget required for the design and construction	- Private partner expected to cover 30% of the finance from own source, and 70% through the bank loan -The capacity of the private partner to raise the 30% of the finance at the required time often raises serious concern
Land	Plots of land having electric and water access	The city allocated most of the land in time, but in some cases due to third party claim. Location changes in some case happened.
Incentives	Tax reduction or exemption, custom clearance issues, priority to locally manufactured and local materials	No incentives have been allocated, only support letter produced to whom it may concern
Risk	Is risk identification involved both parties, are there chance of allocating risk based on negotiation to the best capable party	One party assigned and the other took it hoping to maintain good relationship for future opportunities
Quality	Standard, room number, and size	-The contract overlooked these issues and focused on the number "30%"

Source*: Analysis of extracts from interviews, 2024*

The analysis of the interview result in Table 5, underscores the importance of specifying the room size and material type in the contractual documents and closely monitoring resource allocation and project scheduling to improve the effectiveness of PPP implementation for affordable housing development in Addis Ababa. These findings align with the study on the applicability of PPP in Kenya for housing development, which emphasized the need to strengthen government institutional capabilities, provide robust

political support for PPP initiatives, and focus on comprehensive risk assessments (Giti, 2023).

4.1.5. Risk identification and sharing

Equation 5: RSP =~ 0.92icipr + 0.85ikrpda + 0.76ikqram + 0.72ikquram

When we see the model fitness the result of Comparative Fit Index is 0.995 and Tucker-Lewis Index 0.970 indicating the model fitted very well. This equation indicates that the latent variable "Risk Sharing and Participation" (RSP) is influenced by various measured variables, including icpr (risk identification), ikrpda (risk planning), ikqram (qualitative risk assessment), and ikuram (quantitative risk assessment), with the corresponding path coefficients. The central latent variable in the diagram is "RSP", which represents the "Risk identification and sharing" construct.

In the PPP arrangement risk minimization strategy attained by jointly identifying risk between the public institution and the private enterprise (Bagenda & Ndevu, 2023). The survey data analysis result shown risk was transferred to the private partner. However, the result of the qualitative data indicated though risk shared to the private sector the process of identification of the risk and its sharing was not participatory. This means risk not shared based on negotiation rather assigned which might compromise the effectiveness of the mitigation strategy.

Graph 4, presents the results of a Confirmatory Factor Analysis (CFA) diagram illustrating the "Risk Identification and Sharing" model, based on the survey analysis conducted in 2024.

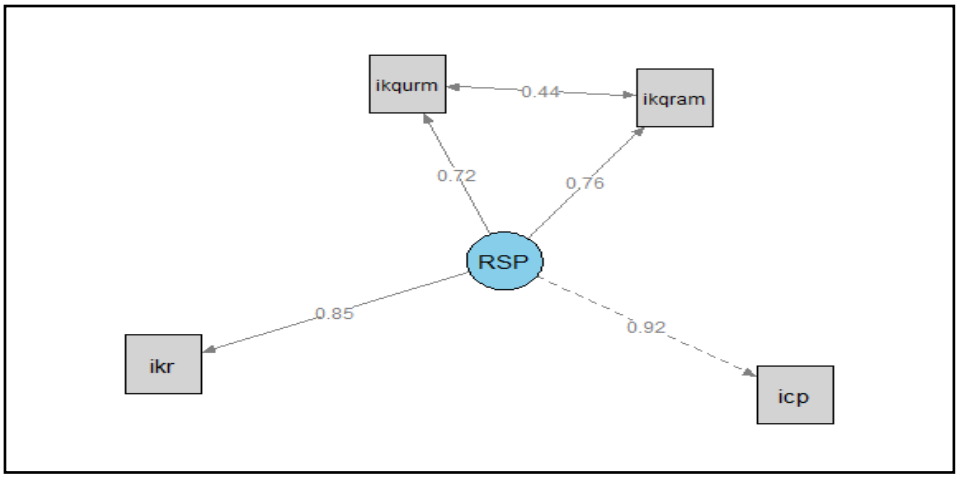


Fig 4: *Risk identification and sharing*

The risk sharing and identification dimension have been influenced by all measured variables, as indicated by the path coefficient results, which were consistently above 0.7. These results signify strong positive relationships. The city administration has taken the responsibility for risks associated with the provision of land and utilities, while private partners were responsible for risks related to design, financing, and construction management. However, these responsibilities were not often negotiated to the greater extent. Without clear, negotiated risk-sharing agreements, it becomes unlikely and unprofessional to decide which party would be better equipped to bear specific risks. This lack of clarity continues to undermine the overall successes of project goals.

Interview excerpts, as presented in Table 5 above, along with signed contract documents, confirmed that risk responsibilities were predefined rather than negotiated. The public sector was tasked with managing risks related to land and utilities, while the private sector has dealt with risks associated with financing, design, and construction.

As shown in Graph 4, the path coefficient for the "Risk Identification and Sharing" variable was 0.58, indicating that this aspect was insufficiently treated in the partnership agreement. This underscores the importance of negotiated risk-sharing mechanisms to ensure the success of PPP initiatives. These findings align with a study on the “Influence of Public Credit Risk on

Private Capital in PPP Models," which highlighted those private investors tend to select projects aligned with their risk tolerance levels (Li et al., 2023).

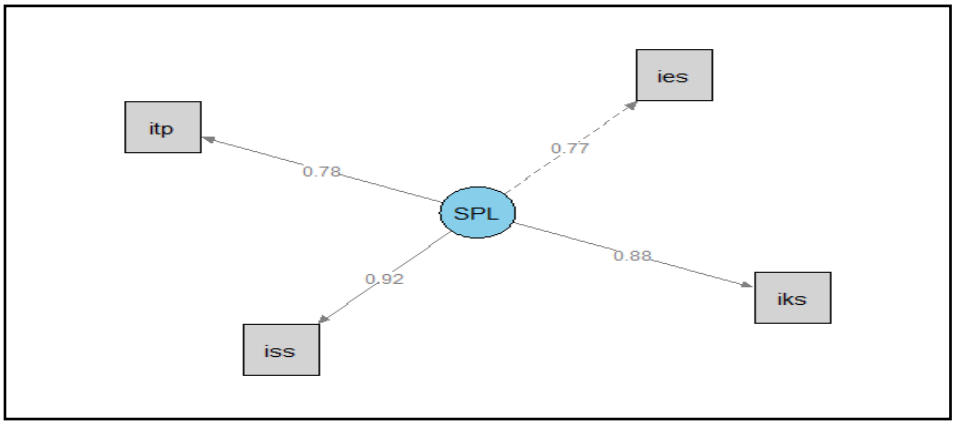
4.1.6. Stakeholder Engagement

In the context of analyzing the PPP housing of Addis Ababa City Administration, stakeholders include those directly affected by the project, both internally and externally. These stakeholders comprise the end users, private partners, and the contracting authority. These are actors directly involved in the city's PPP housing initiatives and projects.

The results obtained from the survey data, which were analyzed using Confirmatory Factor Analysis, along with findings from the thematic analysis of qualitative data, have been discussed and triangulated to provide comprehensive insights complementing with other dimensions of the PPP framework in housing sector. The equation below provides the formula for undertaking the stakeholder's analysis and the variables deployed to measure it.

Figure 5 below presents a CFA diagram depicting the "Stakeholder participation" model developed based on the survey analysis conducted in 2024/25. The equation at the top of the graph shows the mathematical representation of the model:

Equation 6:SPL =~ 0.77ieis + 0.88iksppi + 0.92issac + 0.78itpsmp



Graph 5: *Stakeholder participation*
Source*: Survey December (2024)*

Whereas:

- ieis (stakeholder identification)
- iksppi (stakeholder involvement in implementation)
- issac (stakeholder analysis)
- itpsmp (stakeholder participation at the planning stage).

The central latent variable in the diagram is "SPL", which represents the "Stakeholder participation" construct. This dimension is directly influenced by the measured variables iksppi, issac, and itpsmp, as designated by the path coefficients of 0.88, 0.92, and 0.78, respectively. The path coefficients, ranging from 0.77 to 0.92, indicated the presence of strong influence of the measured variables on the latent variable of Stakeholder Participation and Linkage. This suggests that the PPP institutions have effectively engaged stakeholders.

However, qualitative data in Table 5 uncovered gaps in stakeholder participation. While private partners, public officials, and experts involved in planning were recognized as stakeholders, and end-users (residents) were not adequately consulted. Additionally, pre-determined allocations of 70% of the buildings to be constructed allocated to the private partners as a compensation of the cost it incurred in the construction process and 30% of the houses to public sectors this makes stakeholder participation limited for it lacks flexibility and open negotiation.

Comprehensive analysis of the stakeholder participation model highlights the importance of integrating diverse stakeholder perspectives-especially those of end-users into decision-making and project delivery. Doing so can enhance the effectiveness of PPP frameworks for affordable housing in Addis Ababa.

These findings fall in line with the study by Muthoni and Obuba (2023), which noted that cities like Singapore and Boulder benefited from robust stakeholder participation in PPP, whereas Meru, Kenya, did not fully capitalize on such participation. Similarly, findings by Chileshe et al. (2022) in Kenya echo Addis Ababa's experience. While facets like housing

designation, partner consultation, cost estimation, and contract signing (with 22 private partners) were handled successfully. Overcoming, all the prevailing challenges are essential to optimizing stakeholder engagement and improving the overall outcomes of PPP initiatives.

5. Conclusion and Recommendations

Conclusion

This study focused on the analysis of the planning phase of the PPP for housing development in Addis Ababa City Administration. While the city has taken remarkable steps in introducing alternative financing options and there are areas that still demand improvement. In this regard, the city administration witnessed making commitments in integrating the initiation; planning, preparing the contract document and getting it signed, and pushed the private partners to start the construction process.

Regarding clearly identifying costs and assigned 70% of it assigned as the private partners contribution, the resource allocation of the finance, design, and resources essential for the construction process well planned. In addition, the preparation of the overall planning, contract document preparation, and getting it signed by the invited private partners were the major success achieved in the planning phase. Therefore, the city administration was witnessed promising results in integrating the initiation, planning, preparing the contract document and getting it signed, even in getting some of the private partners to start the construction process.

Among others, lack of participatory risk identification by private partners and the public institution constituted the key challenges undermining the operation of the planning phase. In addition, partners were also expected to agree on how unforeseen risk handling mechanisms are put in place. This engagement requires assigning rolesto the parties in terms of their capacity and experience to handle risks towards the major goal of constructing houses through partnership.

Transparent and competitive procurement processes were also not achieved at the planning phase; demonstrating that this situation can't guarantee that public interest to meet its expectations. The competition gives those partners

technically, and financially capability to mobilize better finances and constructs more houses to meet demands.

These drawbacks are attributed to the poor institutional capacity and lack of experience on the practices of Public Private Partnership. As a result, the preparation of the partnership contract document missed essential components that assure of the quality of the houses and room size including the material type used for constructions. The provision of (30%) alone can't guarantee the value for money of the land allocated for the PPP arrangement as contribution on the side of the City administration.

Furthermore, the limited involvement of housing beneficiaries during the planning and implementation stages revealed a critical a gap in stakeholder engagement, which would compromise the long-term sustainability of housing projects.

Recommendations

To enhance the effectiveness of the PPP framework for at the planning phase of the housing development in Addis Ababa, the following recommendations are proposed:

1. **PPP initiation and planning-** to ensure the sustainability of PPP it is key to consult the end users of the houses on the type, size, room numbers and even on the cost recovery up on rent or transfer. There must be a mechanism for encouraging the private partners to invest their resources in the public sector. This requires to be well documented in the planning phases so that it could be possible to offer incentives, priority in getting raw materials, administrative support or could be minimum profit guarantee.
2. **Promote Transparent Procurement Processes**: develop transparent and competitive procurement mechanisms that allow private entities to negotiate terms. This approach will help balance the private sector's profit motives with the public's need for affordable and accessible housing.. Having clear and transparent procumbent processes shall, minimize corrupt behaviors from the side of the public institutions and opportunistic behaviors in the side of the private partners.

3. **To ensure success in the implementation of PPP,** scope of the contract agreement has to be defined. In this case, the responsibilities of the private partners have to be clearly defined and should be annexed explicitly in the contract document, because once the document is signed, it becomes binding before the law and failing to meet these clauses brings fine.. Moreover, the plan and the contract documents need to demonstrate the time when each of the milestones should start, accomplished and delivered.
4. **Enhance Stakeholder Engagement**: actively engage beneficiaries of housing development, especially residents, in the planning and implementation stages. Their perspectives help to ensure that housing projects align with community needs and gets acceptance.
5. **Strengthen Institutional Capacity**: prioritize investments in capacity-building programs for PPP implementing offices. This will empower them to effectively manage projects, address risks, and harmonize the interests of private partners meeting public interests, laying the ground for smoother project initiation and execution.
6. **Risk identification**, sharing between partners, and designing mitigation strategies: PPP is a long-term contract requiring large amount of finance. This situation demands sharing the inevitable risks such as inflation, bankruptcy of the private partners, regime change in the public institutions, and policy changes. The main goal would be capitalizing on the strengths of each party and put mechanisms for sharing the risks at a planning phase...

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Trends of Climate Change and Variability in Different Agroecological Zones of Sidaama Region, Ethiopia: Application of Innovative Trend Analysis

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Abstract

This paper analyzes climate change trends and variability in the Sidaama region, comparing three agroecological zones (AEZs). The dataset, covering 1981 to 2020, was sourced from the National Meteorological Institute of Ethiopia using a 4x4 km grid. The trend in precipitation and temperature was assessed using Innovative Trend Analysis (ITA), the MK test, and Sen's slope, while the variability was analyzed through the Precipitation Concentration Index (PCI), Coefficient of Variance (CV), and Rainfall Anomaly Index (RAI). Results showed mean annual rainfall of 942.4 mm, 1101.2 mm, and 757.0 mm for the highland, midland, and lowland zones, respectively, with 2020 being the wettest year and 2015 the driest across all zones. Rainfall demonstrated a decreasing trend, while both maximum and minimum temperatures increased. The midland zone experienced the most significant changes, with a rainfall decrease of approximately 12.1 mm/year and a mean annual maximum temperature increase of 0.063°C/year. Most results across tests were consistent, except for a few instances. PCI indicated moderate intra-annual and inter-seasonal rainfall variability, while RAI results highlighted varying drought conditions, particularly affecting the lowland zone. Without timely interventions, these climatic changes could worsen poverty, malnutrition, and migration in the region, necessitating adaptive strategies like enhanced water conservation, climate-resilient agricultural practices, and afforestation to counteract deforestation-induced precipitation declines.

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Keywords: Agroecological Zones,Climate change**,** Climate Variability**,** Innovative Trend Analysis**,** Rainfall Anomaly Index

1. Introduction

Climate change poses a significant challenge to global sustainable development, impacting ecosystems, economies, and livelihoods (IPCC, 2023; Singh et al., 2024). Developing nations, particularly Ethiopia, are especially vulnerable due to their dependence on rainfed agriculture, limited adaptive capacity, and existing socio-economic issues (IPCC, 2023). The increase in the frequency and severity of extreme weather events has been a direct consequence of climate change. Regions are facing prolonged droughts, severe flooding, and dramatic temperature fluctuations, significantly affecting food security, water resources, and biodiversity (Friederike et al., 2024). The Intergovernmental Panel on Climate Change (IPCC) highlights that human activities have caused unprecedented global warming, with temperatures now about 1.1°C higher than pre-industrial levels (IPCC, 2023). This warming has exacerbated weather extremes, including heatwaves and erratic rainfall, disproportionately impacting climate-sensitive sectors like agriculture (Masson-Delmotte et al., 2019). Sub-Saharan Africa, which contains over 60% of the world's arable land and a population reliant on rain-fed farming, faces acute vulnerabilities (Serdeczny et al., 2017). Ethiopia exemplifies these challenges, with climate variability disrupting agricultural productivity and worsening food insecurity and socio-economic inequalities(Alemayehu et al., 2020; Belay et al., 2021).

While initiatives like the Paris Agreement aim to limit global warming to 1.5°C (Erickson & Brase, 2019), varying climate impacts require localized, evidence-based strategies. Agroecological zones (AEZs) have distinct climatic, topographic, and soil characteristics, necessitating tailored adaptation measures(Haas, 2018). However, many studies generalize trends over broad regions, neglecting localized variability (Jjemba, 2021). This is particularly evident in Ethiopia's Sidama Region, where smallholder farmers face diverse climatic risks across highland, midland, and lowland AEZs (Yilma, 2001).

Ethiopia's agrarian economy, which employs 70% of its population and accounts for 34% of GDP, is highly susceptible to climate change(Ebrahim et al., 2022; National Plan Commission et al., 2021). Over the last 40 years, average temperatures have increased by 0.37°C (Mekonnen et al., 2024), coinciding with declining rainfall during crucial cropping seasons(Belay et al., 2021). The Belg (spring) and Kiremt (summer) rains, vital for crops like maize and teff, have become increasingly erratic, leading to recurring droughts every 5–10 years, compared to historical cycles of 20–30 years (Alemayehu &Bewket, 2016; Asfaw et al., 2018).

The Ethiopian government's development strategies, such as the "Home-Grown Economic Reform Agenda" (2020–2030), prioritize climate adaptation and resilience(National Plan Commission et al., 2021). Nevertheless, smallholder farmers in southern and eastern regions are particularly vulnerable to climatic shocks, demonstrated by the devastating 2022 drought that affected millions (Calderon et al., 2022). Climate fluctuations significantly impact the agricultural sector, where many farmers depend on rainfed methods, leading to lower yields and increased food insecurity (Gezie, 2019; Mohammed, 2020).

Research on climate trends in Ethiopia has yielded mixed results. Studies across different AEZs reveal inconsistencies in rainfall and temperature trends (Tesfaw et al., 2024). Some findings indicate minor increases in summer and annual rainfall in parts of Oromia (Assefa & Mengistu, 2021), while others report contrasting trends in temperature extremes (Gashaw et al., 2023). In southern Ethiopia, variations in temperature and rainfall have intensified droughts and flooding, heightening vulnerability (Tesfaw et al., 2024). Despite growing research, these inconsistencies highlight the need for localized, high-resolution studies to better understand climate trends.

Few studies have explored spatiotemporal climate trends in the Sidaama region, with research mainly concentrated on drought-prone districts or specific river catchments (Belihu et al., 2018; Matewos& Tefera, 2020; Mekuyie, 2021). Moreover, conventional trend analysis methods like Mann-Kendall and Sen's slope estimator have dominated climate research

in Ethiopia (Hordofa et al., 2022; Jiqin et al., 2023), including the Sidaama region. However, these traditional methods are limited in identifying subtle trend changes, especially in non-monotonic data, and often overlook intra-annual variability and hidden trends. Although effective for detecting monotonic trends, they fail to differentiate among various data quantiles (Şen, 2017).

Hence, this study aims to address these methodological gaps by using the Innovative Trend Analysis (ITA) method, a novel approach that captures trend behavior across different data segments. By combining ITA with conventional methods like the Mann-Kendall test and Sen's slope estimator, this research seeks to validate findings and enhance the reliability of trend assessments.

This study intends to bridge existing gaps by employing ITA as the primary analytical tool while validating with Mann-Kendall and Sen's slope analyses. Focusing on Sidama's three AEZs (Highland, Midland, and Lowland) from 1981 to 2020, it assesses annual and seasonal rainfall and temperature trends, evaluates variability, and compares findings across different agroecological contexts. By incorporating ITA, this research enhances methodological rigor in detecting complex climate trends, providing actionable insights for climate-resilient planning in Ethiopia's critical agricultural regions.

2. Materials and methods

2.1. Description of the Study Area

Sidaama National Regional State (SNRS) is a south-central Ethiopian region (Fig.1a) with a population density of 694.6 people/square km. It lies between 6°14'–7°18' N latitude and 38°20'–39°20' E longitude. The region, covering 6539 km^2, has 30 districts, Hawassa city, and six town administrations (Planning and Development Bureau, 2023), with an estimated population of 5,301,868 (CSA, 2023). The region's annual population growth rate is 2.9%, which is expected to double in the next 24 years. This region, which is part of Ethiopia's Great East African Rift Valley, has a diverse climate and has been categorized into three

agroecological zones: highlands (30.54%), midlands (45.30%), and lowlands (24.16%). The region's elevation ranges from 1132 m.a.s.l. at Lake Abaya to 3311 m.a.s.l. at Garamba Mountain (Planning and Development Bureau, 2023). The administrative map of the study area is depicted in Fig. 1.

Most households in the region rely on subsistence agriculture, with *waasa (the product of enset or* Enseteventricosum) being the staple food. Cash crops include Sidaama Coffee (a popular Arabica coffee) and khat. Other crops include: barley, wheat, maize, and teff; cereals such as beans, peas, haricot beans, and soya beans; and fruits such as avocado, mango, banana, and apple; and vegetables. This region is wellknown for its coffee production and well-developed agricultural cooperatives (Ware et al., 2023).

Among the 30 rural districts of the region, three were purposefully selected based on agroecological zones because of their vulnerability to climate change and variability, and their impact varies from one AEZ to another.
Traditionally, the Sidaama region is divided into three agroecological zones**:** Highland (*Alicho*), Midland (*Woricho*), and Lowland (*Gammoojje*).

1. Highland (Alicho) – Wet and Cool Temperate Climate
The highland zone, covering 15% of Sidaama's total land, lies at an elevation above 2500 m.a.s.l., receiving 1,200–1,800 mm of annual rainfall and experiencing temperatures between **10–15°C**. This region is the source of major rivers, including the Gannaale River, which flows into Somalia's Wabishabele River. Livelihoods are based on cultivating *enset*(*Weese*), wheat, barley, peas, beans, and apples, alongside small-scale livestock rearing (Worana&Atsimegiorgis, 2022).
2. Midland (Woricho) – Moist to Humid, Warm Subtropical Climate
The midland zone, constituting 48% of Sidaama's land, lies between 1,500–2,500 m.a.s.l., with 1,000–1,800 mm of annual rainfall and temperatures ranging from 15–20 °C. It is the economic hub of the region, dominated by coffee and khat cultivation, with enset as a staple food and maize as an essential crop. Vegetables (cabbage, carrots) and fruits (banana, avocado, mango) are grown for household consumption and the market. Livestock

rearing is practiced, though limited availability of grazing land restricts herd sizes (Worana&Atsimegiorgis, 2022).

3. Lowland (Gammoojje) – Dry and Hot Tropical Climate.

The lowland agroecological zone, covering 30% of Sidaama's land, is semi-arid, with an elevation of less than 1,500 m.a.s.l., annual rainfall of 400–1,000 mm, and temperatures between 20–30°C. Agriculture is primarily subsistence-based, with maize and haricot beans being staple crops, while sorghum, coffee, and khat are grown at higher elevations. The region is known for large-scale livestock production but faces recurrent droughts and food insecurity, making many households dependent on humanitarian aid (Worana&Atsimegiorgis, 2022).

Three meteorological stations (one from each district) were selected to make a trend analysis of climate change (temperature and rainfall). The selected meteorological stations include Arbegona (highland), Leku (midland), and Hantate (lowland) (Fig. 1b).

Factors that are taken into consideration during the selection of AEZs and meterology stations include the location of the AEZ, which is highland, midland, and lowland, in line with the traditional AEZ classification in Ethiopia, and its proportion in the respective villages or centers(Deressa & Hassan, 2010). The second factor is the availability of at least a full year's worth of temperature and rainfall data to help the trend analysis (annual and seasonal) of climatic variables; and the third one is the physical distance between the meteorological stations chosen to represent each AEZ and the number of stations within an AEZ (Amphune& Ababa, 2019). In this regard, in each district, there is only one station that is representative of the distinct AEZ, and only one center is selected from each.

Ethiopia's rainfall season (including Sidaama region) is classified into three time points: Summer/*Hawado* (major rainy season, June - September), Spring/*Badheessa* (short rainy season, February - May), and Winter/Arro (dry season from October to January) (Alemayehu &Bewket, 2017; Matewos& Tefera, 2020). The analysis of the trend and variabilities of rainfall and temperature is based on this classification. For this research, the

selected agroecological zones, metrological stations, and their descriptions are indicated in Table 1.

2.2. Data Source and Quality Control

The National Meterology Institution (NMI) of Ethiopia provided the gridded dataset (4x4 km spatial resolution) for daily total rainfall from 1981 to 2020 and daily maximum and minimum temperature from 1981 to 2018. The researchers tried to obtain station data for the study area from the NMI. However, this dataset was incomplete, with many missing values, poor quality, and a lack of continuity. For some stations, it gives only 10-year data; for others, it gives 15 years and less which makes the trend analysis crippled. Hence, the researchers preferred to use the gridded dataset to analyze the trend and unpredictability of rainfall and temperature. Other researchers (Ademe et al., 2020; Alemayehu et al., 2020; Matewos& Tefera, 2020) have also recommended the use of gridded datasets for climate analysis in the country.

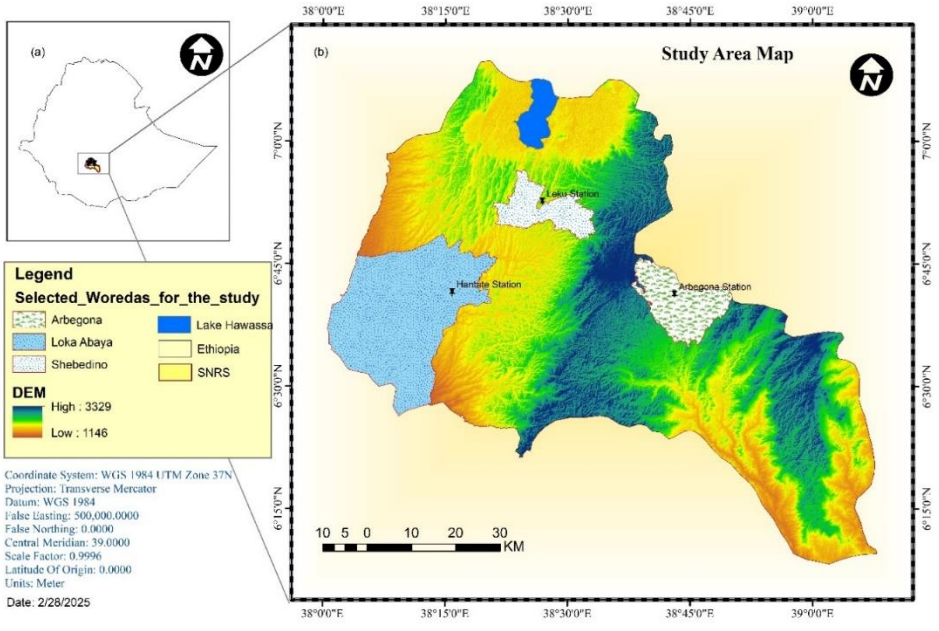


Figure 1. Administrative Map of the Study Area

The data obtained from NMI for total daily precipitation, daily maximum and daily minimum temperatures were converted into monthly, seasonal,

and annual data using Excel 16. The analysis was carried out based on seasonal and annual data. Seasonal rainfall was obtained by adding the rainfall of the corresponding months. The existence of missing data was checked by multiple imputation methods in SPSS (version 27) and it was noted that no missing data was observed indicating the quality of the dataset used.

Table 1. Study Stations, Longitude, Latitude and Agroecological Zones

Station	Latitude	Longitude	Altitude	AEZ	Duration
Arbegona	6.69	38.72	2582	Highland	1981-2020
Leku	6.88	38.44	1911	Midland	
Hantate	6.70	38.27	1698	Lowland	

Source: National Meterology Institution, 2023

2.3Methods of Data Analysis

Time series data on temperature and rainfall were analyzed to assess trends and variability in climate change. Excel 16 was used for data preprocessing, including converting daily data into monthly and annual values and organizing datasets for further analysis. RStudio (version 4.3.2) was employed to conduct trend analysis using Innovative Trend Analysis (ITA) and the Mann-Kendall test, along with Sen's slope estimation. Additional analyses, such as the Precipitation Concentration Index (PCI) and Rainfall Anomaly Index (RAI), were performed as part of the assessment. The detailed analytical techniques are explained in the following sections.

2.3.1 Trend Analysis of Precipitation and Temperature

Innovative Trend Analysis:

Innovative trend analysis (ITA) is based on a subsection of time series plotted on a Cartesian coordinate system. The ITA method offers both qualitative and quantitative interpretations together with a great deal of visual ability for trend detection in graphical representations (Alashan, 2020). The method highlights the fact that when two time series data are plotted against one another and are equal, the grid point system produces a

dispersion of points along the 1:1 (45°) line (Pastagia& Mehta, 2022; Şen, 2017). In this method, the recorded climate time series data are divided into two equivalent subseries, and then, both subseries are organized in ascending order. Thereafter, the 1:1 (45°) axis of no trend, which shows increasing (area above the 1:1 line) and decreasing (area below the 1:1 line) trends, divides the figure into two distinct triangles. A positive trend is shown by data points that fall in the top triangle area of the 1:1 line, whereas lower triangular data points indicate a negative trend. For a more thorough analysis, the scatter points on 1:1-line graphs are also separated into three linguistic clusters: low, medium, and high (Aher & Yadav, 2021; Pastagia& Mehta, 2022). The first subseries values are plotted on the horizontal (X) axis against the second subseries values on the vertical (Y) axis, leading to a scatter diagram. If the scatter points are above or below the 1:1 line with approximately parallel positions, then there is an increasing (decreasing) trend in the records, which is referred to as a monotonic trend. A nonmonotonic trend occurs when all of the scatter points are not exactly above, below, or parallel to the 1:1 line. In this case, the horizontal axis of the graph is split into ranges that include low, medium, and high (Alashan, 2020). In addition, in this work, the following equation (Şen, 2017) was employed to compute the innovative trend slope (SI).

$$S_I = \frac{2(m_2 - m_1)}{n} \text{..... (1)}$$

where m_2 is the second half's arithmetic average; m_1 is the first half's arithmetic average; and n is the total number of observations in the time series data. In ITA, the trend slope represents the rate of change in rainfall or temperature over time, where a positive$S$ value indicates an increasing trend and a negative value signifies a decreasing trend. The slope indicator helps categorize the trend direction, with positive values suggesting an upward trend and negative values indicating a decline. Meanwhile, the slope standard deviation measures the variability in the estimated trend slope, where a higher value indicates greater fluctuations, and a lower value suggests a more stable trend. These metrics provide valuable insights into long-term climate variations (Alifujiang et al., 2020).

Innovative Trend Analysis (ITA) surpasses traditional methods like the Mann-Kendall test and Sen's slope in analyzing rainfall and temperature trends. Unlike rigid statistical approaches, ITA offers remarkable flexibility across diverse datasets and provides an intuitive graphical representation for easy visual interpretation (Alifujiang et al., 2023). Plotting data in two halves of the time series simplifies trend detection, revealing both monotonic and non-monotonic patterns—including increasing-decreasing and decreasing-increasing trends (Alifujiang et al., 2020). ITA is user-friendly, requiring no complex computations, and effectively identifies sub-trends within low, middle, and high categories, delivering a more comprehensive understanding of climate patterns (Gedefaw et al., 2018). However, to validate the results of the ITA method, the outcomes were checked with other methods, such as the Spearman Rho test and the MKtest.

Mann–Kendall Test (MK-test):

The Mann-Kendall (MK) test is a widely used non-parametric statistical method for detecting monotonic trends in time series data. It was first proposed by Mann (1945)and later formalized by Kendall(1975)**.** The test is particularly suitable for analyzing climate variables such as temperature, rainfall, and other environmental data because it does not require the data to be normally distributed and is resistant to outliers. The test evaluates whether there is a statistically significant trend (increasing or decreasing) in a dataset over time. It is based on ranking the data rather than using actual values, making it robust against non-normality and missing data.

Mathematical Formulation

Given a time, series dataset $X_{1,}X_{2,\ldots,}X_n$ with n observations, the Mann-Kendall statistic (S) is computed as:

$S = \sum_{i=1}^{n-1}\sum_{j=i+1}^{n} sgn\,(X_j - X_i)$ …… (2)

where the sign function is defined as:

$$sgn\,(X_j - X_i) \text{ - } \begin{cases} +1, if\ X_j - X_i > 0 \\ 0, if\ X_j - X_i = 0 \\ -1, if\ X_j - X_i < 0 \end{cases} \text{ ---------- (3)}$$

The **variance** of S is given by:

$var(S) = \frac{n(n-1)(2n+5) - \sum t_i(t_i-1)(2t_i+5)}{18}$ ----------(4)

where $t_i$represents the number of tied values for the i^{th} tied group.

The standardized test statistic (Z**)** is calculated as:

$$Z = \begin{cases} \frac{S-1}{\sqrt{var(S)}}, & if\ S > 0 \\ 0, & if\ S = 0 \\ \frac{S+1}{\sqrt{var(S)}}, & if\ S < 0 \end{cases}$$ ---------- (5)

The significance of the trend is assessed using a two-tailed test based on the standard normal distribution. For a given significance level (α), the null hypothesis (H_0) assumes that there is no trend, while the alternative hypothesis(H_1) suggests a significant increasing or decreasing trend:

If $|Z| > Z_{\alpha/2}$, the null hypothesis is rejected, indicating a significant trend in the data.$Z_{\alpha/2}$

If $|Z| \leq Z_{\alpha/2}$, no significant trend is detected.

The MK test has been widely used in climate trend studies in Ethiopia (Ademe et al., 2020b; Belay et al., 2021a; Ware et al., 2023a) and other parts of the world (Kumar et al., 2017; Sibiya et al., 2024).

Sen's Slope Estimator

While the Mann-Kendall test identifies the presence of a trend, Sen's slope estimator(Sen, 1968) quantifies the magnitude of the trend in a time series. It is a non-parametric method that calculates the median of the slopes between all possible pairs of data points, making it robust to outliers and non-normal distributions. For a dataset including n time-sequenced observations, the slope between each pair of observations is computed as:

$Q_i = \frac{X_j - X_k}{j-k}$ for all $1 \leq k < j \leq n$ ---------- (6)

where:

$X_j\ and\ X_k$ are data values at times $j\ and\ k$, respectively.

$j\ and\ k$ represents the time difference between observations.

The Sen’s slope estimator Q is given by the median of all calculated slopes:

Q = median $(Q_1, Q_2, \ldots, Q_m)$ ---------- (7)

where $m = \frac{n(n-1)}{2}$ represents the total number of slope estimates.

To assess the uncertainty in the estimated slope, a confidence interval is computed using the normal distribution approach. The lower and upper confidence limits (Q_L, Q_U) are determined by:

$Q_L = Q_{(m-C_\alpha)}$ ----------(8)

$Q_U = Q_{(m+C_\alpha)}$ ----------(9)

Where $C_\alpha$is derived from the standard normal distribution corresponding to the desired confidence level (e.g., 95%).

A positive slope (Q > 0) indicates an increasing trend over time.

A negative slope (Q < 0) suggests a decreasing trend.

If Q = 0, no trend is detected.

2.3.2 Climate Variability Analysis

Precipitation Concentration Index:

The precipitation concentration index (PCI) values measure the extent of seasonality in rainfall (Alemayehu et al., 2020b). The PCI indicates the rainfall concentration in terms of distribution and variability and is computed on an annual scale (Oliver, 1980).

The formula is:

$$PCI_{annual} = \frac{\sum_{i=1}^{12} pi^2}{(\sum_{i=1}^{12} pi)^2} \times 100 \ldots\ldots\ldots\ldots\ldots (10)$$

whereP_i = the amount of rainfall in the i^{th} month and where $\sum pi^2$ = the summation over the 12 months.

Accordingly, PCI values are interpreted as a uniform monthly distribution of rainfall (PCIs below 10), seasonality in the distribution of rainfall (PCIs between 11 and 20), and high variability in monthly rainfall amounts (PCIs above 20) (Amphune, 2019; C. Li et al., 2020).

Coefficient of Variation:

The coefficient of variation (CV) is a statistical measure of the dispersion of data points in a data series around the mean. A CV's greater value is an indicator of greater spatial variation, conversely. It is computed using the following equation. The inter-annual variability of temperature and precipitation in the chosen AEZs was assessed in this research through the utilization of CV (Oliver, 1980).

$$CV = \frac{\delta}{X} \times 100 \qquad (11)$$

In the given context, CV denotes the coefficient of variation, n stands for the standard deviation (SD) of rainfall and temperature, and X indicates the long-term mean of the aforementioned variables, CV values < 20% denote less variability, between 20% and 30% denote moderate variability, and >30% denote high variability of rainfall among the agroecological zones (Belay et al., 2021b; Habte et al., 2021; Harka et al., 2021).

Rainfall Anomaly Index:

The rainfall anomaly index (RAI) developed by Van Rooy in 1965 (Paul Tume, 2021a) was used to delineate drought and extremely moist periods via data obtained from the NMI of Ethiopia for forty (40) years (1981 to 2020). The precipitation values of each agroecological period of study were ranked in ascending and descending order, where the means of the ten lowest and ten highest values (two extremes) were used in the calculation of the RAI. The mean precipitation value for the study period was also calculated. The formula for calculating positive and negative RAIs is:

$+3\left[\frac{RF-MRF}{MH10-MRF}\right]$ (Positive anomaly) and; ---------- (12)

$-3\left[\frac{RF-MRF}{ML10-MRF}\right]$ (negative anomaly), ---------- (13)

where:

RAI = the rainfall anomaly index

RF = the rainfall for the year in question

MRF represents the mean annual precipitation over the entire period, and MH10 and ML10 represent the means of the 10 highest and 10 lowest values of rainfall (RF), respectively. The RAI was classified as extremely dry (≤ -3); very dry (-2 to -2.99); moderately dry (-1 to -1.99); slightly dry (-.50 to -0.99); near normal (-0.49 to 0.49); slightly wet (0.50 to 0.99);

moderately wet (1.00 to 1.99); very wet (2.00 to 2.99) and extremely wet (≥ 3) (Paul Tume, 2021b).

3. Results of the Study

The results of the analysis are presented in terms of tables and graphs in two main sections.

Trends of Rainfall and Temperature in the Study Area

As the results indicate, in all AEZs of the study area, the highest annual rainfall was registered in 2020, where it was 1723.8 mm for Highland, 1599.5 mm for Midland, and 1529.9 mm for Lowland. Ware et al. (2023b) also obtained a similar result using a dataset from the website TerraClimate for the whole region. The Highland AEZ exhibited the lowest rainfall in 1991 (500.4 mm—the driest year), with mean annual precipitation being 942.44 mm within the 40 years. 1991 was a drier year in the region, with many areas receiving significantly less than the long-term average rainfall, leading to prolonged drought conditions (Ware et al., 2023c). Midland exhibited the lowest rainfall in 2015 (584.6 mm - driest), with a mean annual precipitation of 1101.2 mm. Ethiopia experienced a severe drought in 2015, affecting various regions, including Sidaama, as part of a series of droughts since 1980 (Ware et al., 2023c). In the Lowlands, the lowest was registered in 2012 (728.4 mm—the driest) with a mean annual rainfall of 757 mm (Table 2). 2012, similar to 1991, experienced below-average annual rainfall, resulting in severe drought conditions, with studies indicating that 2012 was among the region's most severe drought years (Matewos, 2019).

The observed extreme variations (both wet and dry years) may indicate increasing climate variability due to climate changes. The frequency of drought years suggests a need for improved water resource management, drought mitigation, and climate adaptation strategies, particularly in the Lowland areas. The differences in the drought years among the AEZs also indicate that there is the need for area-specific intervention in the process of responding to the climate changes and variabilities. The anomalously high rainfall in 2020 could have implications for flood risks, soil erosion, and

agricultural productivity, requiring further investigation into its causes and impacts.

Table 2. Highest and Lowest Annual Rainfall Registered in each Agroecological Zones (1981 to 2020)

AEZ	Highest RF (mm)	Year	Lowest RF (mm)	Year	Mean ARF (mm)
Highland	1723.8	2020	500.4	1991	942.44
Midland	1599.5	2020	584.6	2015	1101.2
Lowland	1529.9	2020	728.4	2012	757

Source: Calculated based on NMI, 2023, RF = Rainfall; ARF = Annual rainfall

In the Highland AEZ, the highest mean maximum temperature was registered in 2018 (26.2 °C), and the lowest was observed in 2011 (18.8 °C). In Midland, the average maximum temperature was registered in 2012 (30 °C) and the Lowland AEZ exhibited the highest maximum temperature in 2015 (29.8 °C). Both the Midland and Lowland exhibited the lowest maximum temperature in 1989, with 26. °C and 25.9 °C, respectively. There is a high variation between the highest and lowest mean annual minimum temperature for the Highland AEZ, where the highest was observed in 2017 (16.8 °C) and the lowest was registered in 1997 (6.5 °C). In Midland AEZ, the highest mean annual minimum temperature was observed in 2017 (15.9 °C), whereas the lowest was observed in 1999 (10.9 °C). There was a higher difference between the highest mean annual minimum temperature and the lowest one for Lowland AEZ as well, where the highest was registered in 1982 (13.6 °C) and the lowest in 1986 (5.5 °C) (Table 3).

Table 3. Mean Highest and Lowest maximum and Minimum Temperatures Registered in each AEZ

AEZ	Highest Tmax (°C)	Year	Highest Tmin (°C)	Year	Lowest Tmax (°C)	Year	Lowest Tmin (°C)	Year
Highland	26.223	2018	16.787	2017	18.791	2011	6.569	1997
Midland	30.008	2012	15.913	2017	26.056	1989	10.931	1999
Lowland	29.871	2015	13.663	1982	25.973	1989	5.567	1986

Source: Calculated based NMI, 2023

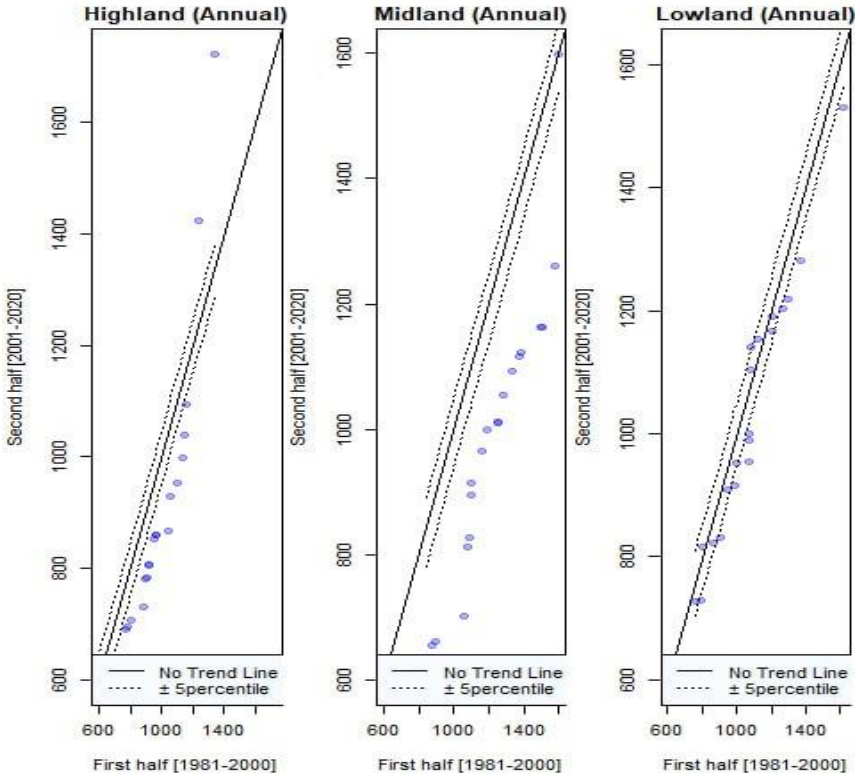
Trends in Annual Rainfall based on Innovative Trend Analysis (1981 to 2020)

The trend in precipitation for Highlands was nonmonotonic. However, there was an extreme increase in the high positive trend (Figure 2). The trend slope of -3.094 indicates relatively small but decreasing trend where the rainfall has been decreasing by approximately 3.1 mm/year. The trend indicator (-0.636) suggests a moderate decreasing trend (Table 4). The trend in precipitation for Midland was monotonic and decreasing (Figure 2). When compared to Highland, the Midland showed a much sharper decreasing trend with a slope of -12.07 or there was approximately a 12.07 mm/year decrease of rainfall, indicating a significant decrease. The trend indicator (-1.976) also confirms the strong and constant decreasing trend. On the other hand, the trend of precipitation for the Lowlands seems to be monotonic and nearer to the "no trend line" (Figure 2). However, most of it exhibited a negative (decreasing) trend, which can be divided into low, middle, and high negative categories. However, as the trend slope indicates, this AEZ exhibited the least sharp decreasing trend compared to others where there was only 2.2 mm/year decrease in precipitation. This was also confirmed by a weaker or very minor decreasing in trend indicator (-0.414). In general, although the magnitude differs, the trend of precipitation for the three AEZs has been decreasing (Table 1 and Figure 2) where Midland exhibited the highest decrease throughout the study period. This could be due to the deforestation caused by agricultural land expansion and fragmentation of the land to invest in afforestation/reforestation. These findings highlight the potential risks of reduced water availability for agriculture and ecosystems, emphasizing the need for sustainable land management and reforestation efforts to mitigate further decline. The result is congruent with some studies in Ethiopia, where all the agroecological zones exhibit a decreasing rainfall trend (Berihun et al., 2023; Engda et al., 2024), while it contrasts with others where the Highland exhibited an increasing trend of rainfall(Sahilu et al., 2024).

Table 4. Innovative Trend Analysis (ITA) Statistics for Annual Rainfall, Maximum and Minimum Temperature (1981 to 2020)

Parameter	Arbegona (Highland)			Leku (Midland)			Hantate (Lowland)		
	PRCP	Tmax	Tmin	PRCP	Tmax	Tmin	PRCP	Tmax	Tmin
Trend SLP	-3.094	0.001	0.035	-12.07	0.063	0.047	-2.227	0.029	0.065
Trend IND.	-0.636	0.015	0.065	-1.976	0.44	0.689	-0.414	0.206	1.186
Slope SD	0.948	0.005	0.012	0.658	0.005	0.001	0.357	0.001	0.003
Correlation	0.861	0.867	0.713	0.948	0.848	0.980	0.977	0.977	0.963

PRCP = Precipitation; SLP= Slope; IND= Indicator; SD= Standard deviation Calculated based NMI, 2023

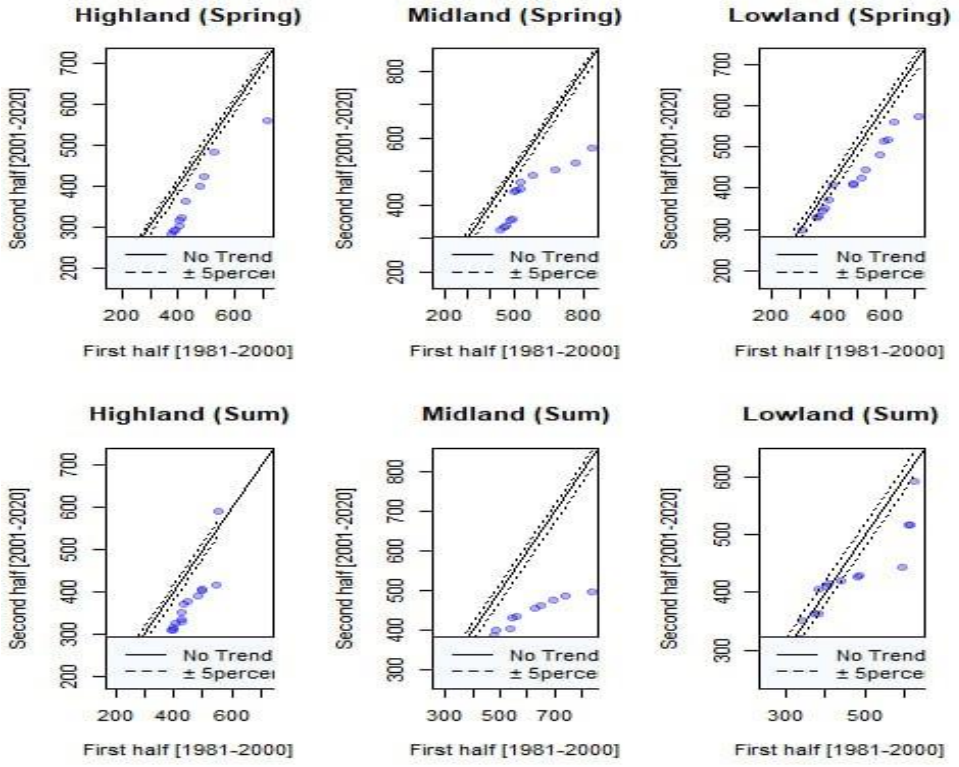


Note: Annual = Annual rainfall

Figure 2. Trends of the Annual Rainfall for the Three Agroecological Zones based on the Innovative Trend Analysis

Trends in Seasonal Rainfall based on Innovative Trend Analysis

In the Highland AEZ, rainfall exhibited a nonmonotonic decreasing trend in both the spring and summer seasons. The result indicated a monotonic decreasing (negative) trend in both the spring and summer seasons for the Midland region, whereas the rainfall indicated a monotonic decreasing trend in the spring season and a nonmonotonic trend for the summer season in the Lowland region. This indicates that the Middle land area experienced a decreasing trend in rainfall throughout the research period. In contrast, spring was the common season where rainfall decreased in all of the AEZs, which may harm crop production and affect the livelihood of smallholder farmers, who solely depend on rain-fed agriculture in the three AEZs of the region. Similar studies also showed that there has been decreasing trend of rainfall in many parts of Ethiopia (Kerebo et al., 2024).



Note: Spring = Spring season rainfall; Sum = Summer season rainfall

Figure 3. Trend in Seasonal Rainfall via Innovative Trend Analysis

Annual and Seasonal Rainfall Trends based on the MK-test and Sen's Slope (1981 to 2020)

As specified in the methodology section, tendencies of annual precipitation were also analyzedvia the MKtest and Sen's slope test for the reference period (1981 to 2020). The results obtained through the analysis indicate that Highland and Lowland AEZs exhibited a nonsignificant decreasing (negative) trend, whereas the Midland AEZ experienced a significant decreasing (negative) trend (pvalue ≤ 0.01) (Table 5) for annual rainfall. When we compare the results of the ITA and the abovementioned tests, they are similar (i.e., decreasing trend) for all the AEZs.

Table 5. Trends in Annual and Seasonal Rainfall based on the MKTest and Sen's slope (1981 to 2020)

AEZ	Annual		Spring (Bdheeessa)		Summer (Hawado)		Winter (Arro)	
	MK	SS	MK	SS	MK	SS	MK	SS
Highland	-1.17	-3.7	-1.01	-2.00	-1.71	-2.66	-0.15	-0.16
Midland	-3.04**	-11.8	-2.7**	-6.14	-2.49**	-4.22	-2.0*	-2.41
Lowland	-0.12	-0.63	-1.23	-2.0	0.048	0.07	0.91	0.98

AEZ = Agroecology; MK = Mann–Kendall test; SS = Sens slope; ** = Significant at the 0.01 level (2-tailed); * = Significant at the 0.05 level (2-tailed); Bdhessa, Hawado, and Arro = represent spring, summer, and winter seasons, respectively, in the local language, SidaamuAfoo.

Similar to the annual rainfall, in the spring season, a nonsignificant decreasing trend occurred for the Highland and Lowland AEZs. On the other hand, the Midland AEZ exhibited a significant negative (decreasing) trend (pvalue ≤ 0.01) (Table 5). This result is also in line with that of Matewos and Tefera (2020). Different trends were observed among the three AEZs in the summer. While the Highlands showed a nonsignificant negative trend, the Midlands experienced a significant decreasing trend for all tests (pvalue ≤ 0.01). In contrast, the Lowlands experienced a nonsignificant increasing (positive) trend for both tests (Table 5).

The observed trends in seasonal rainfall across different Agroecological Zones (AEZs) have significant implications for **agricultural production and productivity, food security, and rural livelihoods**in the study area. The study reveals concerning trends of declining rainfall in key agricultural seasons, particularly for the Midland AEZ, which could threaten food

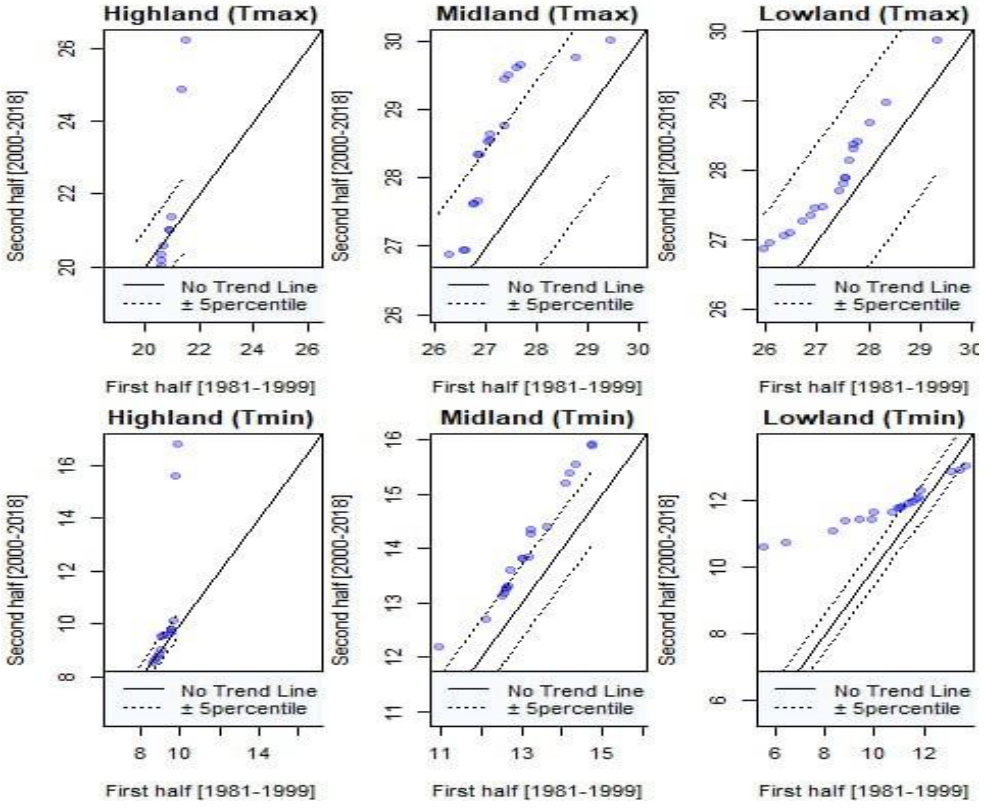
security, livelihoods, and economic stability in the region. Policy and adaptation strategies may include encouraging drought-tolerant crops, investing in irrigation, strengthening weather forecasting, and implementing soil conservation measures to retain moisture and improve productivity.

Trends in Mean Annual Maximum and Minimum Temperatures based on Innovative Trend Analysis

The research examined the mean annual maximum and minimum temperatures in a manner akin to that used in the rainfall study. The findings are shown in Table 4 and Figure 4. The trend in the mean annual maximum temperature for the Highlands was nonmonotonic (both decreasing and increasing). There was also an extreme increase in the high category positive trend, with a positive slope (0.001 °C/year). However, as the trend of slope indicates, the increase is negligible. The trend indicator (-0.636) shows despite the variability, there is a moderately strong trend. In the Midland area, it exhibited an increasing monotonic trend (Figure 4) with a positive slope (0.063 °C/year) and a moderate increase. The trend indicator (0.44) also confirms a moderately strong increasing trend (Table 4). A similar trend of mean annual maximum temperature was also observed for Lowland with monotonic low- and middle-category increasing trends with a positive slope (0.029). However, the increase is small which is also confirmed by the trend indicator (0.206) that shows a weak increase (Table 4 and Figure 4).

The mean annual minimum temperature trend for the Highland AEZ exhibited a nonmonotonic trend during the study period (38 years). No trend was observed in the middle category (Figure 4). However, the magnitude of the trend slope (0.035 °C/year) indicated a small but visible increasing positive trend in minimum temperature where the trend indicator (0.065) also shows weak but positive trend (Table 4). On the other hand, the Midland AEZ showed a monotonic increasing trend, with middle and high category increases similar tothose of the maximum temperature (Figure 4). A moderate increasing trend is also observed through a positive slope (0.7 °C/year) supported by a comparatively strong increasing trend indicator (0.689). An increasing and decreasing trend in the mean annual minimum

temperature trend was also observed for the Lowlands in the nonmonotonic low, middle, and high categories. However, an increasing trend was also observed through a positive slope (0.065 °C/year). The trend indicator (1.186) also suggests a strong increasing trend of minimum temperature in the lowland AEZ, which is the highest of all (Table 4 and Figure 4).



Note: Tmax = Maximum temperature; Tmax = Minimum temperature

Figure 4. Trends of Annual Maximum and MinimumTemperatures

Concerning maximum temperature, the results of the MKtest and Sen's slope indicate that the Highland AEZ exhibited a nonsignificant decreasing trend for the annual and spring seasons, whereas it exhibited a significant increasing trend in the summer season for both tests (p value ≤ 0.05). In contrast to the Highland AEZ, maximum temperature exhibited a significant increasing trend (P value ≤ 0.01) annually and during the spring and summer seasons in the Midland AEZ. Similarly, in the lowland AEZ, the annual and all-season maximum temperature values exhibited increasing

trends. However, while the annual and spring seasons experienced a significant increase (P value ≤ 0.05), the summer season experienced a nonsignificant increasing trend (Table 6 and Figure 4). While the Highlands exhibited a slightly decreasing trend in maximum temperature, both the Midlands and Lowlands experienced an increasing trend within the study period (40 years), where the magnitude was greater in the Midlands. Similar results were also reported by Matewos& Tefera (2020) and Gashaw et al. (2023) in their respective study areas.

Table 6. Trends of Annual and Seasonal Maximum Temperature based on the MKtest and Sen's Slope (1981 to 2018)

AEZ	Annual		Spring (Bdheeessa)		Summer (Hawado)		Winter (Arro)	
	MK	SS	MK	SS	MK	SS	MK	SS
Highland	-1.20	-0.02	-1.79	-0.02	2.18*	0.02	-2.75	-0.04
Midland	3.59**	0.059	3.51**	0.06	3.85**	0.08	1.81*	0.02
Lowland	2.33*	0.029	2.47*	0.041	1.71	0.03	1.94*	0.03

AEZ= Agroecology; MK= Mann–Kendal test; SS = Sen's slope; **= Significant at the 0.01 level (2-tailed); * = Significant at the 0.05 level (2-tailed)

It was also found that for minimum temperature, the Highlands exhibited a nonsignificant increasing trend for the annual and summer seasons, as measured by both tests. However, it experienced a nonsignificant decreasing trend in the spring. In the Midland AEZ, a significant increasing trend (P value ≤ 0.01) was observed for the mean annual value measured via both tests, whereas a significant (p value ≤ 0.05) trend was observed for the spring and summer seasons. In contrast, the Lowland experienced a significant increasing trend in the mean annual minimum temperature, as measured by the Mk test (p value ≤ 0.01). A nonsignificant increasing trend was observed during the spring seasons, whereas the summer season experienced a significant (p value ≤ 0.01) increasing trend for both tests (Table 7 and Figure 4).

In general, both the maximum and minimum temperatures increased in the sample AEZs of the region, which implies that climate change has occurred in the study area. It can be concluded that Midland and Lowland AEZs are experiencing significant warming trends, causing crop stress, drought risks,

and food shortages. Rising temperatures may disrupt crop development, increase evapotranspiration, and cause soil moisture loss. The Midland AEZ faces the highest risks of livelihood instability, potentially leading to increased migration, income diversification, and reliance on climate adaptation measures. Urgent climate adaptation strategies, including heat-tolerant crop varieties, irrigation expansion, and soil moisture conservation, are crucial to safeguard smallholder livelihoods.

Table 7. Trends of Annual and Seasonal Minimum Temperature based on the MKtest and Sen's slope (1981 to 2018)

AEZ	Annual		Spring (Bdheeessa)		Summer (Hawado)		Winter (Arro)	
	MK	SS	MK	SS	MK	SS	MK	SS
Highland	0.25	0.003	-0.79	-0.011	0.013	0.00	0.53	0.009
Midland	3.39**	0.05	1.94*	0.04	2.15*	0.03	3.09**	0.076
Lowland	2.86**	0.06	1.63	0.05	3.7**	0.08	1.76	0.06

AEZ = Agroecology; MK = Mann–Kendal test; SS = Sen's slope; ** = significant at the 0.01 level (2-tailed); * = significant at the 0.05 level (2-tailed)

Comparison of the Trend Tests

It can be concluded from the results obtained by all the tests (ITA, MK test and Sen's slope), that the results of all the tests are similar except for a few instances, where the cross-validation of the findings ensure the reliability of the entire tests in detecting the trend of rainfall and temperature throughout the study period and area.

Measures of Variability of Climate among the Three Agroecological Zones

As discussed in the methodology, rainfall variability in the study area was assessed via the PCI, CV and RAI.

Variability in Rainfall

Precipitation Concentration Index

The results indicate that 77.5% of the study period had a moderate rainfall distribution, while 20% experienced uniform rainfall, and only 2.5% experienced erratic rainfall in the Highlands. In the Midland and Lowland regions, 87.5% and 92.5%, respectively, of the study period exhibited moderate rainfall, whereas 10% and 7.5%, respectively, exhibited uniform distributions. Only 2.5% of the study period experienced erratic rainfall in

the Midland area, whereas in the Lowland, the period did not experience erratic rainfall.

Table 8. Annual Precipitation Concentration Index (PCI) (1981 to 2020)

Category	Highland			Midland			Lowland		
	PCI value	Years	%	PCI value	Years	%	PCI value	Years	%
<10 (Uniform)	9.13-9.97	8	20%	9.19-9.92	4 (1983, 1993,2005, 2010)	10%	9.53-9.94	3 (1982, 2020,1991)	7.5%
Between 10 and 15(Moderate)	10.02-13.12	31	77.5%	10.35-14.98	35	87.5%	10.09-14.91	37	92.5%
Between 15 and 20 (irregular)	17.22	1(2018)	2.5%	15.37	1 (2012)	2.5%	0	0	0
>20 (highly irregular)	0		0	0	0		0	0	0

Compared with the other areas, the Lowland experienced less uniform (7.5%) rainfall. This indicates that the selected AEZs experienced mostly moderate rainfall, even though erratic rainfall was less likely to experience a future trend of rainfall variability (Table 8 and Figure 5).

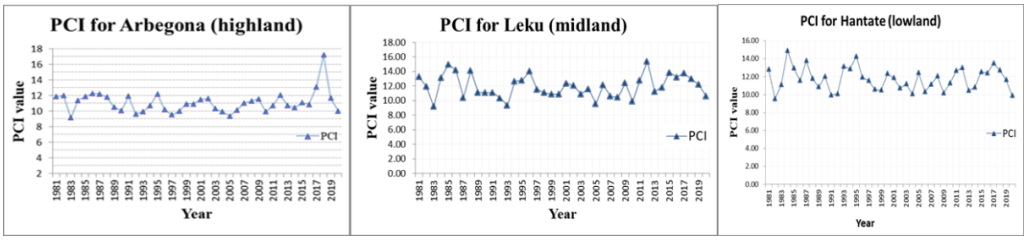


Figure 5. Annual Precipitation Concentration Index (PCI) for the three AEZs

Coefficient of Variation (CV) for Rainfall and Temperature

The coefficient of variation (CV) of annual, spring, and summer rainfall and, annual maximum and minimum temperatures were summarized in Table 9.

Table 9. Results of Coefficient of Variation for the Three AEZs (1981 to 2020)

Category	Highland	Midland	Lowland
PRCPAN	24.1%	23.6%	19.8%
PRCPSP	33.3%	34.7%	28.2%
PRCPSUM	28.4%	28.5%	27.6%
TmaxAN	6.6%	4.1%	3.0%
TminAN	21.0%	8.2%	15.1%

PRCP = Precipitation; AN = Annual; SP = spring; SUM = summer

The results of annual rainfall indicated moderate variability for Highland (24.1%) and Midland (23.6%), while there was less variability for Lowland (19.8%) during the study period in the study area. During the spring season, the Highland (33.3%) and Midland (34.7%) exhibited high variability, while the Lowland experienced moderate variability (28.2%). The results of the study (Highland and Midland) are in congruence with those of Gashaw et al(2023) for the spring season. In addition, the CV of the summer season revealed moderate variability for all the AEZs, i.e., highland (28.4%), midland (28.5%), and lowland (27.6%) indicating a slight shortage of rainfall during the summer (Table 9).

Regarding annual mean maximum temperature, all the AEZs experienced less variability throughout the study period. However, the annual mean minimum temperature exhibited different levels of variability among the AEZs, moderate variability was observed in the Highland, and both Midland and Lowland exhibited less variability throughout the study period (Table 9). This indicates that although there were increasing trends in both maximum and minimum temperatures for all the AEZs (Tables 6 and 7; Figure 4), the variability for both types of temperatures was less in the study area.

Rainfall Anomaly Index (RAI)

The annual and seasonal rainfall anomaly indices (RAIs) based on time series data for the three selected agroecological zones in the Sidaama Region were computed for 40 years. Table 10 lists the dry and wet years for each selected AEZ.

The results revealed that the Midland AEZs had more wet years (RAI ≥ 3) than did the highland and lowland AEZs, whereas the Lowland AEZs experienced more extremely dry years (RAI≤-3). The extreme driest years for the Highlands were 1991, 2015, 2017, and 2012 in terms of severity, while 2015, 2009, 2017, and 2012 were the drought years in the Midland area. Similarly, 2015, 2012, 1984, 1985, and 1999 were the driest years in terms of severity in the Lowlands. The years 2012 and 2015 were common drought years in all the AEZs of the region, whereas 2017 was a common drought year for the Highlands and Midlands. Lebeza et al. (2023), Belay et al. (2021), and Mera (2018) also identified 2015 as a common dry year in their respective studies because El Niño events affect the livelihood of smallholder farmers in many rural parts of Ethiopia. Other studies also note that Ethiopia has experienced twelve major/extreme historical droughts since the 1980s during 1984/85, 1987/88, 1991, 1994, 1997, 2002/03, and 2010/11 and 2015/16 (Belay et al., 2021; Lemma et al., 2022a; Matewos, 2019). In this study area, when the "slight drought" to "extreme drought" classification was considered, the Highlands and Lowlands presented more dry years within the study period (19 years), whereas the Midlands experienced only 15 years of dry conditions, although the magnitude was greater in the lowlands of the study area (Table 10).

Table 10. Results of the Annual Rrainfall Anomaly Index (RAI) for the three AEZs (1981 to 2020)

Index Classifications of V. Rooy (1965)	Agroecology		
	Highland	Midland	Lowland
Extremely wet years	1998, 2019, 2020	1996, 1987, 1988, 1983, 2020	1996, 2020, 1983
Very dry	2005, 2004, 1997, 1984, 2003, 2009	2011, 2002, 1984, 1999	2003, 2009, 2004, 1991
Extremely dry	1991, 2015, 2017, 2012	2015, 2009, 2017, 2012	2015, 2012, 1984, 1985, 1999

Source: Computed based on NMI data, 2023

While analyzing the seasonal RAI, only spring and summer were considered because the incidence of extreme dryness (drought) or extreme wetness manifests during these two seasons, which affects crop production since the smallholder farmers in the study area depend on rainfed agriculture.

Accordingly, the Highlands experienced the driest spring (RAI, -4.25) in 1997 and summer (RAI, -4.72) in 2018. This AEZ experienced the wettest spring (RAI, 7.43) in 1990 and summer (RAI, 7.36) in 2019. Similarly, the Midland exhibited the driest spring (RAI, -3.80) during 2015 and summer (RAI, -4.06) during 2009, whereas it experienced the wettest spring (RAI, 7.01) and summer (RAI, 6.43) in 1987 and 1988, respectively. In the Lowlands, the driest springs (RAI, -5.36) and summers (RAI, -3.73) were observed during 2012 and 1993, respectively, whereas the years 1983 and 2019 had the wettest springs (RAI, 5.51) and summers (4.28), respectively (Table 11).

Table 11. Results of the Seasonal Rainfall Anomaly Index (1981 to 2020)

Index Classification of V. Rooy (1965)	Agroecology					
	Arbegona/Highland		Leku/Midland		Hantate/Lowland	
	Spring	Summer	Spring	Summer	Spring	Summer
Extremely wet years	1990, 1983, 2018,	2019, 2011, 1998, 1982	1987, 1983, 1990	1988, 1996, 1994, 2019, 1986	1983,1987, 1981, 1990	2019, 1983, 1996, 1988
Very dry years	2003, 2015, 2009, 1988, 2005, 2004, 1984	2015, 1987, 2009, 2004, 1993, 1990, 1997	2011, 1984 1999	2004, 2018, 2016, 1987 2000	1999, 2000, 1985, 1988, 2008, 2003	2009, 2016, 1999, 2003
Extremely dry years	1997, 2012, 1991	2018, 1991, 2017	2012, 2015 2009, 2017, 2008	2009, 2015, 2017, 1993 2002	2012, 2015, 2009, 1984	1993, 2004, 1990, 1987, 2015, 2002

Source: Calculated by NMI Data

In addition, within 40 years, the Highlands experienced three extremely dry seasons (1997, 2012, and 1991) and seven very dry seasons (2003, 2015, 2009, 1988, 2005, 2004, and 1984). Similarly, three extremely dry (2018, 1991, and 2017) and seven very dry (2015, 1987, 2009, 2004, 1993, 1990, 1997) summer seasons occurred. In the Midland, five extremely dry (2012,

2015 2009, 2017, 2008) and three very dry (2011, 1984, 1999) spring seasons occurred, whereas five extremely dry (2009, 2015, 2017, 1993, 2002) and five very dry (2004, 2018, 2016, 1987, 2000) summer seasons occurred within the stated period. The Lowlands experienced four extremely dry (2012, 2015, 2009, 1984) and six very dry (1999, 2000, 1985, 1988, 2008, 2003) spring seasons, whereas the AEZ experienced six extremely dry (1993, 2004, 1990, 1987, 2015, 2002) and four very dry summer seasons (2009, 2016, 1999, 2003) (Table 11). Most of these dry spring and summer years were extreme drought years in the country and coincided with other findings (Belay et al., 2021; Matewos, 2019), indicating that the livelihood of the smallholder farmers might have been affected by these extreme climate conditions in the sample AEZs. In comparison, the Highland presented three extremely dry spring seasons and three summer seasons within 40 years. In the Midland area, five spring and five summer seasons occur. Similarly, the Lowlands experienced four and six extremely dry spring and summer seasons, respectively, indicating that the Lowlands were more affected by drought conditions because the crop production of this AEZ was mostly dependent on the spring season (Table 11).

4. Discussion

The findings of this study provide a comprehensive understanding of climate trends and variability in the Sidaama Region of Southern Ethiopia from 1981 to 2020. The study examined trends in rainfall and temperature across three agroecological zones (AEZs) using Innovative Trend Analysis (ITA), with additional validation from the Mann-Kendall (MK) test, Sen's slope, and Spearman's rho test. Furthermore, the study assessed seasonal variations in rainfall patterns and changes in maximum and minimum temperatures.

The results reveal marked interannual variability across the agroecological zones. For instance, while 2020 recorded the highest rainfall in all zones—1723.8 mm in the Highland, 1599.5 mm in the Midland, and 1529.9 mm in the Lowland—other years such as 1991 in the Highland (500.4 mm), 2015 in the Midland (584.6 mm), and 2012 in the Lowland (728.4 mm) were characterized by severe droughts. This contrast, along with the significant

differences in maximum and minimum temperature records across zones, underscores a trend of increasing climate variability. These variations, corroborated by similar findings in recent studies (Ware et al., 2023) highlight the urgent need for targeted water resource management and climate adaptation strategies to address both flood risks and prolonged drought conditions in these distinct agroecological settings.

The analysis of annual precipitation trends revealed a declining pattern across all three AEZs, with the midland region exhibiting the sharpest decline (-12.07 mm/year), followed by the highland (-3.094 mm/year) and the lowland (-2.227 mm/year). The trend indicator values further confirmed these patterns, with the midland AEZ showing a significant and strong decreasing trend, likely driven by deforestation, agricultural land expansion, land degradation and land fragmentation to invest in afforestation or reforestation. These findings highlight the potential risks of reduced water availability for agriculture and ecosystems, emphasizing the need for sustainable land management and reforestation efforts to mitigate further decline. The decline in precipitation is consistent with previous studies in Ethiopia such as Matewos& Tefera (2020) and (Lebeza et al., 2023) which have highlighted similar reductions in rainfall due to environmental degradation and climate change. It also aligns with that of (Gashaw et al., 2023), which reported significant rainfall declines in Ethiopia, and (Balcha et al., 2023), noting reduced precipitation in southern regions due to climate variability. (Gebrechorkos et al., 2019) confirmed drying trends in East African highlands, attributing them to shifts in the Intertropical Convergence Zone (ITCZ), consistent with the Sidaama findings.

Seasonal rainfall trends indicated that the Midland AEZ experienced a monotonic decreasing trend in both spring and summer, suggesting that this AEZ has been particularly vulnerable to declining rainfall over time. The highland AEZ also exhibited a decreasing trend in spring but showed a nonmonotonic pattern in summer. In contrast, the lowland AEZ demonstrated a decreasing trend in spring while showing a nonmonotonic trend in summer, indicating potential fluctuations in seasonal precipitation. Spring was the common season where rainfall decreased in all of the AEZs.

This is especially concerning for smallholder farmers, as spring rainfall is vital for farming activities. A decrease in spring rainfall could negatively impact crop yields and threaten food and livelihood security, particularly for those in Midland and Lowland regions, who rely exclusively on this rainfall for their annual crop harvests. The spring (*badheessa*) dependent cropping system requires policy and adaptation strategies that may include encouraging drought-tolerant crops, investing in irrigation, strengthening weather forecasting, and implementing soil conservation measures to retain moisture and improve productivity. A study by Toni et al., 2022 and Matewos and Tefera (2020) also indicated a declining spring season trend. A study by Hubertus et al., 2023 indicated that farmers in South Wollo (Ethiopia) observe increasingly erratic spring rains, marked by delayed initiation and early termination, corroborated by satellite-derived data indicating increased rainfall variability. Other researches also indicate a declining tendency in spring precipitation in East Africa, especially during the March-May period (Gebrechorkos et al., 2019) confirming the Sidaama's findings, although other Sub-Saharan African regions exhibit varied tendencies, with certain locations having heightened rainfall intensity and variability (Maidment et al., 2015).

Validation through the MK test, Sen's slope, and Spearman's rho test corroborated the ITA findings, particularly for the Midland AEZ, which exhibited a significant decreasing trend ($p \leq 0.01$). The Highland and Lowland AEZs also showed decreasing trends, although they were statistically nonsignificant. These results align with previous studies that have identified declining rainfall trends in various parts of Ethiopia (Kerebo et al., 2024).

Analysis of temperature trends indicated a general increase in both maximum and minimum temperatures across the three AEZs. The Highland AEZ exhibited a nonmonotonic trend for maximum temperature with a negligible positive slope (0.001°C/year), whereas the Midland and Lowland AEZs demonstrated a monotonic increasing trend, with the Midland AEZ exhibiting the highest rate of increase (0.063°C/year). The increasing temperature trend in the Midland AEZ was further supported by a moderate

trend indicator value (0.44), suggesting a relatively strong warming trend compared to the other zones. Rising temperatures may disrupt crop development, increase evapotranspiration, and cause soil moisture loss. The result is in congruence with Mekonen & Berlie, 2019where the annual, maximum, and minimum temperature averages grew at rates of 0.0034, 0.0028, and 0.0095 °C each year, respectively. (Serdeczny et al., 2017)also projected the climate change for the Sub-Saharan region point to a warming trend. Similarly, a finding by (H. Li et al., 2024)indicated that annual maximum temperature exhibited a significant rising trend at the Yellow River Basin of China. However, contradicting evidence exists; for instance, (Kruger &Sekele, 2013) reported stable maximum temperature in some Southern African highlands, suggesting regional variations not observed in Sidaama.

Similarly, minimum temperature showed a weak increasing trend in the Highland AEZ (0.035°C/year), while the Midland AEZ exhibited a more pronounced increase (0.047°C/year) with a stronger trend indicator (0.689). The Lowland AEZ also showed an increasing trend (0.065°C/year), indicating that minimum temperature has been rising steadily across all AEZs. These temperature increases align with broader warming trends observed in Ethiopia and other parts of East Africa, driven by global climate change (Matewos& Tefera, 2020). The result is also in agreement with (Tura et al., 2021) that central highlands of Ethiopia also exhibited minimum temperature increasing trend. Other research in Sub-Saharan Africa indicates a general tendency toward rising minimum temperatures; however, several areas, notably South Africa and Malawi, have shown a decreasing trend (Mupangwa et al., 2023).

Rising maximum and minimum temperatures in the Sidaama region's midland and lowland zones pose significant challenges to agriculture, water resources, and livestock. Higher heat accelerates crop growth cycles, resulting in lower yields and increased moisture loss, which endangers rainfed farming. Livestock are more susceptible to heat stress and disease, while elevated temperatures may promote pest proliferation. These factors pressure smallholder farmers, potentially driving migration and

necessitating adaptation strategies such as heat-tolerant crop varieties, expanded irrigation, and soil moisture conservation to protect their livelihoods.

Rainfall variability, assessed via PCI, showed moderate distribution with erratic years, and RAI identified drought years like 2012 and 2015, with the lowland zone most affected. This aligns with (Lemma et al., 2022), noting frequent droughts in Ethiopia, and with (Funk et al., 2023), who linked East African droughts to El Niño events. Contradictorily, some tropical regions, like parts of the Amazon (Liao et al., 2024), show increasing rainfall due to ocean warming, highlighting spatial heterogeneity not applicable to Sidaama's inland context.

Rainfall variability, with erratic distribution and recurrent droughts, threatens agriculture, water availability, and food security in the Sidaama region, especially in lowland areas. This may heighten reliance on food aid, force livelihood shifts, and drive migration. Adaptive strategies like water harvesting, drought-resistant crops, and climate-smart practices are essential to mitigate these impacts.

5. Conclusion

The analysis of climate trends and variability in the Sidaama Region reveals significant shifts in rainfall and temperature patterns across agroecological zones (AEZs), posing challenges to agricultural production and smallholder livelihoods.

Rainfall trends indicate a decline in annual and seasonal precipitation across all AEZs, with the most pronounced reductions in the Midlands and Lowlands. The spring (badheessa) season, critical for planting, exhibited a significant decreasing trend, particularly in the Midlands. Annual rainfall variability was moderate in the Highlands but lower in the Midlands and Lowlands, while high variability in spring rainfall increased uncertainty in planting and harvesting periods. The summer season also showed a declining trend, raising concerns about water availability during peak growing periods.

The Precipitation Concentration Index (PCI) indicates moderate rainfall distribution throughout most of the study period, with the Lowlands experiencing the least uniform rainfall. This irregularity disrupts cropping cycles and reduces yields, reinforcing concerns about the unpredictability of seasonal rainfall and its impact on agricultural planning.

Temperature trends show a consistent increase in maximum temperatures across the Midlands and Lowlands over the past 38 years, with the Midlands experiencing the highest rise. The Highlands exhibited a slight decrease in maximum temperature during the annual and spring seasons, but a significant increase in summer. Minimum temperatures showed an increasing trend in the Midlands and Lowlands, with moderate variability in the Highlands. Rising temperatures intensify evapotranspiration, reduce soil moisture, and increase heat stress on crops and livestock, while sustained increases in minimum temperature may exacerbate pest and disease prevalence.

The Rainfall Anomaly Index (RAI) highlights frequent extreme dry years, with the Lowlands experiencing the highest number of severe droughts, followed by the Highlands and Midlands. Common drought years, such as 2012 and 2015, were linked to El Niño events, which have historically devastated Ethiopian agriculture. Prolonged droughts have likely reduced crop yields and pasture availability, increasing food insecurity, particularly in the Lowlands, where spring rainfall is crucial for agriculture. These findings underscore the need for urgent climate adaptation strategies.

6. Policy Implication and Recommendations

Policy Implication

The combined effects of declining rainfall, rising temperatures, and increased climate variability threaten the livelihoods of smallholder farmers in the Sidaama region. Reduced water availability, heat stress, and erratic rainfall patterns limit the potential for stable agricultural production, leading to income losses and food shortages. The Lowland AEZ is particularly vulnerable due to its reliance on rainfed agriculture and higher exposure to drought conditions. Without timely interventions, these climatic changes could exacerbate poverty, malnutrition, and migration patterns in the region.

Recommendations

The observed climate trends highlight the need for targeted adaptation measures to enhance agricultural resilience in the Sidaama Region. Policymakers, researchers, and local communities must prioritize climate-smart agricultural practices, such as drought-resistant crop varieties, improved irrigation systems, soil and water conservation techniques, and agroforestry. Strengthening early warning systems and access to climate information will also be crucial in enabling farmers to make informed decisions. Additionally, investment in diversified livelihoods, such as off-farm income sources, can help buffer smallholder farmers against climate-induced shocks.

Given the increasing temperature trends and declining rainfall, appropriate climate adaptation measures are essential to safeguard agricultural productivity and food security. Collaborative efforts among governments, NGOs, and farmers will be key to developing sustainable strategies that mitigate the adverse effects of climate change in different AEZs of the Sidaama Region. Moreover, future research should focus on the long-term impacts of these climate trends on specific crop yields, soil health, and water resources. Developing localized climate models and impact assessments will further enhance the ability to design effective mitigation and adaptation strategies tailored to the needs of smallholder farmers in each AEZ.

7. Limitations of the Study

The study has both strengths and limitations. The National Meterology Institution (NMI) provided a reliable gridded dataset, increasing credibility and reducing missing and incomplete data. The study used various analytical methods, such as innovative trend analysis, Mann-Kendal test, and Sen's slope, to ensure reliability. Comparisons were made among different agroecological zones for area-specific measures. However, the study had limitations, including the lack of recent data from the NMI and the inclusion of more districts for more accurate generalization. Future studies could improve by including recent data on precipitation and temperature, increasing the number of districts/stations as samples, and

analyzing forecasting of trend and variability for future years based on past trends.

The Study Period

Study Period: the study covers a 40 years data (1981 to 2020)

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Declarations

Conflict of Interest

The authors declare that there was no likely conflict of interest.

Funding Statement

The financial support was obtained from Hawassa University as part of the corresponding author's PhD study program.

Availability of the Data

One can access the data used in this study from the National Meterological Institute (NMI) of Ethiopia by a justifiable request made to the institution through the institution's email address: datausers@gmail.com. The dataset that is arranged for different tools and used to analyze the current study is available by request from the corresponding author.

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Determinants of Food Insecurity using Household Food Insecurity Access Scale: A Cross-Sectional Study in Enset-Based Agricultural Practice of Sidama Regional State, Ethiopia

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Abstract

This study investigates the determinants of food insecurity in the Sidama Regional State, Ethiopia, using the Household Food Insecurity Access Scale (HFIAS) as a measure of food insecurity. Employing a cross-sectional research design, the study integrates both quantitative and qualitative approaches. Data were collected from 620 sampled farming households through a multi-stage sampling method and analyzed using SPSS software version 26. Both descriptive and inferential statistics including frequencies, percentages, Chi-square, independent-sample t-test, and binary logistic regression, were utilized for data analysis. The findings reveal that higher levels of education, larger land sizes, longer birth intervals, and greater household asset ownership positively influence household food security. Conversely, heavy reliance on enset (false banana) is associated with lower food security, likely due to limited agricultural yields and reduced dietary diversity. Additionally, the study identifies common coping strategies, such as reducing meal variety, opting for cheaper meals, and limiting portion sizes, as prevalent responses to food insecurity. These results highlight the importance of education, land access, family planning, and diversified food production in enhancing food security in the region.

Keywords: Farmer, Household, Food insecurity, HFIAS, Sidama, Ethiopia

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1. Introduction

Food is a fundamental human need, essential for survival, health, and societal progress. Ensuring access to sufficient, nutritious food remains a global challenge, with millions of people worldwide facing chronic hunger and malnutrition. According to the Food and Agriculture Organization (FAO), approximately 815 million people were chronically undernourished in 2016, reflecting a persistent and pressing issue despite some progress over the years (Herforth et al., 2017). Food insecurity, defined as the lack of consistent access to enough food for an active and healthy life, is a complex problem influenced by a range of factors, including poverty, agricultural productivity, environmental degradation, and population growth.

In Sub-Saharan Africa (SSA), food insecurity is particularly acute due to a combination of structural, economic, and environmental challenges. Ethiopia, the second-most populous country in SSA, exemplifies these struggles. With a population exceeding 104 million and a heavy reliance on agriculture for livelihoods, Ethiopia faces significant food security challenges. Despite its abundant natural and human resources, the country struggles to feed its population, with smallholder farmers who constitute the majority of the agricultural sector bearing the brunt of food insecurity. Even in years without drought or in regions with surplus production, food insecurity remains widespread, underscoring the systemic nature of the problem (Petr, 2010).

The Sidama Regional State, historically considered a high-productivity and food-sufficient area, now grapples with rising food insecurity due to rapid population growth, environmental degradation, low agricultural productivity, and limited economic opportunities (Sidama Agricultural Office, 2020). These challenges have transformed Sidama into a region where food insecurity is increasingly prevalent, despite its agricultural potential. Understanding the determinants of food insecurity in this context is critical for developing targeted interventions and policies to address the issue.

This study focuses on identifying the key factors influencing household food insecurity in Sidama, Ethiopia, using the Household Food Insecurity

Access Scale (HFIAS) as a measurement tool. The HFIAS provides a comprehensive framework for assessing food insecurity, capturing dimensions such as inadequate food access and nutritional deficiencies (Dachner&Tarasuk, 2018). By examining the interplay of agricultural shocks, socio-economic conditions, and environmental factors, this research aims to shed light on the drivers of food insecurity in Sidama'sEnset-based agricultural food systems. The findings will contribute to the broader discourse on food security in Ethiopia and inform evidence-based strategies to combat hunger and malnutrition in the region.

2. Research Methods

2.1 Study area and population

The study was conducted in Sidama regional state. Sidama Regional State is a federal state in Ethiopia located in the southern part of the country. It was established in June 2020 after the Sidama people voted in a referendum to form their regional state. The region is located south of the Oromia Region (except for a brief section in the middle where it shares a border with the Gedeo zone), the Bilate River on the West, which divides it from the Wolayita zone, and the Oromia Region on the North and East. Sidama Regional State is governed by a regional council responsible for the region's administration. The capital of the region is Hawassa, which is also the biggest city in the region. The region is divided into 19 districts (woredas) and one town administration, with each district being further divided into kebeles(Ethiopian Mapping Authority, 2020).

The Sidama people are one of the largestnumber ethnic groups in Ethiopia and are known for their rich cultural heritage, including their music, dance, and traditional dress. In 2017, about 3.2 million people were living in Sidama. With 879 km of all-weather roads and 213 km of dry-weather highways, Sidama has an average road density of 161 km per 1,000 km^2. Agriculture is the leading economic activity in the region, with coffee being the most important crop. The region also has significant potential for tourism due to its natural beauty, including its highlands, lakes, and waterfalls (FAO, 2021).

Also abundant and underdeveloped in the area are water resources. The absence of access to safe drinking water, poor sanitation, and general knowledge about personal hygiene and environmental health are the leading causes of sickness and mortality in the SNNP region. The Sidama place a high importance on livestock, and those without cattle are not seen as fully-grown members of society but as outcasts. Cattle numbers are a solid indicator of prosperity and provide the farmer with the most livestock in more significant popularity. The population of this study includes households, Kebele administrators, Development Agents (DAs), health extension workers, Woreda administrators, and heads of relevant Woreda offices in Sidama Woredas.

2.2 Operational definition

***Food insecurity status*:** Household food insecurity status was measured using Household Food Insecurity Access Scale (HFIAS) developed primarily for use in poor countries by Food and Nutrition Technical Assistance (FANTA). The tool included nine items that represented the general growing severity of food insecurity, as well as four frequencies of recurrence questions. The nine generic incidence questions are organized into three categories of food insecurity (Cohen et al., 2012).

2.3 Sample selection

Households, particularly Woredas of the Sidama regional state, participated in the survey. In total, 620 respondents were included in the study. Using the formula proposed by the UN Economic Division (2005), the sample size was established as follows:

$$n = (z^2)(r)(1-r)(f)(k)/(p)(n_h)(e^2)$$

Where, n = is number of sample, Z^2 = is the upper points of standard normal distribution at α = 0.05, *r*is anticipated prevalence, *f* is the sample design effect (deff), the study design effect is assumed to be (1.5), *k* is a multiplier to account for the anticipated rate of non-response. It is taken as 1.1 which is the recommended value for household survey, p is the proportion of the target population over total population which is 0.15, nh is

the average household size (5). The margin of error (e) is 5%, the maximum recommended value.

Multi-stage sampling was employed to ensure representative sampling. In the first stage, due to the local staple diet, six enset-producing and non-enset-producing Woredas were selected using purposive sampling technique. Wondogenet, Shebedino, Hawassa zuria, Malga, Goricha, and Boricha were the selected Woredas. In the second stage, one representative Kebele from each Woreda was selected using simple random sampling. Thirdly, Kebele households were proportionally selected. Finally, using systematic sampling technique, 620 respondents were randomly picked from the relevant list of respondents, a complete list of households in each Kebeles obtained from the Woredas Administration, and Kebeles offices in the selected Kebeles.

2.4 Data collection and measurements

The data was gathered through the use of a survey questionnaire. To collect the necessary data, both closed and open-ended questions were constructed. Following the development of all questions for the household survey, a pre-test with 30 respondents was conducted prior to the survey to refine the questions in terms of language usage and topic clarity to capture adequate data during the survey.

2.5 Data processing and analysis

The data collected through the questionnaire was edited, coded, and entered into computer software using SPSS version 26. The analysis techniques were performed using descriptive statistics such as frequencies and percentages. Furthermore, inferential statistics such as independent sample t-test and *Chi*-square were used to see the difference between food-secure and food-insecure households across explanatory variables of the study. Binary logistic regression analysis was employed to identify the factors that affect the food security status of sample households in the study area.

3. Results

The following is a rundown of the findings from the investigation about the determinants of food insecurity using household food insecurity access scale.

Table 1: *Summary of Respondents' Socio-demographic Characteristics (n = 620)*

Characteristics	*n*	**%**
Educational status of a mother		
Unable to read and write	280	45.2
Able to read and write	161	26.0
Only primary education	72	11.6
Secondary education	84	13.5
College diploma and above	23	3.7
Mother occupation		
Housewife	119	19.2
Agriculture	285	45.8
Petty Trade / Informal Business	99	15.9
Daily Labor	71	11.4
Public / Private Sector Employment	48	7.7
Housing condition		
Thatch/grass	303	48.9
Corrugated iron sheet	317	51.1
Birth interval		
First birth	22	3.5
1-2 years	258	41.6
>2 years	340	54.8
Enset dominant		
Non-enset dominant	321	51.8
Enset dominant	299	48.2
Asset index		
Very poor	127	20.5
Poor	121	19.5
Middle	135	21.8
Rich	114	18.4
Very rich	123	19.8

HFIAS		
Food insecure	328	52.9
Food secured	292	47.1

Note: HFIAS = *Household Food Insecurity Access Scale*

The educational status of surveyed respondents showed that 45.2% were unable to read and write, indicating that almost half had not received any formal education. 26.0% of mothers were able to read and write, 11.6% had only completed primary education, covering the first few years of formal schooling, while 13.5% had completed secondary education, covering middle and high school years. Only 3.7% of surveyed mothers had completed tertiary education, including college diplomas and higher degrees.

Regarding maternal occupation, 80.8% of the sampled women were engaged in farming, petty trade, daily labor, or public/private sector employment, while the remaining 19.2% reported being housewives. Housing conditions were almost evenly split between thatch/grass (48.9%) and corrugated iron sheet (51.1%). Birth intervals were categorized as over two years for 54.8%, 1-2 years for 41.6%, and only 3.5% reported their first birth. Respondents were divided into enset-dominant areas (48.2%) and non-enset dominant areas (51.8%). The study assessed the asset index, categorizing 40% as poor and 38.2% as rich. Regarding food security, 52.9% of households were found to be food insecure.

Table 2: *The Descriptive Summary of Continuous Variables (n = 620)*

Variables	Minimum	Maximum	Mean	SD
Monthly household income (Birr)	693	5645	3639	670
Total household size	02	12	5.26	1.79
Land size in hectare	.00	7.00	1.32	1.01
TLU	.00	17.50	6.92	6.86

Note:TLU = *Tropical Livestock Unit*

The data for four variables, including monthly household income, total household size, land size in a hectare, and TLU, show the mean and standard deviation. The mean monthly household income is 3639, with a standard deviation of 670. The mean total household size is 5.26, with a standard deviation of 1.79. The mean land size in hectares is 1.32, with a standard deviation of 1.01. Finally, the mean TLU is 6.92, with a standard deviation of 6.86. These statistics provide insight into each variable's central tendency and variability, allowing for a better understanding of the overall distribution of the data.

Table 3: *The Binary Logistic Regression Output*

Variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I.for EXP(B)	
						Lower	Upper
Education level	0.19	0.09	4.76	0.029	1.20	1.02	1.42
Mother occupation	-0.19	0.24	0.63	0.429	0.83	0.52	1.32
Monthly income	0.10	0.08	1.78	0.182	1.11	0.95	1.29
Total household size	-0.10	0.05	3.47	0.062	0.91	0.82	1.01
Housing condition	0.19	0.22	0.74	0.389	1.21	0.79	1.85
Land size	0.44	0.10	20.55	0.000	1.55	1.28	1.88
Birth interval	0.34	0.17	4.04	0.044	1.40	1.01	1.94
TLU	0.00	0.01	0.02	0.883	1.00	0.98	1.03
Enset dominant	-1.05	0.21	25.56	0.000	0.35	0.23	0.53
Asset index	0.21	0.08	6.73	0.009	1.23	1.05	1.44
Chi-square	123.25						
Sig.	0.000						
Number of obs	620						

The results of Table 3 shows that 620 observations are in the dataset for which all of the response and predictor variables are non-missing. The *Chi*-square test ($x^2 =$ 123.25, p<0.001) is significant at less than 0.1% which indicates at least one of the independent variables is significantly related to the response variable. Overall, the results suggest that the binary logistic

regression model is a good fit for the data, and that the predictor variables are helpful for predicting the response variable.

Education level has a positive and statistically significant effect on food security status (B = 0.19, p <0.05). Those with a higher education level are 1.20 times more likely to be food secure than those with a lower education level. Research demonstrated that an individual's level of education had a beneficial impact on their household's food security. In other words, as education levels rise, so does the possibility of a home having enough food to meet its needs.

Land size has a favourable and statistically significant effect on household food security (B = 0.44, p <0.001). Based on the odds ratio figures, a household has a 1.55 likelihood of being food secure if the land size in hectares increases by one unit, regardless of the other independent variables in the model. Research suggested that land size has a favourable impact on food security. Greater land areas are often connected with higher agricultural productivity, which can assist in ensuring that households have enough food to meet their needs.

The results shown in Table 3 indicate that birth interval has a favourable and statistically significant effect on food security status (B =0.34, p< 0.05). Food security is 1.40 times more likely in homes with a longer interval between children's births than in households with a shorter time between children's births. Research demonstrated that households with longer birth intervals have greater food security because they can better meet their children's requirements.

The findings presented in Table 3, which reveals that enset dominance has a negative and statistically significant effect on food security status (B =-1.05, p < 0.001). Households with enset dominant are 0.35 times less likely to be food secure than non-enset dominant households. Research found that households with enset dominance have a lower risk of being food secure than non-enset dominant families. This suggests that households that rely

largely on enset (a species of plant used for food in some places) have lower levels of food security.

The results of Table 3 shows that the asset index has a positive and statistically significant effect on food security status ($B = 0.21$, $p < 0.01$). Households with more assets are 1.23 times more likely to be food secure than those with less assets. The study found that households with higher assets are more likely to be food secure than those with lower assets. As a result, households with higher levels of assets are better prepared to deal with potential food shortages or other obstacles.

Table 4: *Household Coping Strategy during Food Shortage*

Possible coping strategies to food insecurity	Rank Order	N	%
Stop choosing food and eating whatever available	1	470	75.8
Rely on less preferred and less expensive foods	2	459	74.0
Limit portion size at mealtime	3	410	66.1
Reduce number of meals eaten per day	4	366	59.0
Send household members to eat elsewhere	5	342	55.2
Receiving loans	6	332	53.5
Sell off livestock more than usual	7	322	51.9
Engagement in petty trade	8	296	47.7
Selling woods charcoal	9	295	47.6
Selling household asset	10	275	44.4
Working as a daily laborer	11	241	38.9
Sending children to labor market	12	232	37.4
Remittance and food aid	13	231	37.3
Migration to cities	14	206	33.2

Key: Multiple answers were possible; percentages calculated according to the personsinterviewed;does not add up to 100 percent.

Based on the order of prevalence, the most commonly used coping strategy, adopted by 75.8% of the respondents, is "Stop choosing food and eating whatever available." Following closely, "Relying on less preferred and less expensive foods" is another widely used approach, with 74.0% of respondents utilizing this strategy. "Limiting portion size at mealtime" is the third most common strategy, employed by 66.1% of individuals. As the rankings progress, the prevalence of these strategies gradually decreases, with strategies such as "Reduce number of meals eaten per day" (59.0%) and "Send household members to eat elsewhere" (55.2%) being employed by slightly fewer respondents. Other strategies include "Receiving loans" (53.5%), "Selling off livestock more than usual" (51.9%), and "Engagement in petty trade" (47.7%). These findings provide valuable insights into the adaptive mechanisms employed by individuals facing food insecurity, which can inform targeted interventions and policies aimed at alleviating this issue.

4.Discussion

The study found that education level positively affects the food security status of their households. In line with this finding, Garbero and Jackering (2021) found that education, particularly women's education, was positively associated with food security outcomes such as dietary diversity and reduced risk of malnutrition. The authors suggest that education can improve food security by increasing knowledge and skills related to agriculture, nutrition, and health and increasing income and economic opportunities. The study by Zhou et al. (2019) indicated that as the household head's education level increased, the probability of having food security increased. This is because educated households can use any technological innovation faster than their uneducated counterparts. Educated farmers can take a note and read and understand any important information about their farm and their farm sales; they can listen to media in non-local languages. They can easily accept and are more optimistic about future government developmental plans.

Education plays a pivotal role in bolstering household food security by enhancing knowledge, skills, and economic opportunities (Utama et al., 2023). Not only does it empower individuals to make informed decisions

about agriculture, nutrition, and health, but it also leads to better food security outcomes. Crucially, women's education has a particularly strong impact, correlating with improved dietary diversity and reduced malnutrition (Drammeh et al., 2019). Furthermore, higher education levels enable individuals to adopt advanced agricultural technologies, boosting productivity and food availability (Maziya et al., 2017), while also improving their ability to interpret market trends and farming information for smarter livelihood decisions (Adeyanju &Fadupin, 2024). Consequently, increased education attainment directly reduces food insecurity rates (Ogunniyi et al., 2021). Beyond economic benefits, education encourages openness to sustainable farming practices and government initiatives, strengthening long-term food security. This is especially true for women, as educating female farmers significantly enhances household food security by promoting modern techniques, efficient resource management, and better family nutrition (Asitik& Abu, 2020; Adeyanju &Fadupin, 2024). Thus, investing in education, particularly for women, proves essential for achieving sustainable food security and overall well-being.

Land size has a positive effect on the food security status of households. Nkomoki et al. (2019) indicated that households with large cultivated land areas were more likely to be food secured than those with smaller ones. They also added that in addition to increased production, larger land sizes could also help to reduce food insecurity by providing farmers with the opportunity to sell their excess produce. This can provide an additional income source, helping to reduce poverty and increase access to food. Likewise, Rufino et al. (2013) indicated that larger land size usually results in greater agricultural production. Access to more land allows farmers to diversify their production and increase crop yields, leading to better food security. That means households with larger land sizes had access to a greater variety of crops, which allowed for more dietary diversity and better nutrition. Furthermore, larger land sizes are associated with better access to external inputs, such as credit and other resources, which can help increase farmers' productivity and food access.

Land size plays a crucial role in household food security, as larger holdings generally enhance food availability, income stability, and resilience. Households with more cultivable land can produce diverse crops, ensuring a stable and varied food supply while generating surplus for market sales—boosting income for purchasing additional necessities. Larger plots also enable farmers to adopt efficient practices, diversify production, and experiment with innovative technologies, improving yields and adaptability to environmental changes (Gassner et al., 2019; Galeana-Pizaña et al., 2021). For instance, agroecological systems like Mexico's milpa demonstrate how land-dependent practices can significantly bolster food security. However, land size alone is insufficient; access to inputs, markets, and complementary income sources remains critical (Yusriadi et al., 2024). Moreover, in land-scarce regions, strategies such as off-farm employment and optimized crop combinations can mitigate constraints. Empirical evidence consistently confirms that households with larger landholdings achieve greater food security through higher production for both consumption and sale (Molen, 2016; Assefa & Abide, 2022; Diramo et al., 2018; Gazuma, 2018). Yet, without addressing systemic barriers like poverty and resource inequities, smallholders may remain trapped below the poverty line despite their agricultural efforts (Gassner et al., 2019).

Birth spacing is another critical factor influencing household food security. Research by Kiani et al. (2021) in rural Iran found that longer birth intervals correlate with higher food security, as they allow women time to recover from childbirth and provide better care for their children. This practice also reduces child mortality, easing the demand on household resources. Similarly, studies in Ethiopia (Sosina et al., 2012; Adenike, 2016; Getayeneh et al., 2021) reinforce this link, with Sosina et al. (2012) noting that extended birth spacing boosts household income by freeing up resources for productive investments like farming or livestock. Beyond economic benefits, adequate intervals improve maternal and child health by preventing nutrient depletion from short successive pregnancies. Critically, smaller family sizes resulting from spaced births reduce pressure on food and financial resources, enhancing long-term food security. This aligns with Bangladesh's experience, where family planning programs promoting

longer intervals have been leveraged as a strategy to combat poverty and food insecurity (Gazuma, 2018). Ultimately, well-timed births enable households to allocate time and resources more effectively, whether to agriculture, income generation, or childcare, strengthening their path to food security.

Birth spacing significantly enhances household food security by improving both food availability and child health outcomes. In rural Ethiopia, Adenike (2016) found that longer birth intervals increased food access and production, as mothers had more time to recover from childbirth and breastfeeding, allowing them to dedicate greater energy to income-generating activities and agricultural work. Similarly, Getayeneh (2021) demonstrated that extended birth spacing reduces child malnutrition risk, a critical factor in breaking cycles of long-term food insecurity, as malnourished children face diminished health and future productivity. By enabling mothers to replenish their nutritional reserves and provide better care, spaced births help ensure that households can meet the food needs of all members. This is particularly vital in Sub-Saharan Africa, where expanding access to family planning and maternal healthcare is essential for food security. Furthermore, when coupled with women's empowerment and education, key determinants in family size and resource allocation decisions, birth spacing becomes a powerful tool for households to optimize food production, economic stability, and intergenerational well-being (Drammeh et al., 2019).

The findings of the study indicate that the dominance of enset contributes to household food insecurity. In contrast to this finding, Borrell et al. (2020) and Morrow et al. (2023) argue that Enset (Enseteventricosum), often referred to as "the tree against hunger," is a vital perennial crop that sustains millions in the southern Ethiopian highlands. This perennial crop sustains millions in Ethiopia's highlands through its year-round availability, environmental resilience, and multifunctional uses as both staple food and source of animal feed, fiber, and traditional medicine (Abate et al., 2022). Enset significantly enhances nutrition and food security (Serka et al., 2019) while providing ecological benefits like carbon sequestration and soil

conservation, making it indispensable for climate change adaptation due to its exceptional drought tolerance. Its cultivation supports sustainable livelihoods by offering reliable carbohydrate sources, emergency food reserves, additional income streams, and ecosystem services. The crop's demonstrated contributions to community well-being, environmental sustainability, and climate resilience underscore its fundamental importance in southern Ethiopia.

However, an over-reliance on enset farming presents several challenges. One major concern is dietary monotony, as enset is carbohydrate-rich but relatively low in protein, which can lead to nutritional deficiencies if not complemented with other foods (Getahun, 2020). Additionally, the crop is highly susceptible to Enset bacterial wilt (EBW), a devastating disease caused by Xanthomonas campestris pv. musacearum, which threatens food security in regions where Enset dominates (Ambachew, 2018). Land use competition further compounds the issue, as prioritizing Enset over diverse crop production can reduce agro-ecosystem sustainability and limit the availability of other essential food sources (Feleke, 2016). Furthermore, while Enset ensures subsistence, it does not always provide substantial market opportunities, restricting income diversification for farming households (Engida et al, 2022). Lastly, climate change poses an emerging threat, with shifting rainfall patterns and extreme weather conditions potentially undermining Enset production, necessitating disease prevention strategies and technological improvements in processing to sustain its viability (Senbeta, 2022). Addressing these challenges requires a balanced approach that maintains Enset's critical role while integrating crop diversification, disease management, and market access initiatives to enhance long-term food security and resilience.

Household assets play a fundamental role in achieving and maintaining food security by providing multiple pathways to economic stability and nutritional well-being. Empirical evidence from diverse contexts demonstrates that asset ownership serves as both a protective buffer against food insecurity and a foundation for sustainable livelihoods. In developed nations like the United States, Guo's (2011) analysis of low-income

households revealed that assets including savings accounts, vehicles, and home equity significantly improved food security outcomes. The study found this relationship was particularly strong among vulnerable groups such as female-headed households, families with children, and rural residents. Importantly, assets provided stability during income fluctuations, suggesting they serve as a crucial safety net beyond regular earnings. The protective function of assets becomes even more critical in developing economies. Multiple Ethiopian studies (Dunga, 2020; Abafita& Kim, 2014; Szabo et al., 2016) consistently demonstrated that productive assets - particularly land and livestock - substantially reduced household vulnerability to food insecurity. These assets enable three key benefits: (1) direct food production for household consumption, (2) income generation through surplus sales, and (3) risk mitigation during economic or environmental shocks. For instance, livestock can be sold during droughts to maintain food purchases, while land ownership allows for crop diversification to withstand climate variability.

Beyond immediate food access, asset ownership generates important secondary benefits. Women's control over assets (Joshi et al., 2019) leads to improved child nutrition and education outcomes, creating intergenerational benefits. Productive assets enhance agricultural productivity (Aragie&Genanu, 2017), while financial assets enable dietary diversification (Prayitno et al., 2019). Assets also provide critical resilience against various shocks - whether climatic (droughts, floods) or economic (price volatility, job loss) - as households can liquidate or leverage assets in crises (Nega & Shitaye, 2020). The cumulative evidence underscores that asset accumulation represents a strategic approach to food security that addresses both immediate needs and long-term stability. Policies promoting asset building - particularly for vulnerable groups and women - can create durable solutions to food insecurity by enhancing households' productive capacity, economic resilience, and nutritional outcomes across diverse contexts.

5.Conclusion

The study area exhibits a notable prevalence of food insecurity, with several key determinants identified. Factors such as low educational attainment, limited land size, short birth intervals, reliance on enset production, and a deficit in assets were found to significantly influence food security status. Higher levels of education positively correlated with improved food security, potentially attributable to enhanced knowledge, skillsets, income levels, and broader economic opportunities. Additionally, greater land holdings were associated with heightened food security, affording farmers increased production capacity, crop diversity, and improved access to external resources. Birth interval emerged as a critical factor, as longer intervals not only reduce child mortality but also enable households to invest in productive pursuits like agriculture and other income-generating activities. Nevertheless, a dominant reliance on Enset cultivation led to diminished yields and limited diversity in food sources, consequently exacerbating household food insecurity. Addressing this issue is of paramount importance and may necessitate initiatives such as the promotion of crop diversification and the provision of training and support for enhanced Enset cultivation practices. Furthermore, the overall asset base of a household demonstrated a positive correlation with food security, likely due to the heightened capacity to procure and access essential food items. These findings underscore the importance of tailoring policies and interventions to the specific contextual factors influencing household food security, to effectively address the underlying causes of food insecurity.

However, this study is not without limitations. The reliance on cross-sectional data limits the ability to draw causal inferences about the relationships observed. In addition, the study focused on a specific geographic and socio-economic context, which may constrain the generalizability of the findings to other regions. Future research could benefit from longitudinal data to better capture changes over time and explore causal pathways. Moreover, incorporating qualitative approaches could offer deeper insights into household decision-making processes and socio-cultural influences on food security. Expanding the scope to include climate-related variables and market access dynamics could also enhance the understanding of the multifaceted nature of food insecurity.

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A scoping study on Ethiopia's food security challenges and potential way outs

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Abstract

The purpose of this study is to document the challenges of food security and way outs to food insecurity in Ethiopia. It is based on multiple electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar which are commonly used for studies of this nature. The criteria used were to identify studies conducted internationally and in Ethiopia that are relevant to the subject under this study. Accordingly, the main issues with food security in Ethiopia are socioeconomic, biophysical, technological, policy, and institutional, including inadequate infrastructure, land degradation, conflict and displacement, and limited access to markets, credit, and technology. However, family planning, climate-resilient farming methods and enhanced water management systems are some possible solutions to Ethiopia's food insecurity problems. Furthermore, diversification of sources of income, bolstering rural-urban connections, gaining access to agricultural supplies, market and finance services, offering social protection, strengthening extension services, and implementing laws and regulations through appropriate institutions are also potential wayouts.Thus, it is imperative for policy makers and the public to pay attention to the identified challenges and remedies and design appropriate interventions to alleviate the food insecurity problems in Ethiopia.

Keywords*:* food security; family planning; land degradation; climate resilient; conflict

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1.Introduction

The availability, accessibility, use, and stability of food supply are all components of the complex problem of food security. It is clear that a number of ecological, social, political, and economic factors are contributing to Ethiopia's food insecurity. Using existing academic and gray literature as a guide, this report examines the main obstacles to Ethiopia's food security and suggests possible solutions.

Historical Context of Global Food Security

The issue of food problems was first brought into the international forum in the early part of the 1930s by one of the members of the League of Nations, namely, Yugoslavia. Yugoslavia emphasized the importance of food for well-being and urged the Health Division of the League of Nations to gather and disseminate evidence about the food situation in representative nations of the world (Shaw 2007). Accordingly, the Health Division of the League of Nations conducted a survey and submitted a report on “nutrition and public health” in 1935. The report revealed that there is an acute food shortage in poor countries, which, for the first time, revealed the scope of hunger and malnourishment in the world. After the report was published, the League of Nations debated human nourishment and the necessity for harmonized nutrition policies in different nations (Simon 2012). The League of Nations, then, decided to increase food production through improvements in agriculture, which would also serve as an input to industry and expand the world economy through the integration of health and agriculture (Orr 1966, Shaw 2007).

Immediately after the Second World War, the Food and Agriculture Organization (FAO) of the United Nations was established in 1943 at a Food and Agriculture Conference held at Hot-Spring, Virginia, in the USA. The FAO organized its first World Food Survey in 1946, and in 1946/1947, the FAO was invited again to investigatethe likely consequences of an overrun of agricultural harvests, a phenomenon that soon became worrisome for several nations. Given that there was excess food production in the United States of America, food aid worth 3 billion US dollars was sent from the US to Europe between 1948 and 1953 within the agenda of the Marshall

Plan. On October 27, 1960, the United Nations General Assembly voted for a resolution on the delivery of Food Excesses to Food-Deficit people through the United Nations Schemes (UN 1960), essentially launching the World Food Program (WFP). It was predicted that the eventual resolution to the problem of hunger can be addressed using the large volume of surplus food, which can be used for joint progress worldwide. Thus, WFP principally uses excess food supplies for humanitarian and development interventions.

By the early 1960s, world cereal marketplaces had sustained suffering from significant excesses as a result of the increase in the world food production by more than 50 percent and the increase in production per capita by more than 20 percent throughout the 1950s and the 1960s. There was an increase of approximately 2 percent or more than 25 million tons of cereal in the world market each year until the end of the sixties (Simon 2012).

The subsequent decline of world food stocks in the late 1960s and the growth of a request for food supplies by the Indian subcontinent gave rise to the reduced availability of food surpluses, and the increase in the prices of food supplies became evident worldwide. In the meantime, the International Wheat Agreement and the Food Aid Conventions were combined to form the International Grains Agreement, which was approved by the International Wheat Council and the United Nations Conference on Trade and Development (UNCTAD) in Rome at a conference held in 1967. Along with this agreement, there were several additional food aid conventions; however, it was the only one signed in 1999 that was effective and officially documented that the goal of the agreement was to back World Food Security (International Grains Council 1999).

In 1972, dramatic decreases in cereal production were reported in numerous areas of the world because of poor climatic conditions. The reduction in cereal production was approximately 55 million tons less than expected, which was an approximately 3% decrease. Countries such as the USSR and a few others became food importers due to climate change. Accordingly, the US exported 66 percent more cereals in 1974 than in 1973, which is much

higher than the amount exported in 1972. For example, cereal leftover stocks, worldwide, decreased from more than 200 million tons in 1970 to approximately 100 million tons in 1974. On the other hand, OPEC (the Organization of Petroleum Exporting Countries) decided to increase the price of petroleum to extraordinary record levels. This situation further created an unfavorable situation and increased both the cost of fertilizers and the transport of cereals. This resulted in an increase in the price of cereal crops (Simon 2012).

According to Simon (2012), although the output of agriculture in many developing countries improved by approximately 2 percent per year from 1960 to 1970, they are still dependent on imports in the form of either commercial dealings or food aid. Food aid accounts for approximately 40-60% of the total imports of developing countries. In fact, food aid fell from approximately 17 million tons of cereals per year in the late 1960s to approximately 7 million tons in the early 1970s. The international food crisis was a concern for many countries. As a result, at the United Nations World Food Conference, which was held in November 1974 in Rome, the goal of ensuring that no one would suffer from food insecurity within a decade agreed on many endorsements dealing with food security. The Conference accepted an international responsibility for World Food Security, which for the first time accepted that food security was a shared worry of the entire world. Significant advancements were made in 1996 in the history of food security in the event of the World Food Summit, which was organized in Rome by the FAO. The conference agreed with a plan of action that each country is obliged to implement a plan unswerving of its possessions and sizes to attain its distinct objectives and collaborate regionally and globally to shape shared solutions to worldwide problems of food security (FAO 1996). By 2002, as a result of the endorsements of the 1996 World Food Summit, emerging and transitioning nations designed their countrywide food security approaches. Moreover, the United Nations Millennium Summit met in New York in September 2000 as a distinct gathering of the UN General Assembly permitted the 8 Millennium Development Goals (MDGs), the first of which was to Eradicate Extreme Poverty and Hunger by 2015. Furthermore, the follow-up plan, The 2030

Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provided a shared blueprint for peace and prosperity for people and the planet now and into the future, comprising the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries—developed and developing—in a global partnership. It was recognized that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth, while tackling climate change and working to preserve our oceans and forests. The Sustainable Development Goal (SDG), Goal-1: No poverty (End poverty in all its forms everywhere) and Goal-2: Zero hunger (End hunger, achieve food security and improved nutrition and promote sustainable agriculture) are among the significant endeavors by the international community toward attaining food security worldwide (UN 2015).

Definition and pillars of food security

During the 1974 conference, food security was, for the first time, defined on an international forum as *the availability of an acceptable food supply at all times*. In 1983, the FAO Meeting approved a determination on World Food Security (FAO 1983), which specified that the eventual goal of world food security should be to guarantee that all people at all times have access to the food they require.

The 1992 Global Meeting on Nutrition, cooperatively prepared by the FAO and WHO, was carried out in Rome and was a vital milestone in the existing advancement of food security. By the 1990s, there were more than 200 definitions of food security, although the definition of food security was established in 1996 at the World Food High-level meeting in Rome. The access dimension of food security, which was underscored by Sen in 1981, was formally accepted in 1996 by the World Food Summit in Rome and was executed after the 2005 Niger famine and the 2008 food prices increase in the world. Henceforth, there is a broader agreement on the definition food security in that, *food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and when their food preferences are met for an active*

and healthy life. This definition continues to be the most frequently used meaning of food security internationally and a further analysis of this definition brought together the four pillars of food security (food availability, access, utilization and stability).

Then, in 2002, the term "social" was added to the 1996 definition of food security, in the FAO modified definition, which was stated as *when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life* (FAO 2003).

Informed by ongoing developments in the evaluation of the concept of food security, the FAO again modified and publicized the latest definition of food security in 2009. *Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*. This working definition of food security of the FAO (2009) comprises four core dimensions: availability, access, utilization, and stability. where availability addresses the supply side of food security and refers to the term "sufficient". Meanwhile, WFP defined food availability as the amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid (WFP 2009). The access dimension comprises the economic level of the household to afford the food needed (Benedict 2011). It refers to having physical, economic and social access. Food access is related to household's ability to acquire an adequate amount of food regularly through a combination of purchases, barters, borrowings, food assistance or gifts (WFP 2009). In fact, there are three elements in access to food: physical, financial and sociocultural. In agreement with Sens' (1981) thesis, Young et al. (2001) stated that the root cause of food insecurity is the inability of people to gain access to food due to poverty. The other dimension, utilization, is understood as the quality of food that meets the nutritional requirements of the household (Wiggins &Leturque 2010). It refers to "safe and nutritious food which meets their dietary needs". It is not sufficient that food be available and accessible to households to ensure that people will have a

"safe and nutritious" diet. A number of elements intervene here, such as the selection of food commodities, their conservation and preparation, and the absorption of nutrients. Food must be of good quality and safe. Food utilization is also related to clean water, sanitation and health care. This dimension refers not only to nutrition but also to other elements that are related to use, conservation, processing and preparation of food commodities (Simon 2012). Moreover, stability denotes the ability of a household to have continuous access to a food source with minimal risk or the stability of all other dimensions of food security over time (Moltedo et al. 2014). It refers to:*at all times*. This stability applies in the first instance to the previously mentioned three dimensions of food security. Food security is *a situation* that does not have to occur a moment, a day or a season only but on a permanent basis with sustainability. Given the stability dimension of food security, one speaks about chronic and transitory food insecurity: chronic food insecurity is a long-term or persistent inability to meet minimum food requirements, whereas transitory food insecurity is a short-term or temporary food deficit. There is also cyclical food insecurity, such as seasonality (Devereux 2006). According to the 1996 World Food Summit definition of food security, the element that is not included in the four dimensions of food security described above is *food preferences for an active and healthy life*. The elements related to *food preferences* could be the object of further research, which, at the household and individual levels, could be comparable to what food sovereignty is at the country level.

Food Security in Ethiopia

Ethiopia's socioeconomic and environmental circumstances have a significant role in the country's history of food insecurity. Famines have occurred frequently in the nation (de Waal, 1991). Droughts frequently caused these famines, but insufficient infrastructure, violence, and poor governance made them even more severe. With programs like the Productive Safety Net Programme (PSNP), which provide food and cash transfers to households at risk, Ethiopia has made an effort to improve food security and reduce poverty during the last two decades (Berhane et al., 2014). With an estimated 20 million people in need of food aid each year, food insecurity is still a serious problem (WFP, 2022).

Approximately 10% of the Ethiopian population is chronically food insecure (Endalew et al. 2015). Landless, oxen less, female-headed, elderly, poor nonagricultural households and newly established settlers are largely food insecure. Thus, their chronic food insecurity is attributed mainly to the low return of the livelihood system (Weldarufael 2014). Moreover, food security needs to be analyzed within the broader spectrum of the livelihood of the study population. According to Dereje and Abeje (2018), ensuring sustainable livelihoods in rural communities (inclusive policies and strategies) is necessary to integrate rural nonfarm activities into subsistence farming. Thus, treating household food security without considering the livelihood security of household members is inadequate for making feasible policy recommendations (Burchi& De Muro 2012). Thus, food insecurity is a situation in which a household runs a continually high risk of inability to meet the food needs of household members due to a lack of assets. Thus, food insecurity is the result of unacceptable livelihood strategies (ACF 2010).

When we consider food security in Ethiopia, it is imperative to look into the food security situation of the world at large. Ethiopia remains an underprivileged country with some serious encounters to meet the food security challenge, particularly with the variable rainfall created by climate change, and agricultural productivity has also remained relatively low because of the lack of investment and the need to modernize farming practices. While there have been some improvements to the business enabling environment and prospects for developing a dynamic industrial country, Ethiopia needs to undertake additional measures to create many of the conditions for a competitive private sector (African Development Bank Group 2015).

Indeed, 80 percent of the world's hungry people are engaged in food production: 50 percent are small-scale farmers, 20 percent are agricultural workers, and 10 percent are forest dwellers, pastoralists and fishermen. The remaining 20 percent are the urban poor (Glopolis 2010). Furthermore, it is established long before that, a household is said to be food insecure when its

consumption falls to less than 80 percent of the daily minimum recommended allowance of caloric intake for an individual to be active and healthy (Devereux 2000).

Reports indicate that the daily energy intake of average Ethiopia is lower than the WFP minimum standard (2100 calories per day) (FAO 1985, National Academy Press 1995, FAO1998, UNICEF 1999). The most important documented forms of malnutrition in Ethiopia are protein-energy malnutrition and vitamin A, iodine and zinc deficiencies (Dorit et al. 2001).

It is apparent that Ethiopia is one of the food insecure nations in the world and is most vulnerable to climate change, particularly in shifts in rainfall, as the majority of smallholder farmers rely upon rain-fed agricultural practices.Furthermore, a number ofstudies have been conducted on food security in Ethiopia, particularly since the introduction of the PSNP in 2005, the launch of the PSNP is a marker for expanding food security research in Ethiopia. Devereux (2009) analyzed pre-PSNP period research findings and reported three key factors contributing to extreme food insecurity situations in Ethiopia: production failure, exchange failure, and response failure. In addition, there is a growing consensus that food insecurity and poverty problems are closely related in Ethiopia (MoARD 2009). *Livestock and land holding, oxen ownership, livestock feed, access to veterinary and extension services, fertilizer usage, credit access, annual income, remittances, and access to employment are contributors to food security in Ethiopia* (Dagnaygebaw2019). The availability of household labor, farm size and access to draught power are critical factors of relative wealth and family food security as per the food economy baseline valuations carried out in rural Ethiopia by Save the Children (Boudreau 1998; Chapman and Haile Kiros 1999; Haile Kiros et al. 2000).

According to Jemal and Kim's (2014) study, household food security was positively and significantly correlated with the age and education of the head of the household, the amount of rainfall, the ownership of livestock, off-farm activities, soil conservation techniques, and per capita consumption expenditure. Conversely, household food security was negatively correlated with access to credit and remittance. Additionally, the study indicates that household food security may be improved by a prudent combination of

interventions that increase opportunities for income diversification in rural areas by encouraging off-farm activities, education, training, and extension services, as well as by raising livestock productivity. In rural regions, emphasis should be placed on raising awareness about the more efficient and effective use of resources like credit.

According to a study done in East Hararghe, Ethiopia, factors that significantly influenced a person's susceptibility to food insecurity included the size of the cultivated land, the age of the household head, the size of the family, access to irrigation, adoption of soil and water conservation, and the amount of credit received (Million et al. 2019). Food insecurity is a significant issue in Ethiopia that has an impact on rural inhabitants' quality of life. Planting early maturing crops, switching to lower-quality and less expensive foodstuff, altering cropping patterns, selling livestock, and buying food with cash are the primary coping mechanisms, according to a study done in the Central and North Gondar Zones to examine the causes and coping mechanisms of food insecurity (Wondim et al. 2022).

Rural households were found to be severely food insecure, according to a study on the situation of food insecurity in Tigray, drought-prone rural districts, Ethiopia (Tewelde et al. 2024). Moreover, a recent study carried out in Addis Ababa, Ethiopia, found that low-income households in the city experienced a high rate of household food insecurity. In addition, it was noted that households were compelled to lower the quantity and quality of their food in order to deal with the food crisis (Tefera et al. 2024).

Furthermore, Henok & Elsa's research from 2024 gave a thorough grasp of the fundamental causes of Ethiopia's food insecurity, such as poverty, policy shortfalls, and agricultural problems. Their findings highlight the critical need for focused policy initiatives that tackle the underlying causes of malnutrition and food insecurity, stressing the significance of empowering women, assisting smallholder farmers, and giving nutrition-sensitive agriculture priority in Ethiopia.

As a whole, this scoping study is designed to address the need for regular reviews and syntheses of the literature on the food security situation in Ethiopia to update policy makers and practitioners with the current developments. Although there are many research reports related to food security, there are no well-organized reviews or synthesis documents clearly showing food security problems and their remedies in Ethiopia. Thus, this work aims to address the gap of a comprehensive review of the challenges and way outs to food security in Ethiopia, with the belief that the presence of such comprehensive literature can serve as a basis for academic purposes, further research and policy formulation.

2. Materials and Methods

2.1 Search Strategy

The purpose of this scoping study was to summarize and disseminate relevant research findings in Ethiopia and other countries that pertain to food security. In order to map the body of research on Ethiopia's food security issues and solutions, this study used a scoping review methodology. Scoping reviews are especially helpful for revealing gaps in the literature, finding important themes, and synthesizing information over a wide topic (Arksey & O'Malley, 2005; Levac et al., 2010). The scoping study's ability to offer a thorough and open approach to mapping research areas is one of its main advantages. within a comparatively little period of time (Oliver, 2001).

The approach adhered to the framework proposed by Arksey and O'Malley (2005) and expanded by Levac et al. (2010). This framework comprises the following steps: (1) formulating the research question; (2) locating pertinent studies; (3) choosing studies; (4) charting the data; and (5) compiling, summarizing, and presenting the findings.This scoping study was guided by the following main research question: What are the main obstacles to Ethiopian food security, and what strategies have been put forth or put into practice to overcome these obstacles? The role of climate change and the efficacy of policy interventions were among the sub-questions.

To find peer-reviewed papers, reports, and grey literature published, a thorough search was carried out across several electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar. Combinations of the following keywords were listed in the search terms: "food security," "global," "Ethiopia," "challenges," "solutions," "climate change," "agriculture," "policy interventions," and "vulnerability." To narrow down the search, booleanoperators (AND, OR) were applied. In order to find more pertinent material, the reference lists of the included research were also manually searched.

Regarding the search criteria: the literature survey was conducted from March 2024 to February 2025 with the following inclusion criteria:

Study area: Studies conducted in the concerned country (Ethiopia) were considered.

Design: All relevant studies (longitudinal and cross-sectional) that assessed food security and food insecurity in Ethiopia were included;

Language: articles written in English language are reviewed; and

Volume of documents: 1205 publications were downloaded, and after going through the abstracts and summaries, one hundred and twelve related documents were identified. Furthermore, after a thorough reading of the contents of the papers, information from ninety-three documents was used for this scoping study.

This methodology offers a strong foundation for mapping the present level of knowledge regarding Ethiopia's food security issues and solutions for policymakers, researchers, and practitioners.

3.Results and Discussion

3.1 Challenges of food security in Ethiopia

Ethiopia's complex food security issues are examined in this review of the literature. In Ethiopia, poverty contributes to food insecurity. Due to limited access to chances for earning income, a sizable share of the population lives below the poverty line (World Bank, 2020). Ethiopia's food security is seriously threatened by climate change, and since more than 85% of its agricultural output is rain-fed, the nation is extremely susceptible to unpredictable rainfall patterns, protracted droughts, and floods (World Bank, 2020, and 2021). Additionally, the country's ability to become food self-sufficient has been limited by environmental deterioration, which includes deforestation, soil erosion, and land degradation. These factors have further reduced agricultural output (Gebreselassie et al., 2016).

The Horn of Africa, especially Ethiopia, is seeing an increase in the frequency and severity of droughts, which has a direct effect on livestock production and crop yields, according to the Intergovernmental Panel on Climate Change (IPCC, 2021). Furthermore, a population that is expected to grow at a rate of 2.6% per year and reach 150 million by 2050 (UN DESA, 2019 and 2022) puts a great deal of strain on the finite natural resources, resulting in overgrazing, deforestation, and soil erosion. Limited access to improved seeds, fertilizers, and irrigation systems—all crucial for raising agricultural productivity—complicates these environmental issues.

According to Spielman et al. (2011), despite Ethiopia's enormous agricultural potential, a number of problems, such as poor infrastructure, limited access to modern inputs, and insufficient extension services, contribute to the country's low productivity. Furthermore, one of the biggest obstacles to Ethiopia's attainment of food security is the lack of suitable infrastructure, especially in rural areas. Inadequate market accessibility, inadequate storage facilities, and poor road networks raise the cost of moving agricultural goods and lower farmers' profits (Dorosh et al., 2012).

Recurrent conflicts in Ethiopia have caused millions of people to be displaced, agricultural activity to be interrupted, and food insecurity to

worsen (IPC, 2021). The Productive Safety Net Program (PSNP) and the Agricultural Growth Program (AGP) are among the programs Ethiopia has emphasize to combat food insecurity, but their efficacy has been constrained by implementation and coordination issues. The effective implementation of these programs has been hampered by a lack of monitoring and evaluation systems, corruption, and weak institutional capacity (Gilligan et al., 2009).
Although Ethiopia is attempting to reduce malnutrition, there are a considerable number of cases of stunted and underweight children. In 2013, approximately 7 million people were chronically foodinsecure, and an additional 2.7 million people were dependent on emergency food aid (African Development Bank Group 2015).

According to Birara, et al. (2015) and Dagnaygebaw (2019) population pressure, family size, age of the household head, lack of employment opportunities, dependency ratio, environmental degradation, diminishing land holdings, poor soil fertility, climate change (drought, flood, frost attack), lack of oxen, deterioration of food production capacity, outbreak of plant and animal disease and pest, shortage of cash income, poor farming technologies and innovations, weak extension services,poor social and infrastructural facility, pre- and postharvest crop loss,distance to market, limited household assets, instability and armed conflicts, corruption and political instability, and lack of appropriate policies and institutions are the triggers of the food insecurity situation in Ethiopia. On the other hand, 80% of the food harvested in Ethiopia is used for household consumption on farms, and market supplies are insufficient and, consequently, prices are high (Devereux, 2000).

Mulugeta et al. (2018), reported that, in many parts of Ethiopia, a combination of natural and man-made factors has led to serious and mounting food insecurity problems. According to their report, the instantaneous reasons for food insecurity include repeated droughts and irregular rainfall patterns, environmental deprivation, fast population growth, weak rural infrastructure, and legacies of previous policy constrictions,which are considered rudimentary grounds of food insecurity. They further claimed that poverty and food insecurity go together and

continue to be key encounters in apprehending economic progress in Ethiopia.

Similarly, Tariku (2021) stated that there are many details and origins of food insecurity in Ethiopia, including household characteristics, demographic pressure, limited asset ownership and access to institutional services, poor agricultural technology adoption, low participation in extension and other programs, environmental degradation, drought risk, rural urban migration, and conflict. Similarly, Setiye and Teshome (2019) reported that population pressure, land dilapidation, political uncertainty, climate shocks, etc., are the most prolonged negative causes of food insecurity in Ethiopia.

Furthermore, Abduselam (2017) indicated that population burden, land degradation and drought, volatility and armed struggle are core causes of food security glitches in Ethiopia. The report of the FAO (2008) implies that adverse climate circumstances, political volatility, or economic issues (joblessness, mounting food prices) may affect the food security situation in Ethiopia.

According to Asefa andZegaye (2003), thereasons for food insecurity in Ethiopia are population growth, production instability, low nonfarm engagement, low income, regional disintegration of markets, high natural dilapidation, low farm technology, illiteracy and low-quality basic education, poor health and sanitation, poor governance and interstate, intrastate armed conflicts and wars, all of which hamper the attainment of food security and sustainable economic development.

Continuing food insecurity is the result of lengthy periods of poverty and a lack of assets. Chronic food insecurity distresses households that obstinately lack the ability to either buy or produce adequate food on their own. Whereas temporary food insecurity is a momentary man-made and/or natural prodigy that results in instability in food production, household incomes and food prices, in the worst case, it may result in famine (FAO,1996).

The challenge of food insecurity is a worldwide concern;30% of the world's population (2.37 billion) was food insecure in 2020, and more than one-third of them (799 million) were on the continent of Africa (FAO. IFAD, UNICEF W and W., 2021). In 2016, there were 26 million food insecure people in Ethiopia, which was equivalent to one-fourth of its population, and among the urban households, one in seven were food insecure (CSA, 2019). Urban areas are generally less susceptible to food insecurity; however, this assumption is not working, since urban areas are stricken by deep disparities among socioeconomic groups. Thus, urban food insecurity is a growing issue of concern (IFPRI, 2017).

In 2020, the percentage of children underfive years of age stunted was reduced to 35.3% from what was reported as 58% in 2000 in Ethiopia. However, there are reports that approximately 5.8 million under five children are stunted in the country (CSA, 2019). In addition, Sahlu et al. (2020) reported that food insecure mothers were four times more likely to give a low-birth-weight child owing to a deficiency of nutrients in the mothers' diet, which is vital for the growth and development of the fetus at the time of gestation. Consequently, the child may suffer from poor health, weakened cognitive development, poor growth, low learning potential, and less adult work accomplishment and productivity (Moench-Pfanner, et al., 2016). Likewise, the USAID (2020) report indicated that more than 50% of infant and child deaths in Ethiopia are due to malnutrition. On the other hand, in urban Ethiopia, the origins of food insecurity are unsystematic rural–urban population movement, low employment prospects, poor markets, weak services, a poor working atmosphere, a lack of social protection, etc. (PIM, 2016).

Devereux (2000) listed the problems of food insecurity in Ethiopia as follows: land tenure; population increase; fragile natural resources; declining soil fertility; inadequate inputs; recurrent droughts; low yields; inadequate off-farm employment; limited diversification and migration options; and unfeasible agriculture. Moreover, as a result of unreliable weather, food production in Ethiopia is highly variable and volatile. In Ethiopia, national food production decreases by 4.4% if rainfall is reduced

by 10% below its long-term average (von Braun 1991). As climate change is linked to challenges of land dilapidation, population increases, backward technology and a decrease in food security (Setiye and Teshome, 2019). The Horn of Africa, where Ethiopia is located, is the most susceptible region, and it is projected that the global warming will increase by 1–3°C by 2030. Such an increase in mean temperature may result in consequent decreases in staple cereal yields of up to 30% (Parry 1990).

The low level of human capital in Ethiopia is considered a reason for and a consequence of food insecurity as a result of the combined effects of poor education, health, nutritional status, and labor productivity. It is apparent that illiteracy is considered a constraint to access skilled and semiskilled off-farm employment (CSA 1999:91).

According to Dorit et al. (2001), land size and soil fertility, poor crop productivity, and lack of livelihood diversification are famine indicators in households in Ethiopia. If these situations are prompted by conflict, drought, disease, pest infestation, etc., the households will be in menace.

3.2 Way outs to food insecurity in Ethiopia

Millions of Ethiopians are impacted by food insecurity, which also jeopardizes the nation's development initiatives. Ethiopia has enormous agricultural potential, but food shortages still occur often. Using scholarly research, policy documents, and case studies, this literature review investigates possible approaches and solutions to solve food insecurity in Ethiopia.

It is commonly acknowledged that agricultural development is essential to tackling Ethiopia's food insecurity. Agriculture, which employs more than 70% of the workforce and accounts for over 34% of GDP, is a major contributor to the nation's economy (World Bank, 2020). But because of antiquated farming methods, restricted access to inputs, and inadequate infrastructure, the sector is still primarily subsistence-based and has low productivity.

Building climate change resilience requires the adoption of climate-smart farming practices. According to Lipper et al. (2014), these methods include conservation agriculture, the adoption of drought-resistant crop types, and enhanced water management strategies. Furthermore, reforestation and sustainable land management can improve ecosystem services and lessen environmental damage. Therefore, securing long-term food security requires increasing resilience to climate change.

Social safety net initiatives like the PSNP can be expanded and improved to give vulnerable households much-needed assistance. To lessen reliance on food assistance, these programs must be supplemented by measures that encourage livelihood diversification, like access to finance and vocational training (Gilligan et al., 2009). Investing in rural infrastructure, such as roads, storage facilities, and market accessibility, is another crucial sector. Post-harvest losses, which can make up as much as 30% of Ethiopia's total agricultural output, can be decreased with improved infrastructure (FAO, 2017).

Enhancing productivity and tackling the issues of land scarcity and climate change require more funding for agricultural research and development. This involves creating and distributing better farming methods, fertilizers, and seed varieties (Spielman et al., 2010). These advances, including better seeds, fertilizers, and irrigation systems, can also be adopted more readily if extension services and farmer education are strengthened. According to Minten et al. (2016) using sustainable farming methods and high-yield crop types can greatly boost agricultural production.

In Ethiopia, social safety nets have become an essential instrument for reducing food insecurity, especially for disadvantaged groups. One of Africa's biggest social protection initiatives is the Productive Safety Net Programme (PSNP), which was introduced in 2005. In exchange for taking part in public works projects, it gives food or cash transfers to households that experience chronic food insecurity (Berhane et al., 2014).

According to research, the PSNP has improved access to food and stabilized household incomes, which has improved food security (Gilligan et al., 2009). However, its efficacy has been restricted by issues like targeting errors, coverage gaps, and reliance on outside funding (Sabates-Wheeler & Devereux, 2010). Experts advise combining social safety nets with complementary measures, such livelihood diversification and nutrition education, to increase their effectiveness (Hoddinott et al., 2012).

Food security results can be improved by empowering women via education, financial availability, and agricultural cooperative involvement (Quisumbing et al., 2014). Achieving food security in the meantime requires tackling gender inequality. Enhancing household food security and promoting wider economic growth can be achieved by empowering women via education, resource access, and decision-making involvement (Quisumbing et al., 2015). However, without stability and peace, sustainable food security is impossible. To create an environment that supports agricultural development and food security, efforts must be made to resolve conflicts and foster social cohesion (FAO, 2018). This entails tackling the underlying causes of violence, like ethnic conflicts and land disputes, as well as making sure that civilians are protected in times of emergency.

Furthermore, the intricate and interconnected causes of food insecurity can be addressed by a multi-sectoral strategy that combines social protection, health, education, and agriculture (Maxwell et al., 2013). Additionally, during times of scarcity, community-led projects like grain stores and seed banks can improve the availability of food (Tadesse et al., 2014). Promoting nutrition-sensitive agriculture, which combines food production with dietary variety and nutrition education, is another promising strategy. For example, by expanding access to fruits and vegetables, home gardening initiatives have been effective in enhancing household nutrition (Girma et al., 2018).

According to FAO, (2008), food stability should be sustained to ensure food security at the global, regional, national, household, and individual levels. Similarly, Setiye and Teshome (2019) reported that *Land and livestock holdings, off-farm activities, household head education, household size,*

household income, the use of yield-enhancing technologies such as access to irrigation, good rainfall and soil fertility status meaningfully determine the food security of households.

In Ethiopia, people use sales of livestock, agricultural employment, and *short-term/seasonal* migration to other areas; requesting grain loans; sales of wood or charcoal; small-scale trading; limiting the size and frequency of meals; *seeking alternative or additional jobs; relying on less preferred and less expensive food; seeking relief assistance; seeking alternatives or additional jobs; becoming temporary traders; engaging in household splitting; consuming wild food; remittance; participating in cash basis projects; diversifying livelihood incomes; purchasing grains from the market; and renting out land* as major coping mechanisms (Birara, et al. 2015; Abduselam, 2017; Dagnaygebaw, 2019).

Meanwhile, the food security of poor people can be enhanced through the promotion of social justice in planning and implementing social protection interventions. In sub-Saharan Africa, there is an encouraging relationship between social protection programs and the results of food security (Devereux, 2016).

Dercon and Krishnan (1998) reported that through agricultural production and rural income, resources, such as access to land and labor, infrastructure, technologies, credit, and geographic suitability, it is possible to affect the level of food insecurity. To increase agricultural yields, there is a need for structural transformation through land tenure reform and the injection of technological inputs. Moreover, it is also necessary to consider reducing the role of agriculture in the economy by increasing growth in other sectors, as agriculture is characteristically vulnerable to conditions such as climate change (Befekadu and Berhanu 2000). Finding and investing in different engagement openings other than rain-fed agriculture are crucial for future food security in Ethiopia (Devereux, 2000).

Increasing access to financial facilities is also important for increasing the yield of rain-fed agriculture through improved land and water resource

management (The African Development Bank Group, 2015). For the landless, the road to food security is creating a conducive situation for rural economic diversity, meaning, allowing active farmers to increase their land size and increase their agricultural output, for example, by employing landless workers. Furthermore, livelihood strategies such as crop and livestock production, working in off-farm activities, engaging in food for work programs and even migration are potential paths to address the food insecurity of the landless (Scoones,1998).

According to the food security strategy of Ethiopia (FDRE, 2002), the main goals of food security in Ethiopia are to increase agricultural production countrywide, build a resource base for lingering food shortfall households, increase employment and income in rural and urban areas, and offer targeted handovers to deficit households.

In Ethiopia, pastoral and agropastoral areas constitute approximately 12% of the population and constitute more than 60% of the land mass.Given the intricate and varied nature of pastoral circumstances, improving food security situations is central to strengthening an early warning scheme that is based on outmoded survival approaches, such as the introduction of forage legumes wellmatched to dry areas; suitable technologies; large commercial ranches; and broadening of local economic systems where appropriate (FDRE, 20002).
Dorit et al. (2001) indicated that, to advance food security in Ethiopia, interventions such as introducing diverse income creation activities, applying varied study outputs, implementing up-to-date technologies, broadening income, creating new employment prospects and using different resources (land, labor, capita/asset) managing instruments should be taken into consideration.

According to the Ethiopian Food Security strategy (2002), the two most important strategies for realizing food security in Ethiopia areincreasing agricultural productivity and asset building.

4. Conclusion and Recommendation

4.1 Conclusion

It is about to be one century since the world recognized the need to address the food shortage problem of the globe. The founding of organizations such as the FAO in 1943 and the commitment of the United Nations to stand behind interventions such as the Millennium Development goal (MDG: 2000-2015) and that of the Sustainable Development Goals (SDG: 2015-2030) are clear indications of international concerns to address the challenges of food insecurity, which is driven by poverty.

Climate fluctuation, population pressure, low agricultural productivity, infrastructure constraints, and gaps in policy implementation are some of the factors contributing to Ethiopia's ongoing complex and multifaceted food security issue. A comprehensive strategy that incorporates infrastructural development, population control techniques, climate-resilient agricultural practices, and efficient policy execution is needed to address these issues. For Ethiopia to achieve long-term food security, it is imperative that institutional capacity be strengthened, sustainable land management be encouraged, and access to contemporary agricultural inputs and technologies be improved. To overcome these obstacles and guarantee a future where all Ethiopians have access to food, cooperation between the government, foreign organizations, and local communities is crucial.

Conflict, poverty, population expansion, and climate change all continue to impede efforts to ensure universal access to food. It will take consistent funding for social safety nets, agricultural research, gender equality, climate-smart agriculture, and peacebuilding to meet these problems.

It's also important to remember that food insecurity and poverty and inequality are intimately related in Ethiopia, where some people live below the poverty line and have little money to buy wholesome food. Despite these obstacles, efforts to combat food insecurity, like the Agricultural Growth Programs, which aim to increase agricultural productivity, and the Productive Safety Net Programme (PSNP), which distributes food and cash

transfers to households at risk, must be expanded and combined with long-term plans to foster resilience and guarantee sustainable food security.

4.2 Recommendations

1. Strengthen Climate Resilience: Ethiopia needs to give climate-resilient agricultural practices top priority because droughts and other climate-related shocks are occurring more frequently. This entails encouraging crop types that can withstand drought, enhancing water management using small-scale irrigation systems, and putting soil conservation strategies into practice. The government ought to teach farmers in sustainable land management techniques and make investments in climate-smart agriculture (CSA) technologies in coordination with foreign partners.

2. Strengthen Agricultural Research and Development: Ethiopia should invest more in agricultural research and development (R&D) in order to solve the low adoption of contemporary agricultural technologies. This entails creating crop types that are both disease-resistant and high-yielding, expanding access to high-quality seeds and fertilizer, and encouraging mechanization. When it comes to expanding the distribution of these technologies to smallholder farmers, public-private partnerships can be quite important.

3. Enhance Market Access and Infrastructure: Improving rural infrastructure, such as roads, storage facilities, and market connections, is essential to addressing food insecurity. Improved infrastructure will guarantee the effective distribution of food, lower post-harvest losses, and improve farmers' access to markets. In order to enhance agricultural products and generate job opportunities, the government should also encourage the growth of agro-processing enterprises.

4. Encourage Social Safety Nets and Poverty Reduction: By growing social safety net initiatives like the PSNP, needy households can receive short-term assistance while gaining long-term resilience. These initiatives should be supported by initiatives to combat poverty in the areas of healthcare, education, and job creation. Achieving food security requires empowering women, who are vital to agriculture and food production.

5. Promote Peace and Stability: Conflicts and political unrest are two of Ethiopia's main causes of food insecurity. To foster a climate that is favorable to agricultural development, the government must give peacebuilding and conflict resolution top priority. This includes resolving the core causes of conflicts, such as land disputes and ethnic tensions, and assuring the protection of civilians during crises.

6. Strengthen Data Collection and Monitoring: Accurate and timely data on nutrition and food security are essential for the development and execution of effective policies. Ethiopia should make investments to improve its systems for gathering and tracking data in order to keep tabs on developments, spot gaps, and guide decision-making. This entails using technology for data analysis, performing routine household surveys, and enhancing early warning systems for disasters like droughts.

7. Encourage Regional and International Cooperation: Ensuring food security is a global issue that calls for coordinated efforts. Ethiopia should work more closely with foreign partners and regional organizations like the African Union and IGAD in order to exchange ideas, gather resources, and carry out cooperative projects. This involves taking part in regional trade agreements to improve the affordability and availability of food.

All things considered, combating food insecurity in Ethiopia necessitates a multipronged strategy that combines immediate fixes with long-term plans. Ethiopia can significantly advance its goal of providing food security for its people by boosting climatic resilience, increasing agricultural output, fortifying infrastructure, and promoting peace and stability. However, this will necessitate ongoing dedication and cooperation from local communities, development partners, and the government.

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Transboundary Water Resources Management Practices: Comparative Analysis of Nile and Senegal River Basins

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Abstract

This study discusses the existing transboundary water resource management practices in Nile and Senegal River basins. By identifying key drivers of change that contribute to successful management of shared water resources, this study draws lessons in building effective institutional frameworks towards a common call for cooperative utilization of Nile waters. It adopted a Qualitative Comparative Analysis (QCA) design, with in-depth qualitative analysis of selected cases and Key Informant Interviews (KII) to analyze the drivers of change and evolution of the institutional frameworks that have been governing the Nile and Senegal River Basins and how they are affecting the cooperation process. The study argues that the compound effects of hydro-ecological phenomenon, legal regimes, historical beliefs and unilateral actions of the riparian's have been among the major factors that have influenced the cooperation process and determined their outcomes. The study has put forward some recommendations aimed at striking win-win solutions that could pave the way for Nile riparians come to a cooperative framework. These include, among others, focusing on benefits sharing than water allocations, focusing on scientific or technical issues than political, understand the views of local actors, contest the legitimacy of the old-regimes through re-negotiation of Cooperative Framework Agreement (CFA) with Egypt and Sudan, and change power relations in the basin.

Keywords: Nile River Basin: Senegal River Basin: Transboundary Waters Management: Water Cooperation: Hydropolitics

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1. Introduction

Water is referred to as the life blood of Earth's ecosystems because of its important significance in the natural world. Ayaa (2012) argues the delineation of water as an essential resource is interwoven in the various functions of the nature and the human society in countless ways making it one of the most complicated sources of challenges of the mankind (Varis et al., 2008). Water is also associated to the creation of many dramatic conflicts among different competing demands and users throughout human history (Abukhater, 2013).

Amid this demand leading to conflicts and the increasing significance of water resources shared across national borders and the underlying resources management practices have attracted considerable research interest in many scientific fields. Pressed by a mix of demographic, political, social, environmental, technological and economic drivers the underlying challenges thus call for seeing water in a broad development framework (Varis et al., 2008). Because water knows no political boundaries (GIZ, 2011), nations vie for their fair share of water for different uses. The situation gets more complex as transboundary water resource, which can describe as water shared across political, economic, or social boundaries (Beach et al., 2000). Hence, the intricacy of man-made boundaries and the natural delineation of the concerned parties as upstream or downstream riparians make the issue of international water disputes a formidable and volatile one (Mirumachi et al., 2016).

This situation is further complicated by the fact that a large portion of major freshwater basins in the world fall within the jurisdiction of more than one nation (Uitto and Duda, 2002). UN states that approximately 40% of the world’s population lives in river and lake basins that comprise two or more countries, and perhaps even more significantly, over 90% lives in countries that share basins (UN-Water, 2008). As to Varis et al. (2008) nearly 47% of the area of the world (excluding Antarctica) falls within transboundary basins, while nearly 60% of the area i.e. 20 countries in Africa; at least 80% of their total areas are within transboundary basins. As a result, water related conflicts are expected to escalate due to exponential population growth, industrial

development, and increasing urbanization, as well as the negative consequences of climate change.

Therefore, according to Varis et al., (2008), the way forward for these competing interests is whether to cooperate in order to sustainably manage and reap maximum benefits from the shared water resource or languish continuously. However, the management of transboundary water resources remains a complicated process which presents policy-makers with complex geopolitical, economic, and environmental as well as supranational challenges that are being amplified by exponential population growth, uneven economic development, and environmental degradation. Abukhater (2013) argues that the persistence of water conflicts in many arid regions is not simply a matter of water shortages, but rather the lack of equitable agreements that govern the allocation of disputed water resources to mitigate the adverse impacts of hostility and resentment. Thus, managing these resources efficiently, pragmatically, and equitably is increasingly becoming a priority for policy decision processes (Iyob, 2011).

In order to confront such complex conflicts over shared water resources, many riparians chose to address the issue through Integrated Water Resource Management (Merrill, 2008). This approach has a mixed success in different parts of the world, such as among the Senegal River Basin (SRB) countries that show regional cooperation for equitable utilization rather than conflicting over the shared resource. However, historically, the Nile River Basin (NRB) has exemplified many of the transboundary water resources management problems as witnessed by inter-basin conflict, devastating floods, crippling drought, and unstable political and economic development as well as diplomatic spat (ibid).

Driven by a number of factors the NRB countries – Burundi, Egypt, Ethiopia, Eritrea, Kenya, Sudan, South Sudan, Republic of Congo, Rwanda, Tanzania and Uganda – have been engaged in long tumultuous teamed up as ‘upstream’ and ‘downstream’. Interactions between the Nile riparian countries are characterized by mutual distrust, intimidation, and competition. Although Ethiopia and other upstream riparians have been demanding for “reasonable and equitable utilization” through a negotiated cooperative institutional framework, however downstream countries of Egypt and Sudan advocating

for the doctrine of “limited territorial integrity” and insist their right to have the water resource preserved by citing the principle of “do no harm” (Brady, 2015).

Egypt,in particular maintains its hypersensitivity to any reduction or diversion of Nile’s flow calling the river as a life-sustaining umbilical cord (Hefny and Amer, 2005). Decades old efforts bore no fruit to engender trust and cooperation among the NRB riparians with an ultimate aim of concluding a just and comprehensive basin-wide organization, eventually leading the basin to remain elusive (Azarva, 2010). This left the NRB with neither commonly agreed views on how the Nile waters should be equitably and reasonably used nor common views with collaborative solutions on sharing the resource (Tafesse, 2017). Because of the interest and obligation among every riparians to utilize its water resources to maximum level there is possibility of conflict in the NRB (Arsano, 2007). The conflicting interests of upstream and downstream countries have generated inter-regional tension that inhibited cooperative efforts in order to realize basin-wide win-win mechanism.

Contrastingly, the SRB has a long history of water cooperation. It encompasses Guinea, Mali, Mauritania and Senegal. The SRB countries signed 13 international treaties and established Organisation pour la Mise en Valeur du Fleuve Sénégal (OMVS) in 1972. When the Senegal River Basin (SRB) transboundary water resource management experience is not only a political success in conflict resolution to augment cooperative approach in water negotiation in general, but according to (Alam and Dione, 2004), it is also a success in improving access to basic services by contributing in reducing poverty. While the basin also sets good example in crafting and developing institutional framework for cooperation, the countries further move towards a closer regional integration. Eventually, to address the potential for conflict the SRB riparian countries employed several methods towards practical cooperation concepts in water negotiation in general.

This study draws lessons in building effective institutional frameworks for cooperation on transboundary waters, and the methods used in conflict resolution with reference to the NRB and the SRB. Although the two river basins differ in complexity ways of size, hydrology and socio-political factors,

however they also share colonial heritage, mutual trust and pan-African solidarity. The objective of this study, therefore, is to investigate key drivers of changes in both the NRB and the SRB, and analyzes methods used in conflict resolution lessons and parallels that can be extrapolated to benefit the theory and practice of cooperation concepts in water negotiation in general, as well as examine the experience of crafting and developing institutional framework of cooperation on both basins.

By drawing lessons in building effective cooperation and examine the experience of crafting and developing institutional framework of cooperation, this study intends to contribute on ways to make positive progress towards ending the impasse among the NRB riparians through successful practical lessons driven from the SRB.

2. Theoretical Framework

This section synthesizes relevant theories which are pertinent to the subject of investigation. By focusing on major theories that has been written on transboundary waters in relation to cooperation, conflict, power and perception, and equitable utilization, it offers a summary and analysis of relevant theories.

Collective action theories

Researchers discussing “collective action” tend to emphasize more proximate, historically contingent causes, rather than cost-benefit matrices; think in terms of large human groups with marked differences in power, wealth, and hierarchy; and favor the compilation of case based surveys as an analytical method (Carballo, 2012). Terje Tvedt sees limitations of the theory and tried to incorporate the idea which holds that when rational individual behavior and companies’ profit-seeking fail to provide public goods, the common or shared interest of a group might enable collective action (Tvedt, 2010). "The tragedy of the commons," written by Garrett Hardin in 1968, centers scholarly and policy discussions on the management of resources from common pools on institutions – or rather, on their seeming absence (Hardin, 1968).

Power asymmetry and water hegemony theory

Politics, power structure, and relationships have been identified as important factors by water governance scholars in shaping common pool resources, primarily in the context of irrigation system management and hydropower development (Suhardiman et al., 2018). Scholars like Zeitoun and Warner (2006), in particular, posit that relative power differences can cause various forms of hydro-hegemony. According to their "Framework of Hydro-Hegemony," if a basin state with superior power acts for the collective good of the basin, there is leadership in this form of hydro-hegemony (Mirumachi et al., 2016).

Hydropolitics theory

The term "hydropolitics" is believed to have first coined by John Waterbury in his book "Hydropolitics of the Nile Valley" (Waterbury, 1979). He implicitly defines hydropolitics as the study of inter-state politics regarding the management of shared water resources, in order to respond to a question "how can sovereign states, pursuing national self-interest cope with the challenge of bi- or multinational coordination in the use of a common resource?" In a broader and more comprehensive interpretation Meissner (1998) portrays hydropolitics as the "systematic investigation with respect to the interaction between states, non-state actors and a host of other participants, like individuals within and outside the state, regarding the authoritative allocation and/or use of international and national water resources".

Water stress theory

Water stress occurs when water demand exceeds the available amount during a certain period (Roy, 2022), and areas with low rainfall, high population density or intense agricultural or industrial activities exhibit high frequency to water stress. Wiebe (2001) states that as water stress becomes water scarcity, more water projects will be planned and constructed, increasing discord between riparians. Moreover, many scholars theorize that increasing water scarcity creates conflict in transboundary basins (Bernauer and Böhmelt, 2014).

Equitable and reasonable utilization theory

Zeitoun and Jägerskog (2011) see equitability in transboundary water management as a key to effective cooperation. However, operationalization of the concept of cooperation for equitable utilization, which is seemingly context specific, presents a definitional challenge. To that end, it is necessary to formulate concrete yet flexible and adaptable parameters of cooperation process in terms of parameters of treaty formation, which are a moving target themselves, to be able to evaluate the impact of a cooperation policy-development approach, or lack thereof. However, UN Convention (2008) mandates river basin states to establish joint mechanisms of cooperation with a number of factors such as, the population, the social, economic and other needs, present and future, the natural characteristics, the contribution to the formation and recharge, the existing and potential utilization, and its effects of the water system among others.

In this research, we draw upon a combination of three key theoretical frameworks: water stress, power asymmetry (water hegemony), and the principle of equitable and reasonable utilization of water resources. Water stress, which refers to the strain on available water resources due to factors like population growth, climate change, and inefficient management, serves as a central theme in understanding the challenges faced by regions with limited water availability. The concept of water hegemony highlights how power imbalances shape the distribution and control of water, often resulting in inequitable access and use. By integrating these theories, we are able to critically examine how power dynamics and water scarcity intersect to impact water governance in the Nile and Sengal basins.

In the results and discussion section, our analysis aligns with the core tenets of these theories to explore the implications of water stress and hegemony on the fair and reasonable allocation of water resources. We examine how power disparities influence decision-making processes, particularly in both Nile and Sengale river basins where water resources are scarce or contested. Additionally, we assess how the principle of equitable water utilization, which emphasizes fairness and sustainability, can either be upheld or undermined by prevailing power structures based on the experience of two basins. Our

findings reveal the complex interplay between these theories, providing insights into more just and sustainable approaches to water management.

3. Methods of the Research

3.1 Physical and Political Context of NRB and SRB

The Nile River is the longest river in the world (6,825 km), its basin connecting 11 riparian countries: Egypt, Ethiopia, Sudan, South Sudan, Burundi, Eritrea, Kenya, Republic of Congo, Rwanda, Tanzania and Uganda. It is very large both in terms of drainage area as well as in terms of the quantity of water it carries in its watercourse, making up a relatively modest portion of the area of the majority of other nations (Tadesse, 2008). Being the most important reliable sources of renewable water supplies in the Nile basin countries, and a source of food and water security has historically led to tensions around management of the scarce water resources (ECDPM, 2017). The Nile Basin's extraordinary variety of geographical and ecological systems makes it challenging to categorize or separate. Geographically, a state that water flows into (Egypt and Sudan) is known as a downstream state and a state that water flows out of (Burundi, the Democratic Republic of the Congo (DRC), Ethiopia, Eritrea, Kenya, Rwanda, South Sudan, Tanzania, and Uganda) is known as an upstream state. The separation between the two primary sources of the Nile River, the Blue and White Nile states, adds a crucial geographical component to the interaction between the nations that make up the Nile River Basin.

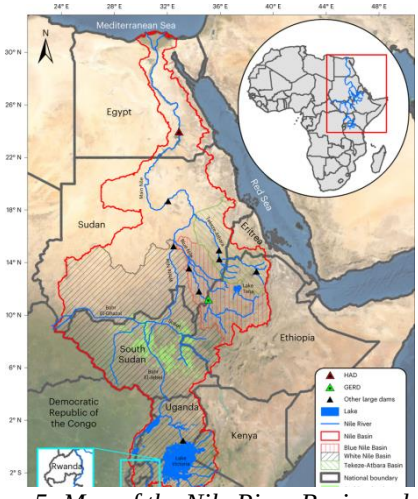

Figure 5: Map of the Nile River Basin and its tributaries (Nature Climate Change, 2023)

The three main tributaries of the Senegal River, located in Guinea's Fouta Djallon Mountains, are the Bafing, Bakoye, and Faleme. Together, they flow, making it the second largest in West Africa. The Senegal River rises in Guinea and flows 1,800km to reach the Atlantic Ocean, passing through Senegal, Mauritania, and Mali (Newton, 2008). The basin is divided into three separate areas: the valley, home to wetlands and ecological richness, the upper basin with its mountains, and the delta. These three locations have radically varied topographical, hydrographic, and climatic circumstances, as well as wide seasonal temperature changes (Adams, 2000). Landlocked Mali sought to have the Senegal River's international status recognized after independence in order to ensure navigation rights. Freedom of navigation on the Senegal River derives from the principle of reciprocity, not universal access (Alam and Dione, 2004).

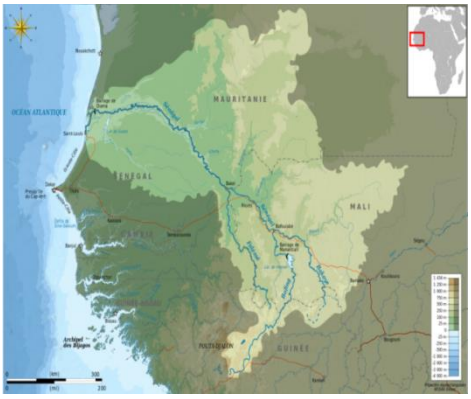

Figure 2: Map of the Senegal River Basin ©OMVS

3.2 Methods of Data Collection and Analysis

The research methodology is designed in a way that seeks to construe a better understanding of the issue of cooperation process in the contexts of the two river basins, on the one hand, and to clarify the significance of equitable utilization in influencing perception and boosting future cooperation for regional development among the NRB countries on the other. Having established this need for a new understanding and expansion of research, and to address the profound research problem and examine the perplexing questions, this study explores using the convergent design within Qualitative Comparative Analysis (QCA).

To meet its methodological approach the study employed Key Informant Interviews (KIIs) as primary and document review as secondary sources of data. Interviews were conducted with two (2) professional transboundary water negotiators, two (2) officials from basin organizations, two (2) scholars

and/or scientific experts knowledgeable about the intricacies of the NRB and the SRB water management. Thus, the study analyzed three major cases that are systematically selected based on contextual characteristics of the two river basins. These cases were carefully identified based on existing literatures, which reflect a variety of categories and geopolitical contexts, to be able to examine, test, and validate casual associations. Using multiple literatures, the development and effectiveness of cooperative framework relating to the NRB and the SRB have been analyzed.

Interviewees were selected deliberately to ensure that quality data is obtained, as well as to select participants that illustrate the full range of viewpoints about basin cooperation. Snowballing technique was also utilized in order to encounter and discuss the central questions with knowledgeable and helpful subjects, identified based on their reputation.

In order to ensure representation interviewees were from Ethiopia, Uganda, Senegal and USA in person, via video call applications, and on phone call. The purpose of these interviews was to develop a contextual understanding of implementation, as well as perceived cooperation, and of the level of satisfaction between the river basins. This follows the technique of semi-structured interviews using both grand tour questions and floating prompts to allow respondents to share freely while maintaining enough consistency across interviews to aid hypothesis testing. However, other backup questions were also asked when needed, to clarify certain issues or to obtain more relevant information. The responses were transcribed and analyzed to extract significant lessons and relevant content fitting to the case under discussion. However, given the significant number of riparian states involved among the two river basins, selection and identification of KIIs limits to investigate every potential objective and subjective arguments offered for each phenomenon, and its players in the analysis.

The research adheres to ethical code of conduct when obtaining data or information from either KIIs or institutions. Accordingly,KIIs were invited based on voluntary participation, and they were also given informed consent and time to review the information they provided, maintaining anonymity with a promise to communicate findings.

4. Results and Discussions

This section presents the results of the study and provides a comparative analysis on two basins based on identified theme of the discussion. Therefore, the results and discussions cover findings based on the cases collected from the NRB and the SRB and interviews conducted to substantiate the analysis.

4.1 Key drivers of change in NRB and SRB

4.1.1 Water stress in the basins

The "Falkenmark Water Stress Index" leveled the NRB as a water-scarce region lived with turbulence and riparian disputes (Falkenmark, 1989). The decline of the annual discharge of the Nile during the 1899–1945 sub-period was the most significant aspect of the physical environment of the NRB that have induced Egypt to concentrate its efforts to guarantee and to try to increase its annual supply of water (Tayia et al., 2021). In this regard, the NRB displays an inherent water stress problem mainly because the current amount of waters in the basin is not sufficient for its hundreds of millions of people.

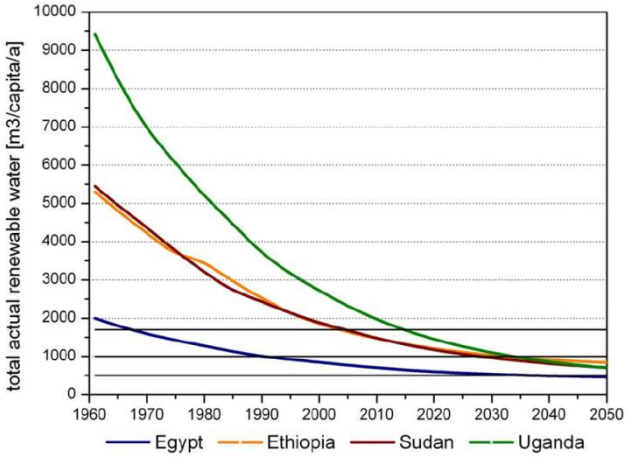

Figure 3: Increasing water stress projection in all Nile countries under the assumption of constant water availability (Link et al., 2013)

Figure 3 shows that since 1960 the NRB exhibits an increasing water stress, and the same threshold projection in all Nile countries under the assumption of constant water availability shows since 1990s Egypt surpassed water stress and falls under water shortage at below 1000 m^3 per inhabitant per year. Similarly, the basin becomes more likely contentious, particularly between Ethiopia,

Egypt, Sudan and Uganda falling under water shortage at below 1000 m^3 per inhabitant per year starting from early 2030s (Link et al., 2013). A UN report (2021) states that Egypt could run out of water by 2025 as the country is facing an annual water deficit of around 7 BCM. Hydrology of NRB is "very much skewed," and yet the population growth of the basin pause another challenge. In 1950s the total population of the Nile Basin countries was around 100 million and in 2010 it grew to more than 400 million and now it is well over 500 million people. Even if not all the population in most of the basin countries is dependent on the Nile; but "the water volume does not grow that much, while the per capita of the water availability is going down" (KII 1, 2023).

Similarly, the NRB becomes more likely contentious, particularly between Ethiopia, Egypt, Sudan and Uganda falling under water shortage at below 1000m^3 per inhabitant per year starting from early 2030s (Link et al., 2013). In this regard, the NRB displays an inherent water stress problem mainly because the current amount of waters in the basin is not sufficient for its hundreds of millions of people. Out of the total estimated net evaporation on loss from the dams has been estimated as 18 billion cubic meter (BCM) per year the High Aswan Dam in Egypt is the biggest loss due to the size of the reservoir surface area and the climate (NBI, 2015). Prior to evaporation at Aswan Dam the Nile used to be calculated 84 billion m^3 of water (Zeidan, 2015). However, "that is clearly not enough to supply the needs of all people in the NRB" (KII 2, 2023). AQUASTAT database results show a trend of water stress or scarcity for the SRB at below 1700 m^3 per inhabitant per year, and then of water shortage at below 1000 m^3 per inhabitant per year (Zisopoulou et. al., 2022). At below 2500 m^3 per inhabitant per year, Senegal and Mauritania are in a situation of water vulnerability (Faye, 2022).

Table 1: Declining renewable freshwater resources per capita (m^3) in SRB

Country	Period		Characteristics of renewable freshwater per capita (m^3)
	1958 – 1962	2017 – 2022	
Mali	22,301 m^3	6290 m^3	Renewable freshwater resources per capita (in m^3) continued to decrease between 1958 and 1962 and 2018–2022 at the level of the three countries.
Mauritania	12,538 m^3	2589 m^3	
Senegal	11,612 m^3	2458 m^3	

However, the water stress in the SRB was "shared due to the 1960s and 1970s severe draught that led the basin countries to look at ways to work together to mitigate the disaster" (KII 3, 2023).

4.1.2 Power asymmetry and hydro-hegemony in the basins

The different trajectories of relations among the NRB and the SRB countries show how power manifests in water allocation, management and development. The role of asymmetric power and hydro-hegemony or a state with more relative power in the basin can determine the status-quo of "water allocation".

> *"The NRB has unnatural water right politics because, it is a basin where the sources of the water did not benefit, but those non-contributors or downstream countries, namely; Egypt and Sudan are politically powerful" (KII 4, 2023).*

This expert argument is supported by Cascão (2008), who states Egypt's overwhelming asymmetry in power sustained its Nile hegemony. This gains an absolute hydro-hegemonic view in the NRB because; the 1959 bilateral agreement between Egypt and Sudan which allocates 100% of the Nile waters to themselves is "the major challenge to strike cooperation in the river basin" (KII 5, 2023). The old agreements lay the foundation for downstream countries of "Egypt and Sudan insist on their historical right and have agreed to stand against any demand arising from upstream countries, and they cannot change their thoughts" (KII 4, 2023). The regular views expressed by these downstream countries of the NRB are often "threat rather than good faith and cooperation" (KII 6, 2023).

However, Ethiopia's role through its effort for the NBI demonstrated a relatively weak upstream country can influence the institutional structure of basin-wide water management via reconfiguration of domestic water policy (Brady, 2015). In the SRB, France's absolute control over the river during its colonial rule brought each riparian country to rally together in a spirit of Pan-Aficanism. Although Senegal is a dominant power in the region, "there is no absolute hegemonic practice, except for Senegal has been considered as a benevolent hegemony" (KII 4, 2023). Two of the river's three headstreams rise in Guinea, however it joined OMVS lately in 2005, it expressed dissatisfaction and left the organization in 2023 (Africanews, 2023).

Table 2: Key differences in power asymmetry and hydro-hegemony in NRB and SRB

Aspect	NRB	SRB
Power Dynamics	Characterized by asymmetric power, with Egypt as a hydro-hegemon due to its military, economic, and international support.	No absolute hydro-hegemony, with Senegal being seen as a benevolent hegemon.
Geopolitics	Geopolitical influence is significant, with Egypt's control over the Nile affecting regional politics.	Guinea's strategic interests were less considered within OMVS, leading to its departure in 2023.
Water Allocation Approach	Water allocation is heavily influenced by historical agreements and hydro-hegemony, often seen as a zero-sum game.	More equitable approach with less dominance from any one country, despite colonial history and sporadic tensions.
Upstream Countries	Upstream countries like Ethiopia are politically weak but have attempted to influence basin-wide management (e.g., NBI).	Guinea, Mali, Mauritania, and Senegal share a more cooperative relationship with less dominance from any

		single country.
Downstream Countries	Egypt and Sudan dominate water allocation, with a historical agreement (1959) allocating 100% of Nile waters to them.	No historical agreement with absolute water rights, but collaboration within the Senegal River Riparian States Organization (OMVS).

4.1.3 Unilateral actions enforcing equitable utilization in the NRB

The pursuit of unilateral actions and resisting any political pressure in order to push for governance architecture that promotes equitable utilization from Nile waters. Upstream countries can employ the tactics of leverage mechanisms, which include water diplomacy, unilateral construction of development infrastructures and coalition with other upstream countries (Endaylalu, 2019). The benefit coming out of the "unilateral development projects should target other basin member states" (KII 2, 2023). Although Egypt, Ethiopia, and Sudan recognize Nile River's international character, however there is no agreed regime governing the actions of the three countries (Kendie, 1999a). This situation creates unilateral development projects. Such unilateral action will eventually influence Egypt and Sudan positively to come to smooth governance architecture that brings everybody to the negotiating table with equal power (KII 5, 2023).

4.1.4 The role of GERD in creating upstream counter hydro-hegemony in NRB

When Ethiopia announced the GERD project, which provides an alternative countering discourse, Egypt responded negatively and decided to use all means to subvert the project (Endaylalu, 2019). One of the senior expert whom I interviewed noted that

> *GERD has broken the myth that downstream countries have veto power over the use of the Nile. The project demonstrates that countries can build and operate huge hydraulic infrastructure without external aid or loan countering the negative campaign of Egypt to block external financing of projects on Nile" (KII 5, 2023).*

As noted by a senior expert above, GERD brought a paradigm shift on hydro hegemony of the NBR. The GERD also initiated a lot of "discussions, negotiations, and diplomatic activities including the 2015 Declaration of Principles (DOP) between upstream Ethiopia, and downstream Egypt and Sudan" (KII 4, 2023). After the GERD the upstream non-hegemonic riparian country began challenging the age-old Egypt's hydro-hegemony. Other upstream countries have also supported Ethiopia as they argue that Egypt should not undermine Ethiopia's right to the Nile (Chen and Swain, 2014).

4.2 Conflict and cooperation in the basins

Like many other international river basins Nile and Senegal River basins take into consideration a number of "historical contexts," that give them exceptional characteristics that go beyond water management but tackle conflict" (KII 4, 2023). There is a consensus that there is some degree of cooperation in the NRB. But in many cases Nile didn't come with an actual cooperation that brings basin-wide benefits associated with not negotiating when there are strong power asymmetries between the basin countries. Brady (2015) argues that the NRB sees an emergence of cooperation of both institutional and legal cooperation during which time water scarcity was continuously increasing because of population growth, economic development, and climate change. Yet, bilateral cooperation agreements remain "the preferred courses of action by few countries, as the cooperating riparians expect the benefits to eventually outweigh the risks" (KII 6, 2023).

> *"Even though cooperation has been promoted in the NRB, still some of the approaches followed by downstream countries are not conducive for cooperation" (KII 1, 2023).*

Despite this senior expert's argument, eventually, there has been a move from tension to cooperation as part a universal aspiration of riparians, and yet several cooperation projects have been listed under the NBI. However, Link et al. (2013) say, the Nile basin countries are still far from implementing an efficient basin-wide water resources management system.

In contrast, the SRB countries, from the start, were attempting to find a mutual interest in the light of ever-changing context (Mbengue, 2014). The river basin

states sought to artificially control the availability of water in the basin amid the emerging tremendous social, economic and ecological problems due to unsustainable water management (Vick, 2006). The vulnerability of the populations of the Senegal basin states serve as a catalyst for cooperation, because in order to improve "the countries believed that collaboration on the development of the water resource would improve the standard of living of the population in the region" (KII 3, 2023). Hence, the SRB countries did not wait for a conflict to happen to adhere to a cooperative approach over the use of the water resources.

> *"The Senegal River Basin is a successful international cooperation model" (KII 1, 2023).*

These expert hails the SRB's track in accordance with the ultimate reason why the SRB has overcome all possible differences between the four riparians unlike the NRB is that "the SRB is not politically contested river basin" (KII 4, 2023). Similarly, the cooperation between the SRB countries is implied through a joint planning, non-visa requirement for citizens to move from one basin to the other basin country.

Table 3: Key differences in conflict and cooperation in NRB and SRB

Aspect	NRB	SRB
Cooperation & Conflicts	Cooperation is hindered by Egypt and Sudan's stance on 'historical rights' and their resistance to upstream countries' demands.	Despite past conflicts such as 1991 Mauritania-Senegal conflict, there has been successful restoration of diplomatic relations and joint work.
Institutional Arrangements	Egypt and Sudan's opposition limits effectiveness of Nile Basin Initiative (NBI)	OMVS serves as the main basin-wide management organization, though Guinea's exit in 2023 reflects tensions.
Historical Context	The 1959 bilateral agreement between Egypt and Sudan is a key challenge to cooperation, based on 'historical right' to	France historically controlled the river during colonial times, but post-independence

	Nile waters.	cooperation has been key.

4.3 Vision sharing Vs benefit sharing

The cultural orientation governing the NRB and the SRB diverges between "vision sharing" and "benefit sharing," respectively, as means to equitable utilization of the water resources. This defines 'what is desirable' and 'what was possible' in either river basins. The NRB countries initiated a program called "shared vision" as of 1999, with about eight projects, which were designed to build confidence between the riparians and to put in place enabling environment for cooperation (NBI Act, 2002).

> *"Desire of the NRB 11 riparians differs from one another, and the situations for many of the upstream countries, necessitates the agenda of development, but for downstream countries like Egypt it means an issue that affect its water security" (KII 1, 2023).*

As to this authority there is divergence of interests between riparians mainly on development among upstream countries and water security issue for downstream country of Egypt. In contrary, in the SRB the sharing of benefits between the SRB countries is governed by the principle of "common and indivisible property" which is designed to manage the common facilities in the basin (Bolognesi et al., 2015). The benefit sharing identifies mutually beneficial and sustainable arrangements to ensure "the direct benefits generated by the facilities and distributed benefits derived from the multiple uses of water rather than physical water allocation" (KII 3, 2023).

4.3.1 Legal and institutional frameworks for cooperation: *Nile Basin Initiative (NBI) and Cooperative Framework Agreement (CFA)*

The birth of NBI in 1999 emerges instrumental for the first time, among the NRB riparians, to agree on a "shared vision objective" which aims to achieve sustainable socio-economic development through "equitable utilization" of the Nile waters (NBI, 2020). The NBI is much comprehensive in the sense that the riparians establish cooperation in order for all countries in the basin can have the chance to develop without interring to unnecessary conflict. The Nile ripariansstill continue to collaborate on things they think they can collaborate under the NBI; "however sustaining the NBI has its own ups and downs" (KII 4, 2023). Initiated in 1997 and concluded in 2007, the Cooperative Framework

Agreement (CFA) is also an approach that seeks multilateral negotiations for a comprehensive legal framework among NRB countries (NBI, 2007).

> *"CFA is a good basis to implement the principle of equitable and reasonable utilization in the NRB" (KII 6, 2023).*

Even though the NBI envisions for the creation of a basin-wide cooperation and the CFA is taken as a good basis for cooperation over Nile waters as indicated by an expert above, however another mode of cooperation between "Egypt and Sudan solely protects their interest by avoiding a further basin-wide cooperation like through CFA" (KII 5, 2023).

4.3.2 Organization for the Development of the Senegal River (OMVS)

The legal and institutional framework for the SRB is comprehensively defined through OMVS. The OMVS has implemented a special legal regime since 1978's Bamako Convention with the adoption of specific instruments for the management and operation of joint works (Bolognesi et al., 2015). Not only was the Bamako Convention the first post colonial West African treaty concluded in relation to water resources management, but also the institutional machinery upon which it rested was progressive and the powers entrusted to the Inter-State Committee departed from general international law as well as international practice. Mbengue (2014) says the Convention has left almost no room for unilateral action by the riparians in the exploitation of the river. The Convention provides that "the SRB countries share the investment costs and operational fees on the basis of the benefits that each co-owner country will have from the operation of common works" (KII 3, 2023). Thus, OMVS is depicted as a demonstration of "a pioneering approach to transboundary water cooperation in Africa" (KII 2, 2023).

In the light of the findings of this exploratory research, it would be important to improve further the understanding of the local, national, regional, geopolitical and economic or developmental dynamics that keep NRB and its riparians in a full-fledged non-cooperative state. At the same time, it would be important to better understand the dynamics that could not bring the riparian countries closer in good-faith, trust and genuine and sustained dialogue. It would also be particularly important to further investigate how the national political dynamics within Ethiopia, Egypt and Sudan affect the nature of the

transboundary water interactions and future development of the Nile waters.

5. Conclusion and Recommendations

5.1. Conclusion

Context Matters

The SRB countries shared a common colonial heritage, such as the French language and institutions. The leaders also built mutual trust and confidence imbued with the spirit of Pan-Africanism borne out of anti-colonial struggle. This laid the foundation for the emergence of a strong sense of solidarity. The OMVS includes only four members whose economic interests are close and very interdependent.

The NRB echoes the realities in the SRB, where the challenges are similar and the aspirations and opportunities parallel each other. The situation of the NRB is notably characterized by policies that are primarily dependent on the national scale and on the implementation of exclusive bilateral agreements, recalling the strong heterogeneity of preferences from within the basin countries. The SRB countries never had long, adversarial not to say hegemonic interstate histories. Compared to the NRB countries their size, both in terms of population and land area, is considerably smaller.

A perspective on coordination

In the SRB, Senegal initiated fostering asymmetries for the emergence of a hegemon directing negotiated actions and eventually avoiding a political-economy of the status-quo. Yet, the NBI is dealing with a number of actors and with asymmetries which complicate the identification of win-win situations and the accounting of preferences. Therefore, the risk of inaction in the NRB is greater. The history of the NBI highlights this difficulty to go beyond the status-quo, particularly through the ongoing CFA ratification process that aims to institutionalize basin-wide organization. The OMVS parties come together around a “shared vision” of the river. The stability of the governance framework seems to have favored the inflow of financial resources at an early stage of cooperation. In parallel, riparians benefit from highly interconnected economic dynamics, in addition to being relatively good and predictable. This economic environment is particularly favorable

to cooperation. Nevertheless, the definition of a "shared vision" for the action of the NBI and the matching of costs and benefits into coordination efforts clearly illustrate the progress made towards revitalization in collaborative action.

Unlike the case for the SRB, there is to date no international instrument that is specifically dedicated to bring the NRB countries together for equitable utilization of the Nile waters. But arrangements for observing the contours of the plan are contained in the NBI instruments adopted in the "shared vision" program that was launched in 1999. The past interactions between the NRB riparians over Nile waters development could be summarized as an opposition between exclusive unilateral resource capture and containment strategies. The NBI comes as a transitional project for Nile riparians to augment discussions, while OMVS emerges a strong, stable regional organization, proving its critical importance for regional integration in West Africa.

Change in hydro-political structure

There is a consensus that the NRB shows some degree of cooperation but often lacks basin-wide benefits due to power asymmetries between countries. Bilateral agreements remain favored by some countries, expecting long-term benefits. Cooperation in the NRB has grown, despite increasing water scarcity from population growth, economic development, and climate change. However, some approaches from downstream countries hinder full cooperation. While cooperation has moved forward, the basin is still far from an efficient water management system. In contrast, the SRB countries have sought mutual interests from the start, facing pressures from demographic and urban growth. Water consumption has led to competition, but Senegal, as the region's economic engine, plays a "benevolent hegemon" role. SRB countries pursued cooperation early on, aiming to improve living standards through joint water resource management. The SRB's success in overcoming differences lies in its lack of political contestation, with joint planning and free movement across basin countries.

Vision sharing Vs benefit sharing

Thecultural orientation governing the NRB and the SRB diverges between "vision sharing" and "benefit sharing," respectively, as means to equitable utilization of the water resources. This defines 'what is desirable' and 'what is possible' in either river basins. The NRB countries initiated a program called "shared vision" as of 1999, with about eight projects, which were designed to build confidence between the riparians and to put in place enabling environment for cooperation. Desire of the NRB 11 riparians differs from one another, and the situations for many of the upstream countries, necessitates the agenda of development, but for downstream countries like Egypt it means an issue that affect its water security. In the SRB the sharing of benefits between the SRB countries is governed by the principle of "common and indivisible property" which is designed to manage the common facilities in the basin. The benefit sharing identifies mutually beneficial and sustainable arrangements to ensure the direct benefits generated by the facilities and distributed benefits derived from the multiple uses of water rather than physical water allocation. The OMVS parties come together around a "shared vision" of the river. The stability of the governance framework seems to have favored the inflow of financial resources at an early stage of cooperation.

In parallel, riparians benefit from highly interconnected economic dynamics, in addition to being relatively good and predictable. This economic environment is particularly favorable to cooperation. Conditions that are particularly conducive to cooperation surround the OMVS, which has demonstrated its ability to adequately address challenges. Moreover, the SRB riparians took advantage of their shared commonalities, such as the French language and education systems and other institutions. The countries Pan-African drive for anti-colonialism serves as a historical basis for the emergence of a strong sense of solidarity among each other.

5.2. Recommendations

Based on the findings of the study that draw lessons from the SRB, we recommend riparian countries to take the following policy measures in order to overcome the challenges that observed in NRB.

1. ***Develop a mechanism to share benefit***

The concept of benefit sharing is recognized to play an important role in the management of hydroelectric facilities that eventually resolved conflict and reduce tensions among the countries in the region. Nile riparians may require allocating the investment costs and operational fees on the basis of the benefits that each co-owner country will have from the operation of common works.

2. ***Riparian countries should focus on scientific issues, not only on political matters***

Trust, good faith, awareness, technical research and capacity development are necessary but not sufficient conditions for the NRB countries to create. Continuing to develop awareness among the NRB riparians on the CFA is necessary if dialogue is considered as the best way forward. Awareness raising could also go beyond the legal aspects of transboundary water resources development. A technical understanding of the possible impacts and issues at stake may also be important to ensure that decisions are taken on the basis of information that encompasses all aspects of the challenges.

3. ***Riparian countries should be open to understand the views of local actors***

Independent research would be needed to understand the views of local actors. No agreement on basin-wide development architecture is likely to be viable if local water users are not convinced that it is in their best interests.

4. ***Develop and support programs that meet increasing water demand***

The foreseeable increase in irrigation water demand and storage capacity in the NRB riparians due to their growing development ambitions is at the heart of the existing and future tensions with downstream countries. Rather than focusing only on exploitation of the Nile waters, the upstream countries could try to find a balance between the exploitation and the gains that is going to happen.

5. ***All riparian countries should contest the legitimacy of the old legal regime and reposition power relations in the basin***

The upstream or non-hegemonic riparians of the NRB may further push contesting the old-age hydro-hegemony ushered by Egypt and Sudan through the use of consistent diplomacy. They may also reinforce counter-hydro hegemony mechanisms such as the NBI and its programs such as the

CFA. Unilateral construction of investment infrastructures, like the GERD project, by non-hegemonic riparians is also recommended.

6. ***Egypt should accept the new reality and behave as a "benevolent hegemony"***

As a primary economic power on the NRB, which has been using different forms of power to execute its hydro-hegemony such as geography, economic or material power, and diplomacy or bargaining power, Egypt may take on the "genuine intention" so as to bring the NRB countries together by endorsing the CFA and its objectives.

ConflictofInterest

The authors declare that there are no known conflicts of interest.

Acknowledgement

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Appendix A-1

Interview Protocol for NRB

The following questions are aimed at soliciting the best refection of experts/officials on the practices transboundary water resource management in the Nile River Basin (NRB).

1. Why does river basin management matters in NRB?
2. Is there cooperation in NRB?
3. What is desirable and what is possible to cooperative over Nile River?
4. What is the hydro-political traction of the NBI around different policy areas?
5. In terms of preconditions what kind of governance architecture are needed for equitable utilization?
6. What was the most challenging scenario in striking cooperation among the NRB states?
7. How doesthe Nile hydro-politics changed with the GERD?
8. Does Cooperative Framework Agreement (CFA) failed and why?
9. How should riparian countries avoid zero-sum game?
10. If upstream countries in other river basins can build development projects, what is preventing Ethiopia, and other upstream states from doing the same on the Nile?
11. What are the foreseeable practical limitations for cooperation with the existing agreements in Nile River?

Appendix A-2

Interview Protocol for SRB

Questions générales sur le bassin du fleuve Sénégal pour les experts de l'OMVS

1. Quels sont les principaux moteurs de changement dans le bassin du fleuve Sénégal qui expliquent les résultats de la coopération dans les négociations, les traités et d'autres domaines du droit international et quelles sont leurs implications politiques ?
2. Quel a été le scénario le plus difficile pour établir une coopération entre les États du bassin du fleuve Sénégal ?
3. Le plus souhaitable devient-il le résultat possible dans la gestion du fleuve Sénégal ?
4. Quelle a été la traction hydropolitique de l'OMVS autour de différents domaines politiques ?
5. Quels sont les principaux intérêts des États membres dans l'OMVS face à l'hégémonie hydroélectrique ?
6. Quels sont les domaines dans lesquels l'OMVS s'attachera le plus à promouvoir la coopération et l'intégration autour de domaines spécifiques ?
7. Quelle est la contribution des partenaires au développement pour que l'OMVS atteigne ses objectifs ?
8. Comment évaluez-vous la participation du public au développement de l'OMVS ?
9. Quels sont les enseignements et les parallèles qui peuvent être extrapolés pour bénéficier à la théorie et à la pratique des concepts d'utilisation équitable dans la négociation de l'eau dans le bassin du fleuve Sénégal ?

Policy Integration for Sustainable Environmental Management of Lake Tana, Amhara Region, Ethiopia

MelkemariamGenet[1], BamlakuAlamirew[2], Solomon Tsehay[3]

Abstract

This study analyzes the integration status of environmental protection policies for Lake Tana using a convergent mixed methods approach within a pragmatism research paradigm. Data was collected through observations, focus group discussions, document reviews, and interviews with policymakers and stakeholders. Content analysis and CapScan analysis were employed to assess the extent of policy integration pertinent to Lake Tana. The result shows significant gaps in policy integration particularly in policy design, implementation, and evaluation. Results further indicate that stakeholders lacked alignment on key issues, resulting in poor sectoral coordination and fragmented efforts. Integration challenges including poor stakeholder engagement, insufficient institutional capacity, and fragmented policy frameworks are exacerbated by varied levels of leadership, accountability, and monitoring. Furthermore, policymakers and experts emphasized the need for stronger institutional structures and enhanced coordination to tackle these issues effectively. The study suggests the need for increased political commitment, better stakeholder collaboration, financial alignment, and improved monitoring systems. It also suggests policy reforms to strengthen institutional frameworks and develop a unified strategy for the sustainable management of Lake Tana, contributing to a broader understanding of policy integration in environmental governance.

Keywords: Lake Tana, Policy Integration, Environmental protection

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1. Introduction

Ancient civilizations such as the Indus, Roman, and Greek societies implemented early forms of environmental laws to prevent overexploitation, indicating that environmental management has a long history (Bueren, 2019). However, since the Industrial Revolution, rapid population growth, urbanization, and industrialization have led to significant environmental degradation (Choudhary & Chauhan, 2015; Nanda & Pring, 2013). In Ethiopia, environmental degradation has also become a pressing issue driven by deforestation, land degradation, and unsustainable agricultural practices (Tesfaw et al., 2023). These challenges have led to soil erosion, biodiversity loss, and declining water quality, significantly impacting rural livelihoods (Engdaw et al., 2024). To ameliorate these problems, the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) have emphasized environmental sustainability through integrated policies and partnerships in water resource management and biodiversity protection (Duberry, 2019; Global Water Partnership, 2009; and Water Policy Group, 2021). Emerged in the 1990s, Environmental Policy Integration (EPI) become a critical strategy for embedding environmental concerns into broader policy frameworks to promote sustainable development (Nilsson et al., 2007; Tosun & Lang, 2017). EPI aims to address fragmented decision-making by mainstreaming environmental issues across sectors, thereby enhancing policy coherence and effectiveness (Persson, 2004).

Despite these efforts, researches indicate that the lack of coordinated action and effective policy integration remains a major barrier to sustainable development in Ethiopia (Dejene & Cochrane, 2019; Stave & Kopainsky, 2017). The problem of Lake Tana faces severe degradation due to sedimentation, deforestation, and the invasive water hyacinth, which disrupts its ecological balance and undermines local livelihoods (Dersseh et al., 2020; Goraw & Shimelis, 2017). Although the Lake Tana Protection Authority has attempted to mitigate these problems, poor policy coordination, weak stakeholder engagement, and inadequate institutional capacity have hindered progress (Stave & Kopainsky, 2017).

While existing studies have provided valuable insights into specific challenges such as sedimentation, water hyacinth proliferation, and wetland degradation (Dersseh et al., 2022; Goshu & Aynalem, 2017; Hanibal et al., 2020; Shimelis et al., 2017), a significant research gap remains pertinent to policy integration. Few studies have explored the need for holistic, policy-driven approach that integrates these concerns into cohesive strategies. This study seeks to address this gap by assessing the integration of environmental protection policies in the study area.

2. Theoretical Framework

Theoretical frameworks, such as those developed by Underdal(1980), have been expanded through empirical studies demonstrating how integrated policies can lead to more sustainable outcomes (Briassoulis, 2017; Nilsson & Persson, 2003). Policy integration theory stresses the importance of coherence among policies affecting the environment to ensure that different sectors work together toward common sustainability objectives (Hogl et al., 2016). This study employs a robust theoretical framework to analyze and propose solutions for the environmental policy integration challenges at Lake Tana, Ethiopia. The core of this framework rests on two fundamental theories: Policy Integration Theory and Sustainability Theory. Policy Integration Theory emphasizes the necessity of coherence and coordination across diverse policy sectors and governance levels (Candel & Biesbroek, 2016; Nilsson et al., 2012). In the context of Lake Tana, this translates to addressing the fragmented management of the lake by fostering both horizontal integration (coordination among sectors like agriculture, fisheries, tourism, and environment) and vertical integration (alignment of national, regional, and local policies). The theory aims to mitigate policy conflicts and inefficiencies that often lead to unintended environmental degradation, while also highlighting the critical role of stakeholder involvement to ensure policies are inclusive, informed, and supported by local communities (Briassoulis, 2017; Persson, 2007; Underdal, 1980).

Adding Policy Integration Theory, Sustainability Theory provides the ethical and aspirational goals for environmental management (ORCD, 2018). It promotes a balanced approach, integrating environmental

protection, social equity, and economic viability (Hoekstra & Kaptein, 2014; Runhaar et al., 2014). For Lake Tana, this means ensuring that management strategies preserve the ecological integrity of the lake while simultaneously supporting local livelihoods and economic activities. The theory addresses pillars of sustainability in; environmental sustainability, focusing on protecting water quality, biodiversity, and ecosystem services; social equity, ensuring equitable access to resources and benefits for all communities; and economic viability, promoting sustainable economic activities like eco-tourism and organic farming. By integrating these theoretical perspectives, the study ensures that policies not only promote long-term ecological health but also social well-being and economic resilience (Amare & Wubneh, 2017; Engdaw et al., 2024).

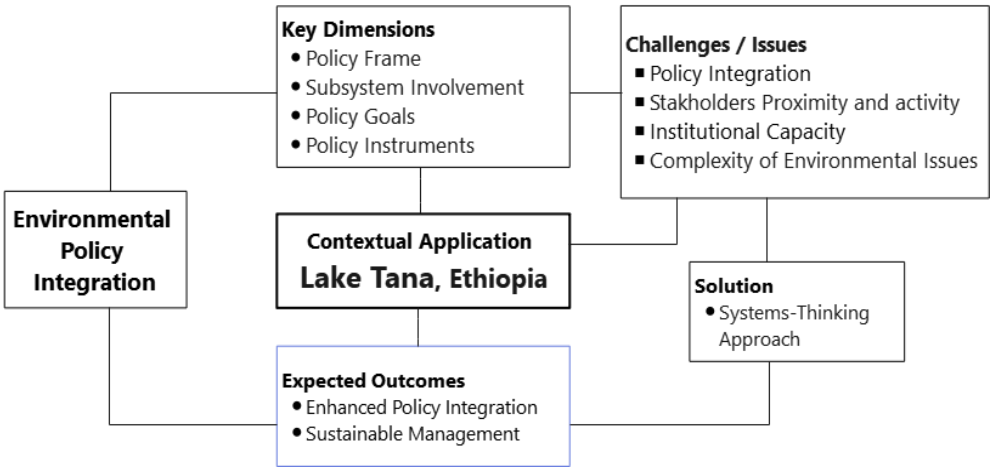

Figure 6. Conceptual Framework
Source: Adapted from Candel &Biesbroek(2016)

To operationalize these theories, the study adopts a conceptual framework (Figure 1) adapted from Candel &Biesbroek(2016). This framework provides a structured approach to analyzing and improving policy coherence and effectiveness in environmental governance. It focuses on four key dimensions: Policy Frames, which define how environmental issues are understood and prioritized; Subsystem Involvement, emphasizing the engagement of various actors and institutions; Policy Goals, focusing on the alignment of policy objectives; and Policy Instruments, involving the tools used to achieve policy goals. This framework addresses challenges such as

policy integration, stakeholder proximity and activity, institutional capacity, and the complexity of environmental issues. To overcome these challenges, the study proposes a systems-thinking approach, which aims to provide actionable solutions for improving environmental governance. Ultimately, the expected outcomes of this approach are enhanced policy integration and the sustainable management of Lake Tana.

3. Materials and Methods

3.1. Research Paradigm and Approach

This study adopts a pragmatism research paradigm, allowing for the flexible use of mixed methodologies to address the research objectives effectively (Creswell & Creswell, 2018). A convergent mixed methods approach was employed, integrating both quantitative and qualitative data to provide a comprehensive understanding of policy integration and environmental challenges in the Lake Tana area. This design enabled the simultaneous collection and analysis of diverse data types, offering a nuanced understanding of the research problem **(Chesnut et al., 2018)**. The integration of quantitative and qualitative data during the interpretation phase, as suggested by Cohen et al. **(2018)**, enhanced the depth and validity of the results.

3.2. Research Design

The research employed a convergent mixed-methods approach to investigate policy integration and stakeholder engagement. The qualitative component included document reviews, interviews, focus group discussions (FGDs), and workshops, while the quantitative component relied on structured questionnaire survey results. The integration of both methods during the interpretation phase provided a nuanced analysis, capturing measurable aspects of policy implementation alongside contextual insights from stakeholder perspectives.

3.3. Population and Sample

Key policies directly influencing the lake's environment were purposefully selected for document review to assess the status of policy integration. These policies included the Ethiopian Environmental Policy, the Ethiopian Water Resource Management Policy, and the ANRS strategies concerning environment, water, agriculture, tourism, and land. For the proximity map analysis, key stakeholders identified included the Ethiopian Environmental

Protection Authority, the Ministry of Water and Energy, ANRS bureaus, local communities, monasteries, universities, and non-governmental organizations (NGOs). A combination of purposive and census sampling methods was employed. Purposive sampling identified key institutions responsible for environmental governance, particularly the ANRS bureaus. Within these institutions, census sampling included all policymakers and experts engaged in strategy development and monitoring. This approach resulted in a total of 56 respondents from the following ANRS bureaus: Bureau of Agriculture (16), Environment Protection Bureau (13), Lake Tana Protection Agency (4), Land Administration Bureau (6), Tourism and Culture Bureau (11), and Water and Energy Bureau (6).

A structured questionnaire was administered both in person and via email, focusing on policy training, stakeholder mapping, and barriers to effective policy integration. Additionally, **12 workshop participants** (two from each of the six bureaus) contributed to the Capacity Scan (CapScan) framework analysis aimed at assessing governance capacity and identifying key factors influencing policy integration. Two focus group discussions (FGDs) were conducted. The first FGD comprised two groups, each with 12 participants, drawn from water hyacinth-affected areas, specifically the highly impacted kebeles of Lemba Arbaytu and Shihagomengie. The second FGD included 12 participants representing academic institutions, NGOs, and religious organizations, aiming to validate the policy integration framework for Lake Tana management.

3.4. Data Collection Tools and Methods

Data were collected using a combination of qualitative and quantitative tools and methods. The qualitative component involved document reviews, in-depth interviews, focus group discussions (FGDs), and observations. Document reviews focused on national and regional policies, including the National Environmental Protection Policy, the Ethiopian Water Resources Management Policy, and regional strategies from the ANRS. Interviews and FGDs provided insights into stakeholder roles, challenges, and opportunities for policy improvement.

Stakeholder mapping was conducted using a proximity map, categorizing stakeholders into four levels of involvement: directly accountable, routinely accountable, regular contact, and relatively remote. This qualitative tool helped visualize stakeholder relationships and roles, providing a foundation for further exploration through interviews and FGDs. A workshop was conducted to collect data using the Capacity Scan (CapScan) framework, designed to assess institutional capacity across four key dimensions: Leadership, Planning and Budgeting, Accountability, and Monitoring, Reporting, and Verification (MRV). Workshop participants included representatives from key bureaus involved in Lake Tana's governance, such as the Lake Tana and Other Water Bodies Protection and Development Agency, the Environment, Forest, and Wildlife Protection Bureau, the Bureau of Agriculture, the Water and Energy Bureau, the Land Administration Bureau, and the Tourism and Culture Bureau.

For the quantitative component, a structured questionnaire survey was administered to the **56 respondents** from key stakeholder bureaus. The survey focused on three main areas: training experiences of policymakers in policymaking and stakeholder mapping, the nature of existing environmental policies for Lake Tana, and key reasons for poor policy integration, such as lack of coordination, insufficient resources, and weak monitoring mechanisms.

3.5. Data Analysis

The data were analyzed using both qualitative and quantitative methods, consistent with the mixed-methods approach. Qualitative data were analyzed through content analysis and thematic analysis. Document reviews were evaluated using a Policy Integration Framework adapted from Candel &Biesbroek(2016), which assessed four dimensions of policy integration: Policy Frame, Subsystem Involvement, Policy Goals, and Policy Instruments. Interviews and FGDs were transcribed and analyzed to identify recurring themes, challenges, and opportunities for policy improvement. Stakeholder analysis, using proximity maps, visualized stakeholder relationships and roles, categorizing them into four levels of involvement.

Quantitative data were analyzed using descriptive statistics, such as frequency analysis, to summarize survey data. The CapScan Framework was applied to quantify stakeholder performance across four dimensions: Leadership, Planning and Budgeting, Accountability, and Monitoring, Reporting, and Verification (MRV). Additionally, CapScan results were complemented by qualitative insights from interviews and FGDs, exploring underlying reasons for identified gaps in institutional capacity. Stakeholder analysis using the proximity map further enriched the qualitative component by visualizing relationships and roles among key actors, enabling a nuanced understanding of stakeholder engagement in policy processes.

3.6Ethical Considerations

Ethical considerations were rigorously adhered to throughout the study. Respondents' confidentiality was maintained, ensuring that the information provided did not expose any individual participants. Data handling was conducted with respect, avoiding any misinterpretation of responses. All research articles were properly acknowledged and cited in accordance with ethical research standards.

4. Results and Discussions

4.1. Stakeholder Analysis

Interviews conducted with the Lake Tana and Other Water Bodies Protection and Development Agency (LTWBPDA) provide a comprehensive overview of the diverse stakeholder landscape involved in the lake's conservation and development. Established in 2019 under the Amhara National Regional State (ANRS), LTWBPDA works to align with global sustainability goals by coordinating stakeholders, managing invasive species, controlling pollution, and promoting sustainable water use through research, awareness, and training. Using a Stakeholder Proximity Map, stakeholders are categorized into four groups: directly accountable, routinely involved, regularly contacted, and relatively remote. Institutions directly accountable for the lake's protection, including LTWBPDA, the ANRS Environment, Forest, and Wildlife Protection Bureau, and the Ethiopian Environmental Protection Authority, play a crucial role in conservation efforts. However, their effectiveness is often undermined by

conflicting policies. For example, the Bureau of Agriculture's emphasis on productivity has led to pollution and siltation, while poor land and urban administration practices have exacerbated environmental degradation. Similarly, the Ethiopian Ministry of Water and Energy and the ANRS Water and Energy Bureau significantly impact the lake through hydroelectric projects that disrupt natural water flow, increase extraction, and stress the ecosystem.

Beyond direct management institutions, routinely involved stakeholders such as tourism and transport offices influence both conservation and degradation. While they enhance the lake's economic potential, infrastructure projects like transport terminals often lead to pollution and ecological disruption. In contrast, monasteries around the lake act as environmental custodians, preserving biodiversity and maintaining low pollution levels. Regularly contacted stakeholders, including Bahir Dar, Debre Tabor, and Gondar Universities, contribute through research and policy recommendations, particularly on issues like water hyacinth control. However, these institutions face challenges in policy integration and implementation due to governance gaps. Relatively remote stakeholders, such as NGOs and affiliated groups, provide valuable support through research collaborations, even if their direct impact on lake management is more limited.

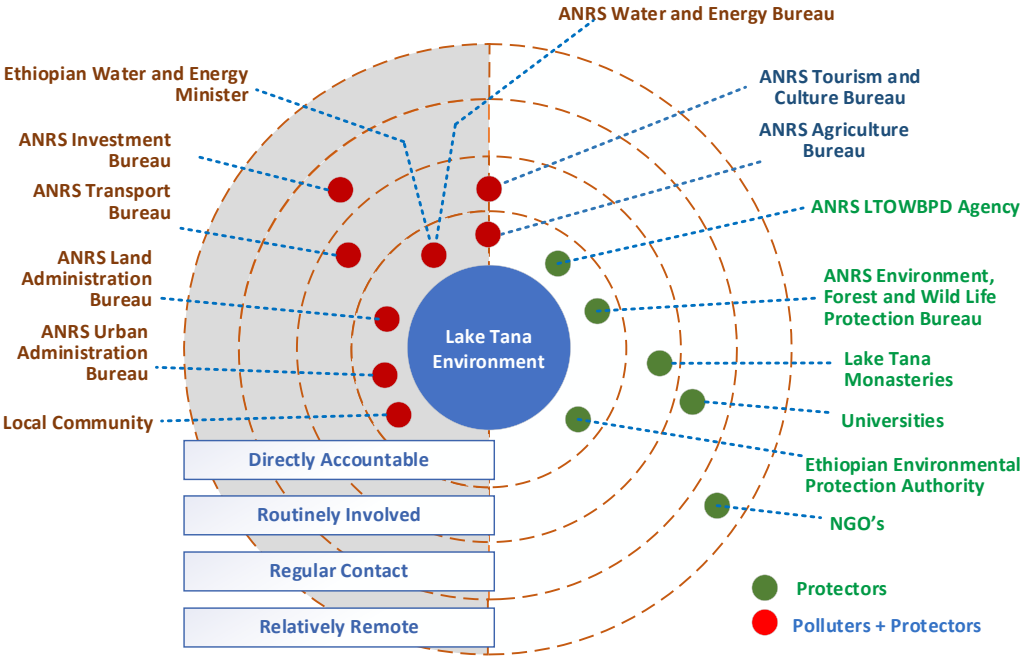

Figure 7. Key Stakeholder Proximity Mape of Lake Tana (Source: Authors' construction based on Stakeholder Proximity MapStated by Clayton (2024)

The Stakeholder Proximity Map (Figure 2) illustrates the varying degrees of involvement and their impact on Lake Tana's environmental and socio-economic health. Effective stakeholder collaboration is essential to addressing the lake's environmental issues, as weak coordination can hinder policy implementation and exacerbate ecological degradation. Given the diverse interests of stakeholders and the urgency of Lake Tana's environmental challenges, stronger inter-organizational collaboration is needed to ensure sustainable management and long-term conservation.

4.2. Assessment of National and Regional Policies and Strategies

Integrating policies for the environmental protection of Lake Tana is critical to addressing challenges like pollution, sedimentation, and habitat degradation. Analyses reveal gaps in policy application, leading to fragmented management. Effective strategies must align with the lake's unique ecological needs.

4.2.1. Analysis of Dimensions of Policy Integration

Policies were evaluated using four dimensions: policy frame, subsystem involvement, goals, and instruments. National policies (Environmental Protection Policy, Water Resources Management Policy) and regional strategies (ANRS Ten-Year Strategic Plan) provide broad frameworks but lack specificity for Lake Tana. Table 1 summarizes policy integration dimensions, showing strong integration in national policies but significant limitations in ANRS strategies, particularly in subsystem involvement and clear goal setting.

Table 5. Summary of Environmental Concerns Based on Policy Integration Dimensions (Document Review Result)

Policy	***Policy Frame***	***Subsystem Involvement***	***Policy Goals***	***Policy Instruments***
Environmental Protection Policy	*Clearly Stated*	*Clearly Stated*	*Clearly Described*	*Provides Mandates to Government Laws and Regional Courts*
Ethiopian Water Resources Management Policy	*Clearly Stated*	*Clearly Stated*	*Clearly Described*	*Offering Guidance to Legislative Bodies*
ANRS - Environment	*Clearly Stated*	*Described with Major Limitations*	*Clearly Described*	*Mentions Some Laws*
ANRS - Water	*Shallow Concern*	*Not Clearly Stated*	*Little Attention*	*Not Mentioned*
ANRS - Agriculture	*Clearly Stated*	*Moderately Described*	*Not Clearly Described*	*Mentions Some Instruments*
ANRS - Tourism	*Shallow Concern*	*Little Description*	*Not Clearly Described*	*Not Clearly Mentioned*
ANRS - Land	*Not Framed*	*Not Clearly Stated*	*Little Attention*	*Not Mentioned*

Source: Document review results, 2024

Table 2 illustrates deficiencies in both vertical and horizontal policy integration, revealing robust alignment at the national level alongside weak coordination in regional strategies. Enhanced collaboration between national

frameworks and regional implementation is imperative, with the Lake Tana Protection Agency playing a pivotal role.

Table 6. Summary of the Vertical and Horizontal Integration Levels of each Policy

Policy	Vertical Integration	Horizontal Integration
Environmental Protection Policy	***Strong**: Aligns effectively across all governance levels with clear mandates and comprehensive governance.*	***Strong**: Coordinates well across various sectors with clear goals and policy instruments.*
Ethiopian Water Resources Management Policy	***Strong**: Provides clear guidance and support across governance levels for effective water management.*	***Strong**: Demonstrates coherence and integration across relevant sectors with well-defined goals and instruments.*
ANRS Environment Protection Strategy	***Moderate**: Defined framework and clear goals, but limited subsystem involvement affects its effectiveness.*	***Moderate**: Partial coordination across sectors with constraints in subsystem involvement and policy instruments.*
ANRS Water Strategy	***Low**: Lacks adequate attention to policy framing and support, leading to ineffective management.*	***Low**: Minimal coordination and coherence across sectors, with inadequate goals and instruments.*
ANRS Tourism Strategy	***Minimal**: Shallow concern with poor alignment and support across governance levels.*	***Minimal**: Limited coordination and coherence across subsystems, affecting management effectiveness.*
ANRS Agriculture Strategy	***Moderate**: Some alignment and clear framework but lack comprehensive goals.*	***Moderate**: Reasonable integration across sectors but requires more coherence and comprehensive goals.*
ANRS Land Strategy	***Lowest**: Lacks clear framework and minimal alignment and support across governance levels.*	***Lowest**: Poor coordination and coherence across sectors, with absent goals and instruments.*

Source: Document review results, 2024

Effective policy integration requires cross-sectoral collaboration, yet many stakeholders struggle with holistic implementation. Improved coordination between national frameworks and regional execution, led by the Lake Tana and Other Water Bodies Protection and Development Agency, is crucial. Conflicting priorities, with economic growth often overshadowing sustainability, undermine efforts. Local communities, though reliant on the lake, inadvertently contribute to contamination. National stakeholder contributions remain minimal, according to agency directors.

4.2.2. CapScan Analysis

The CapScan analysis, conducted with six key regional stakeholders involved in Lake Tana's protection, reveals critical gaps across four pillars of policy integration: (1) leadership, (2) accountability, (3) planning and budgeting, (4) monitoring, reporting, and verification. The stakeholders, including the Lake Tana and Other Water Bodies Protection and Development Agency, the Environment, Forest, and Wildlife Protection Bureau, the Bureau of Agriculture, the Water and Energy Bureau, the Land Administration and Use Bureau, and the Tourism and Culture Bureau, show significant variations in their commitment and execution of environmental policies.

The findings from the CapScan framework indicate critical challenges in policy integration for the protection of Lake Tana, particularly due to the lack of strong political leadership and accountability. This fragmentation in institutional coordination has direct implications on the effective protection of Lake Tana. Without a cohesive and committed leadership structure, environmental policies are poorly executed, leading to ineffective environmental governance. According to Ostrom (2009), effective governance requires collaboration across different agencies, and the weak coordination between the Lake Tana Agency and other critical institutions, such as the Water and Energy Bureau and the Environment Bureau, suggests a systemic failure in policy integration that could limit sustainable resource management (ANRS-LTOWBPDA, 2023).

Likewise, the weak accountability structures undermine the role of stakeholder institutions. Donor coordination and stakeholder consultations, while present, remain largely in exploratory phases, showing limited progress. As Stave & Kopainsky (2017) argue, stakeholder engagement is key to adaptive environmental management, but this report shows that responsibilities remain poorly assigned across government levels, which restrains the progress of environmental initiatives for Lake Tana. The slow progress in stakeholder consultation and accountability will likely diminish the effectiveness of environmental policies and programs in protecting Lake Tana, creating gaps between policy intentions and practical implementation.

Table 7. Tana Stakeholders Offices CapScan Matrix Response

Pillars	Item	Level of Execution			
		Awareness	Exploration	Transition	Full Implementation
Leadership	1. Is there a clear political statement at the highest-level spelling out the government's commitment to policy integration for the protection of Lake Tana?	LT, L, T	A	E, W	-
	2. Is there a lead institution responsible for overseeing the implementation of policy, and strategy integration for environmental protection measures in the Lake Tana environment? (e.g. central unit, ministry, inter-ministerial committee, bureau, institute).	W	L, T	-	LT, E, A
	3. Is there a normative framework (e.g. legislation, directives, decrees) that supports the integration of environmental protection into existing and new sectoral strategies, plans, programs, or policies?	-	-	*	-
Accountability	1. Do you consult with key stakeholders for policy integration to protect Lake Tana?	A, L	LT	E, W, T	-
	2. Are there offices assigned with clear donor coordination platforms for Lake Tana? Is there any donor coordination for the value of life on land and water to protect the Lake Tana environment?	A, T	LT, L	W	E
	3. Do the various tiers of the government have clear assignments of responsibilities and mandates for the Lake Tana environment case?	LT, L	E, T	W	A
Planning and Budgeting	1. Have policies, strategies, and plans been integrated into the national strategy for environmental protection through the use of defined priority areas, time-bound	L, T	LT, E, A, W	-	-

Pillars	Item	Level of Execution			
		Awareness	Exploration	Transition	Full Implementation
	actions, and performance indicators?				
	2. Are the goals in the plans, strategies, and policies for the environmental protection of Lake Tana integrated into the budgetary processes?	LT, A	E, W, L, T	-	-
	3. Does a sufficient budget been allocated to implement environmental protection policies of Lake Tana, if not, what alternatives do you use?	LT, T	W, L	E, A	-
Monitoring, Reporting, and Verification	1. Do the policies and strategies pertinent to the protection of Lake Tana have SMART objectives and clear indicators?	T	LT, W, L	E, A	-
	2. Is the performance of policies in environmental protection, especially in the case of Lake Tana, properly evaluated?	A	LT, W, L, T	E	-
	3. Is there a standard monitoring and reporting system for environmental protection around lake Tana?	-	LT, A, W, L, T	E	-
	4. Is there a central database system where quality data can be stored and retrieved?	A, L	W, T	LT, E	-

Key: [LT] Lake Tana and other Water Bodies Protection and Development Agency, [E] Environment, Forest, and Wildlife Protection Bureau, [A] Bureau of Agriculture, [W] Water and Energy Bureau, [L]Land Administration Bureau and,[T] Tourism and Culture Bureau, * All stakeholders

Source: Data Compilation, 2024

Results of the CapScan analysis indicates that the execution of the various pillars related to policy integration for the protection of Lake Tana is currently in different stages, ranging from awareness to full implementation. While some aspects of governance, accountability, and stakeholder involvement are progressing toward full implementation, other areas, such

as standardized monitoring systems and budget allocations, are still in the process of being developed or refined. This indicates that although progress has been made, further efforts are needed to integrate policies effectively and ensure the long-term protection of Lake Tana's environment.

A) Leadership

In the Leadership pillar, Lake Tana and Other Water Bodies Protection and Development Agency (LT) is in the awareness and exploration stages, recognizing the importance of leadership and institutional responsibility but still in the early phases of policy development and formalization. Similarly, the Environment, Forest, and Wildlife Protection Bureau (E) is in both the transition and exploration stages, showing progress in leadership commitment but facing significant challenges in securing resources and formalizing its role in policy execution. The Water and Energy Bureau (W) is positioned in the transition stage, where efforts are underway to assume leadership but full responsibility and effective monitoring are still lacking. The Land Administration Bureau (L), in the exploration stage, faces challenges in aligning its strategies with environmental protection goals and lacks significant influence in policy implementation. The Tourism and Culture Bureau (T) is also in the exploration stage, with limited involvement in leadership and needing stronger integration into broader environmental strategies.

B) Accountability

For the Accountability pillar, which focuses on stakeholder consultation, donor coordination, and clear assignment of responsibilities, Lake Tana and Other Water Bodies Protection and Development Agency (LT) is in the awareness stage, where initial steps towards accountability are recognized. The Environment, Forest, and Wildlife Protection Bureau (E) is in both the transition and exploration stages, still working to secure adequate resources and implement effective accountability measures. The Water and Energy Bureau (W), also in the transition stage, faces difficulties in integrating SMART objectives and performance indicators, limiting its ability to manage environmental responsibilities effectively. The Land Administration Bureau (L), in the exploration stage, has yet to define its role in donor coordination and accountability for environmental protection, while the

Tourism and Culture Bureau (T), also in the exploration stage, struggles to establish accountability structures for policy integration.

C) Planning and Budgeting

In the Planning and Budgeting pillar, Lake Tana and Other Water Bodies Protection and Development Agency (LT) is active in the exploration and awareness stages, but still faces challenges in securing dedicated budgets for environmental protection despite efforts to integrate environmental protection goals into national strategies. The Environment, Forest, and Wildlife Protection Bureau (E) is in the transition stage, working on aligning environmental protection goals with national budgeting processes but has not yet achieved full implementation. Similarly, the Water and Energy Bureau (W) is in the transition stage, trying to incorporate environmental protection into its budgeting processes, but lacks full financial allocation for these efforts. The Land Administration Bureau (L) is in the transition stage as well, with some progress made but still facing challenges in securing financial resources for environmental protection. The Tourism and Culture Bureau (T) is in the exploration stage, with limited engagement in financial frameworks for environmental protection, indicating a need for further development in this area.

D) Monitoring, Reporting and Verification

Monitoring and evaluation are essential for ensuring the effectiveness of environmental protection policies and adapting to changing conditions. However, the results indicate that there are inconsistencies in monitoring, reporting, and verification stemming from the lack of standardized systems, ongoing stakeholder exploration, and the absence of a central database. As studies argue, these limitations hinder progress tracking and accountability enforcement (Soares, 2015; Swartling et al., 2007). Additionally, other studies also validate that the absence of SMART objectives impedes effective policy evaluation, further undermining sustainability efforts to protect Lake Tana (Oostena et al., 2018).

According to the CapScan analysis, the Monitoring, Reporting, and Verification pillar shows significant gaps in the establishment of standardized systems for tracking policy performance. Lake Tana and Other Water Bodies Protection and Development Agency (LT) is in both the

awareness and exploration stages, recognizing the need for monitoring and reporting systems but still in the process of developing these structures. The Environment, Forest, and Wildlife Protection Bureau (E) is in the transition and exploration stages, engaging in some performance evaluations but still lacking a consistent and formalized monitoring system. The Water and Energy Bureau (W) is in the transition stage, refining its approach to policy monitoring but not yet fully implementing a comprehensive monitoring system. The Land Administration Bureau (L), positioned in the exploration stage, faces challenges in establishing effective monitoring and reporting systems due to a lack of centralized data, hindering progress in tracking environmental protection efforts. Similarly, the Tourism and Culture Bureau (T), also in the exploration stage, lacks a formalized system for monitoring or reporting, limiting its ability to evaluate policy outcomes.

4.3. Challenges in Integrating Policies for Lake Tana's Protection

Integrating effective policies for the protection of Lake Tana involves overcoming complex administrative, financial, and operational challenges. Despite the critical importance of safeguarding this vital water body, efforts face several significant obstacles, which can be categorized into issues related to policy design and implementation, monitoring and evaluation, and financial and capacity constraints.

4.3.1. Policy Design and Implementation Issues

Effective policy integration for Lake Tana faces significant challenges in policy design and execution, including limited knowledge among policymakers, fragmented stakeholder participation, and weak political commitment. The research reveals major gaps in training, most of (50%) policymakers lack formal training in policymaking and 59% in policy integration and stakeholder mapping. These deficiencies hinder the ability to manage environmental policies and coordinate with stakeholders effectively, leading to ineffective policy development and implementation. Key informants argued that there is a critical need for public awareness campaigns and training for both local communities and stakeholders to improve their role in sustainable management and protection of Lake Tana.

Additionally, proper stakeholder mapping and role clarification are essential to enhance coordination and integration across sectors, ensuring all key

actors, including government bodies, NGOs, and the private sector, are effectively involved in environmental protection efforts. As Metcalfe (1994)argues, a better knowledge foundation for policymakers and experts is essential for environmental policy integration to address existing environmental issues. Soares (2015) further underscores the need for robust frameworks and targeted capacity-building initiatives to address these gaps and enhance policy integration efforts. Addressing these issues requires targeted capacity-building initiatives and stronger political commitment to improve policymaking skills and policy integration.

Table 8. Training Experience of Policymakers of the Key Lake Tana Stakeholders Response (n=56)

Training Types	No (%)	Yes (%)
Policymaking	50	50
Policy Integration and Stakeholder Mapping	59	41

Source: Data Compilation, 2024

The effectiveness of environmental policies is further compromised by inadequate stakeholder engagement. Results indicate that 91% of participants believe the current policies are neither adequate nor inclusive, and 98% highlight insufficient stakeholder consultation during policy development. The high percentage of respondents who feel that certain stakeholders were excluded (95%) and the 82% advocating for policy revisions demonstrate a clear disconnect between policy objectives and stakeholder needs. These findings emphasize the urgency for policymakers to address the shortcomings of the current policy framework, emphasizing the importance of genuine stakeholder engagement, inclusivity, and responsiveness to ensure the preservation and sustainability of Lake Tana's ecosystem.

Table 9. Responses on the Existing Environmental Policy Nature for Lake Tana(n=56)

No	***Items***	***Yes (%)***	***No (%)***
1	*Do you think the current policy is adequate and inclusive to accommodate the problems of Lake Tana?*	*9*	*91*
2	*Do you think that all relevant stakeholders have been adequately consulted during the preparation of the policy?*	*2*	*98*
3	*Do you feel that there are some stakeholders left unconsulted during policymaking processes?*	*95*	*5*
4	*Do you feel that the current policy related to Lake Tana should be revised?*	*82*	*18*

Source: Data Compilation, 2024

A comprehensive stakeholder analysis is crucial for identifying influential actors and understanding their relationships, which can uncover potential collaboration opportunities. Findings from this study indicate that the absence of a structured stakeholder mapping process has hindered the ten-year strategic plan (2021–2030) for Lake Tana, particularly in aligning sectoral institutions and addressing competing interests. Interviews with key stakeholders revealed concerns about unclear roles, weak inter-agency coordination, and fragmented policy implementation, corroborating similar findings in environmental governance studies (Swartling et al., 2007). The CapScan framework analysis further highlighted gaps in stakeholder engagement, reinforcing the need for a structured, multi-level integration mechanism.

Discussions with key regional stakeholders emphasized that the absence of formally established organizations at the Kebele level significantly limits effective collaboration and alignment of environmental initiatives. Focus group discussions (FGDs) with community representatives confirmed that uncoordinated local governance weakens environmental policy execution, affecting resource allocation and enforcement mechanisms. These findings

align with broader governance challenges in decentralized environmental management (Hoekstra & Kaptein, 2014). Similarly, document reviews of regional environmental strategies revealed inconsistencies in stakeholder engagement, particularly in decision-making processes, further obstructing inclusive policy formulation. The combined evidence underscores the necessity of developing a robust stakeholder analysis framework that accounts for both top-down policy directives and bottom-up engagement strategies to enhance collaboration and improve implementation outcomes, as also highlighted by Trein et al (2020).

Key informant interviews provided critical insights into the challenges associated with the existing policy framework for protecting Lake Tana. Participants highlighted a gap between policy formulation and practical implementation, noting that while policies exist, their application often lacks effectiveness in addressing specific environmental concerns. A recurring theme was the limited involvement of key stakeholders during policy development, leading to coordination challenges and misaligned priorities among agencies. This top-down approach often excludes local community perspectives, further complicating implementation. Additionally, findings suggest that the newly established office (Lake Tana Protection Agency) faces institutional constraints in terms of capacity and operational efficiency, which limits its ability to enforce and monitor environmental policies effectively. Respondents underscored the importance of strengthening stakeholder engagement mechanisms to enhance policy coherence and foster integrated environmental management strategies. The need for a long-term, sustainability-focused approach was emphasized, as current policies tend to prioritize immediate economic interests over comprehensive ecological protection. Improved stakeholder mapping and cross-sectoral collaboration were identified as key factors in advancing more effective and inclusive policy interventions for Lake Tana's conservation.

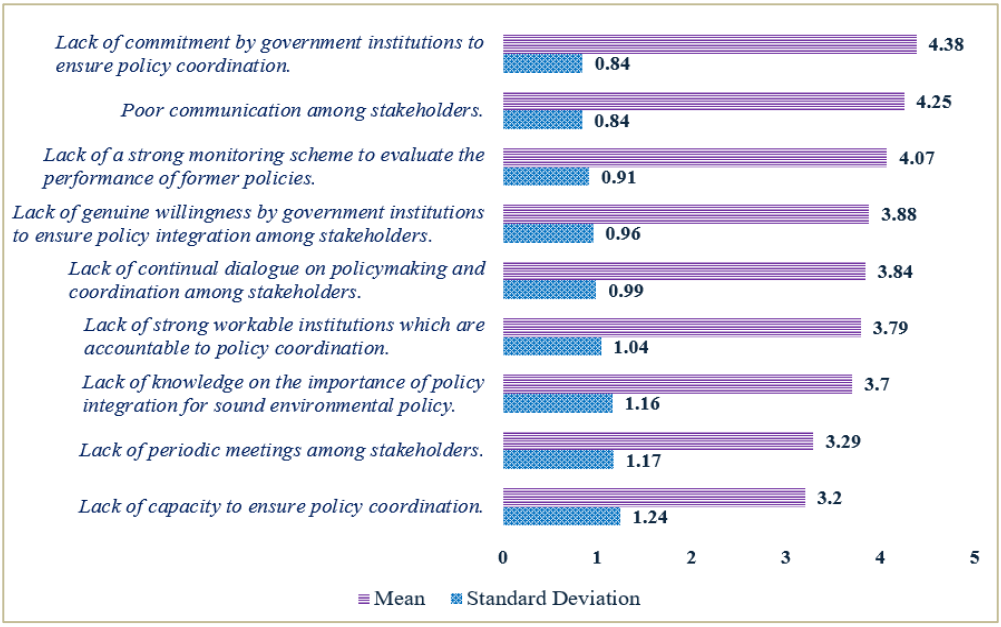

Figure 8. Key Reasons for Poor Policy Integration for Lake Tana Environmental Protection Management. (Source: Data Compilation, 2024)

The responses from policymakers among Lake Tana stakeholders highlight the key reasons for poor policy integration regarding Lake Tana's environmental protection management. Based on the result (figure 3)the highest-rated challenges are a lack of institutional commitment from the government, poor communication among stakeholders, and an inadequate monitoring scheme. Additional factors include insufficient dialogue, weak institutional accountability, limited knowledge on policy integration, infrequent meetings, and a lack of coordination capacity. These barriers, coupled with a perceived lack of genuine willingness from government bodies to integrate policies, significantly hinder effective policy integration and implementation.

4.3.2. Monitoring, Evaluation, and Financial Constraints

Monitoring and evaluation are crucial for assessing the impact and effectiveness of policies, yet significant gaps persist in the protection policies for Lake Tana. Many regional stakeholders exhibit limited awareness and experience in monitoring and reporting, as highlighted by the CapScan Matrix, which underscores the urgent need for improved

management practices. Effective public policy integration necessitates robust monitoring and evaluation procedures (OECD, 2015). However, field observations and interviews have revealed a concerning absence of rigorous national and regional impact evaluation research within institutions involved with Lake Tana stakeholders. Furthermore, these stakeholders' strategies often lack dedicated sections for monitoring and evaluating environmental impacts, and the deficiency of a strong monitoring scheme is among the most cited reasons for poor policy integration regarding Lake Tana's environmental protection.

Key Informant Interviews have identified several critical issues related to monitoring, evaluation, and financial constraints in the context of protecting Lake Tana. There is a significant lack of clear policy execution guidelines, hampering effective monitoring and evaluation of existing environmental policies. Additionally, the Lake Tana Protection Agency lacks the necessary capacity and efficiency to coordinate evaluation efforts, complicating the monitoring process. The emphasis on short-term economic gains further undermines long-term financial planning, which is essential for sustainable environmental protection. Moreover, the absence of sustained projects dedicated to the lake's protection results in inadequate financial resource allocation, ultimately hindering both monitoring and evaluation activities. Strengthening these aspects is crucial for improving policy integration and ensuring effective environmental management.

4.3.3. **Governance and Institutional Capacity Issues**

Governance and institutional capacity present significant challenges to effectively protect Lake Tana. Findings (figure 3) indicate that weak institutional commitment, poor stakeholder communication, and inadequate monitoring mechanisms hindering policy integration. Additionally, the lack of specific regulations, such as a well-defined buffer zone, allows unregulated activities that threaten the lake's environment, leaving it vulnerable to degradation. Financial and human resource constraints further impede the ability of responsible agencies to enforce policies and manage the lake sustainably. Addressing these governance deficits is crucial for strengthening environmental policy frameworks, as emphasized by Solomon (2017).

Key Informant Interviews reveal that the absence of a dedicated institution for managing Lake Tana exacerbates these issues. The Lake Tana Protection Agency lacks the necessary capacity and efficiency, and high-level officials often overlook research outputs in policymaking, rendering the existing Protection Office ineffective. Poor coordination among stakeholders and conflicting priorities further complicated governance efforts, with key offices like the Investment Office neglecting essential environmental concerns. The absence of sustained protection projects underscores the urgent need for improved governance structures and enhanced institutional capacity. Effective governance, supported by adequate resources, is essential for implementing successful environmental policies (Briassoulis, 2017; Oostena et al., 2018). Strengthening governance frameworks and building institutional capacity are vital to ensuring the long-term sustainability of Lake Tana.

5. Conclusions and Implications for Policy

4.1 Conclusions

This study on policy integration for Lake Tana's environmental protection highlights the urgent need for coordinated stakeholder efforts to address key issues like deforestation, wetland degradation, pollution, and invasive species. Despite existing policies, ineffective integration has led to fragmented management, compromising the lake's ecological integrity and value to local communities. Key challenges include insufficient policy integration, poor stakeholder coordination, low engagement, and fragmented goals. The study reveals gaps in policy design, implementation, and evaluation, largely due to weak leadership, accountability, and monitoring systems. Although awareness of environmental protection exists, it hasn't translated into comprehensive action or robust monitoring frameworks.

Significant barriers, including fragmented policies and limited institutional capacity, hinder effective conservation. To address these, the study calls for stronger stakeholder engagement, enhanced institutional capacity, and improved monitoring systems. Effective coordination between regional and national policies is vital for a unified strategy. While national policies like the Ethiopian Environmental Policy provide a foundation, they require

better integration to meet Lake Tana's unique challenges. The CapScan results in underscore weaknesses in leadership, financial planning, and accountability, threatening both the lake's ecological health and its socioeconomic benefits. Stronger political commitment and targeted reforms are needed to ensure sustained policy implementation and protect this vital ecosystem.

4.2 Implications for Policy

The study presents several recommendations to improve policy integration for Lake Tana's environmental protection. Key suggestions include engaging all stakeholders and enhancing coordination by forming joint committees or task forces. It emphasizes the importance of increasing awareness and capacity building through targeted training programs and public education campaigns. Community involvement in policy development and implementation is crucial for sustainable outcomes. The study also highlights the need for a comprehensive framework that integrates environmental and socio-economic considerations across sectors like agriculture and tourism. Establishing a centrally coordinating body to align efforts among key stakeholders is essential. Supporting research and innovation with a focus on long-term impacts of policy integration is recommended to ensure sustainable conservation efforts. These recommendations aim to develop a robust, integrated policy framework that prioritizes environmental protection and socio-economic well-being. System thinking is necessary to improve policy coordination and achieve effective conservation of Lake Tana. By implementing these strategies, Lake Tana's environment can be protected while also supporting the overall well-being of the surrounding communities.

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Employment Challenges: Key Influential Factors in the Higher Education-To-Work Transition Experiences of Graduates in Sebeta Town, Oromia Region

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Abstract

Transitioning from school to work is a critical period in young people's lives, marking their entry into the labor market and the pursuit of economic independence. However, in Ethiopia, a growing number of higher education graduates, coupled with limited job growth, have made this transition nonlinear, challenging, and increasingly complex. This study aimed to explore the key factors influencing the entry of higher education institution graduates to work and their success of transition to work in Sebeta Town, Oromia Region. The study employed a mixed-methods approach, combining both qualitative and quantitative methodologies to enhance the depth and breadth of the research findings. A total of 146 survey respondents were selected from 378 higher education institution (HEI) graduates, using Taro's (1967) formula at a 95% confidence interval. Participants for the qualitative approach were selected through purposive sampling. Data collection utilized a multi-source approach, incorporating primary data and secondary data sources. The findings reveal that graduates' transition to work is influenced by multiple structural and institutional factors, such as the nexus between education and the labor market, collaboration among key sectors, the competency and integrity of service providers, ethnicity and cultural proximity, and access to finance and infrastructural facilities. Furthermore, individual-level factors, including job preferences, entrepreneurial mindsets, and social networking, contributed to difficulties in the transition to work. The key factors identified are not mutually exclusive; rather, they are interwoven and

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mutually reinforcing. The findings suggest a comprehensive, multi-stakeholder approach to address the complex and contextual nature of the key factors influencing the education-to-work transitions of graduates.

Keywords*:* Graduates, Higher Education Institution, Key influencing factors, Labor market, School to work transition, and Youth.

1. Introduction

Transitioning from school to work is a critical period in young people's lives (Tafere, 2014; Morrow, 2015; Young Lives, 2022). It symbolizes a departure from formal education, entry into the labor market, and the pursuit of economic independence from parents and relatives. This period encompasses the completion of full-time education or training and subsequent entry into continuous full-time employment (Elder, 2009; ILO, 2017). However, in Ethiopia, a growing number of higher education graduates coupled with limited job growth have made this transition nonlinear, challenging, and increasingly complex (Abeje 2021; Kassa & Abebe 2016). Consequently, many graduates in Africa including Ethiopia find themselves trapped between the education system and the labor market (Elder & Koko, 2014; Melese, 2016).

Ethiopia has a predominantly youth population, with individuals aged 15-29 comprising 60 to 70 percent of the working-age population (World Bank, 2013). Additionally, evidence from different sources show that the youth labor force in the Ethiopia has expanded rapidly due to a surge in universities and technical and vocational training institutions over the past three decades, resulting in hundreds of thousands of graduates entering the labor market annually (Asmera, 2017; Zeru et al., 2018; Amare et al., 2018). The economy's inability to absorb this increasing labor supply has led to extended job searching periods and a high unemployment rate among graduates (CSA, 2014; Alemayehu, 2014). Consequently, the school-to-work transition among higher education institution graduates is a growing concern as the supply of labor exceeds the capacity of the economy to provide the jobs graduates aspire to. For instance, the number of graduates from higher education institutions has increased significantly,

from approximately 250,000 in 2018 to 450,000 in 2022 (Ministry of Education, 2022). Nevertheless, the employment opportunities have not kept pace with the steadily increasing number of graduates. The Ethiopian Development Research Institute (2021) report shows that only about 100,000 formal jobs are created annually. The report of Central Statistical Agency (CSA) of Ethiopia, moreover, indicates that in 2022, the unemployment rate for graduates was approximately 21.5%, markedly higher than the national average of 18%. The statistical evidence indicates a substantial gap between the number of graduates and available employment. Data from the study area shows similar trends that the numbers of HEI graduates have increased rapidly (Plan Commission of Sebeta, 2020). This issue necessitates a comprehensive understanding of the transition process encountered by higher education graduates, as well as the inherent challenges associated with this transition.

Thus, this qualitative and quantitative mixed case study aimed to provide area-specific and context-based empirical findings regarding thehigher education-to-work transition experiences of graduates and key influential factors in Sebeta Town, Oromia Region. The finding would contribute to the existing body of knowledge by providing a contextualized understanding of the school-to-work transition dynamics and challenges, going beyond generalized explanations. In addition, it contributes significantly to how higher education institutions can better prepare graduates for the labor market and improves their school -to -work transition prospects. It also informs policy making on how to adequately deal with employment needs and education-to-work transition prospects of higher Education Institutions (HEIs) graduates.

2. Problem Statement

Studies and reports from various sources indicate a rapidly rising rate of graduate unemployment in Ethiopia (Ethiopian Ministry of Education, 2020; African Development Bank, 2021; World Bank, 2020; International Labor Organization, 2020). The Ethiopian Ministry of Education (2020) report acknowledges that graduate unemployment rose from 18% in 2015 to 29% in 2020 due to a rapidly increased university enrollment, driven by mass higher education policies. Similarly, the ILO global employment

trends for Youth (2020) identifies Ethiopia as one of the highest rates of educated youth unemployment in sub-Saharan Africa. The report estimates that 32% of Ethiopian graduates aged 15-29 were unemployed in 2019, compared to 19% for non-graduates. Studies have also indicated that elevated rates of youth unemployment have profound social, economic, and political implications for youth, their families, and the nation as a whole (Martha, 2012; ILO, 2010; UNDP, 2014). Specifically, Martha (2012), the ILO (2010), and UNDP (2014) noted that high rates of youth unemployment jeopardize national security, contribute to the underutilization of human capital, and exacerbate the challenges to national growth and development.

Underemployment, along with issues of unemployment, has negatively impacted the future career development and other transitional aspects of graduates, including marriage, family formation, civic participation, and citizenship (Tesfaye & World Bank, 2020; United Nations Development Program (UNDP), 2020). Literature suggests that several factors are contributing to the employment challenges faced by graduates. Among these, the education system in Ethiopia is identified as a significant challenge, primarily characterized by an overemphasis on maximizing enrollment at the expense of quality (Edukans Foundation, 2012; Jerusalem, 2016; World Bank, 2015; Woldeyohannes 2017). A study by Woldeyohannis (2017) noted the quality of education in Ethiopia has been compromised due to the rapid expansion of enrollments. This assertion is also supported by the World Bank report that indicates rapid expansion of enrollment in Ethiopia's education system has led to a decline in educational quality (World Bank, 2015). It's a fresh memory where nearly 97 percent of secondary students who sat for the national school leaving examination scored below the 50 percent minimum proficiency benchmark established by the Ethiopian Ministry of Education (Tiruneh & Molla, 2023). A weak link of education with the labor market has also been a significant challenge in the Ethiopian education system (ILO, 2019). As a result, many graduates from higher education institutions (HEIs) in Ethiopia find themselves caught between the education system and the labor market. Mesele (2016) described the disconnection between these two sectors as a "broken bridge".

In addition to the quality of education, the transition of graduates to the workforce is a complex process influenced by various structural, institutional, and behavioral factors (Kameni et al., 2020; Anyanwu, 2013; ACET 2014; Wang 2012; Zhang et al., 2022; Adejibowo, 2020; Makinde, 2020; Kiprono, 2020; Tsegaye, 2020).

This case study aimed to explore the key factors influencing the transition from education to work for a relatively understudied population: graduates of higher education institutions (HEIs). Several bodies of literature suggest that the labor market conditions for young HEIs graduates remain underexplored, with existing research often focusing on broader trends that encompass the general youth and adult populations (Shimekit& Oumer, 2021; Karkee& O'Higgins, 2023; World Bank, 2019; ILO, 2019; OECD, 2018; Economist Intelligence Unit, 2019; Cedefop, 2015; Economic Co-operation and Development (OECD), 2018; African Economic Research Consortium (AERC), 2018; Ethiopian Economic Association (EEA), 2020).

Meanwhile, studies such as 'Youth Employment in Ethiopia: Trends and Challenges' by Shimekit and Oumer (2021), 'The Impact of Informal Employment on Youth in Ethiopia' by Karkee and O'Higgins (2023), 'Characteristics and Determinants of Youth Unemployment, Underemployment, and Inadequate Employment in Ethiopia' by Kirishinan et al. (2005), 'Child Labor and Youth Employment in Ethiopia' by Guarcello and Rosati (2008), and 'Unemployment and Labor Market in Urban Ethiopia: Trends and Current Conditions' by Fitsum (2014) primarily focus on the broader youth and adult populations.

This gap indicates the need for targeted studies that address the unique challenges faced by young graduates of higher education institutions (HEIs). Specifically, this study aimed to investigate the key structural, institutional, and individual behavioral factors influencing graduates' transition from education to employment in Sebeta, Oromia Region. Additionally, it sought to suggest actionable policy directives to enhance the transition prospects of these graduates.

Key Factors Influencing the Transition from Education to Work: A Brief Literature Review

Literature from various contexts, including Ethiopia, reveals that several key factors significantly influence the transition to work. Among these, the mismatch between the skills acquired during higher education and the requirements of the labor market is a major barrier (Kameni et al., 2020; Anyanwu, 2013; ACET, 2014; Wang, 2012; Zhang et al., 2022; Adejibowo, 2020). Limited job opportunities have also been cited across multiple studies (Adejibowo, 2020; Kiprono, 2020; Tsegaye, 2020). Additionally, corruption and bureaucracy in hiring processes are frequently mentioned as significant factors (Makinde, 2020; Tsegaye, 2020).

The support provided by higher education institutions, quality of education and training, as well as its relevance to labor market needs, are widely cited as key institutional factors (Al-Ajam et al., 2020; Zhou et al., 2022; Adejibowo, 2020; Anyanwu, 2013; ACET, 2014; Wang, 2012; Mark et al., 2016). Furthermore, the employer-employee relationship (Makinde, 2020) and university-industry partnerships and collaborations (Kiprono, 2020) are also significant institutional factors influencing transitions.

Behavioral factors, such as career adaptability and flexibility, are suggested in the literature as key influences on the transition to work (Adejibowo, 2020). Individual factors, including career aspirations and self-efficacy, are also discussed in studies by Tsegaye (2020) and Makinde (2020). Evidence from the literature review indicates that most studies on the factors and determinants of employment have primarily focused on structural and institutional factors affecting youth employment outcomes, while insufficiently addressing the influence of individual behavioral factors. Therefore, this case study aims to examine the influence of individual behavioral factors such as job preferences and expectations, entrepreneurial mindsets, and social networking in conjunction with institutional and structural factors.

3. Methodology

3.1. Description of the Study Area: The study was conducted in Sebeta, a town adjacent to Addis Ababa, the capital city of Ethiopia. Sebeta town offers several features that make it suitable for this study. In addition to its location adjacent to Addis Ababa, Sebeta town is characterized by diversified livelihoods: a combination of on-farm and off-farm livelihoods, and a blend of urban and rural lifestyles. It also exhibits the highest rate of youth in-migration for job seeking (Abate, 2014); Tadesse, 2019; Gashaw, 2016); and Mesfin and Melaku, 2018). These researchers mentioned that the town's proximity to Addis Ababa and its expanding job market attract many rural migrants seeking improved livelihoods. Particularly, Abate (2014) indicated that economic opportunities and the search for better living conditions are primary drivers of in-migration to Sebeta. A remarkable labordynamic marked by spontaneous hiring and firing and the researcher's informal knowledge of the study area were also factors in selecting Sebeta Town for this inquiry.

In 2018 the total population of the town was estimated to be around 352,000, and over half (52.6 percent) of the population was aged between 10 and 35 years old (Oromia Planning and Economic Development Bureau (OPEDB), 2017). This indicates that young and middle-working age groups dominate the population, similar to the age structure in many sub-Saharan African countries (World Bank Report, 2018; African Development Bank (AfDB), 2019; United Nations (UN), 2015 and United Nations Population Fund (UNFPA), 2020). The migrant population constituted about 56 percent of the total population of the town administration where the mass influx of youth migration to the city is mainly in search of employment opportunities (OPEDB 2017; Efa, & Gutema, 2017).

3.2. Research Design: The study employed a mix of quantitative and qualitative approaches. The qualitative approach was used to depict the overall situation of the transition process mainly focusing on graduates' experiences and feelings about their journey from education to employment and difficulties they face in the process. It was advantageous for examining ongoing processes and allows for iterative data analysis that enables researchers to move back and forth

between data, which is particularly useful when new situations may arise during the overall progress of the research (Fossey et al., 2020; Hamilton et al., 2021).It also allowed for deeper engagement with the data, facilitating the emergence of themes and insights (Fossey et al., 2020; Hamilton et al., 2021). Quantitative approach was employed to generate numerical data analyzed statistically, offering concrete evidence to supplement qualitative findings. It was to examine trends and patterns across different demographics (Tariq and Woodman, 2013; Ford and Goger, 2021).

3.3. Data Collection: Sources and Instruments

Data Sources: Data collection involves a multi-source approach, incorporating both primary and secondary data sources. Primary data include graduates from higher education institutions and service providers of sector offices in Sebeta town. Additionally, academic staff and leadership of the higher education institutions and employment providers in the study area were the primary sources of data. The use of multiple primary data sources was to capture a wide range of perspectives. Secondary sources of data were archives of the Sebeta City Administration, the periodic labor force survey, and urban employment and unemployment survey of Ethiopia, and relevant domestic and international journals on labor markets and school-to-work transition. Secondary sources were reviewed to situate the findings within broader national and international contexts.

Data Collection Instruments: The quantitative data was collected from graduates using structured questionnaires. Questionnaires were distributed to participants through hand delivery, and for those with internet access, survey guides were sent via Telegram. Ultimately, 146 (76%) questionnaires were returned, while 29 graduates declined to participate for various reasons, predominantly time constraints and 19 graduates did not respond for unknown reasons.The qualitative data was collected using in-depth interviews and FGD. The in-depth interview method was employed to thoroughly explore the subject and to gather the experiences and opinions of the participants. A semi-structured interview was utilized to facilitate detailed discussions while allowing participants the freedom to express their

views. Additionally, focus group discussions (FGDs) were conducted to enable participants to share their experiences in a group setting on selected topics, moderated by facilitators. Data from secondary sources were reviewed to shape the study and to relate with the findings from the field data.

3.4. Sampling Design: A total of 378 graduates from universities and Technical and Vocational Education and Training (TVET) colleges were screened from the archives of the Sebeta City Administration (Plan Commission of Sebeta, 2020), serving as the basis for sample size determination for the survey. The inclusion criteria for these 378 graduates, drawn from a total of 730 archived records, required that they possess reasonably complete documentation, including a valid residency ID for the study area, complete credentials, and an active address. Consequently, 194 respondents were ultimately selected for the survey.

The sample size was determined using the Taro Yamane (1967) formula at a 95% confidence interval. Yamane's formula for calculating sample size is expressed as follows:

$$n = \frac{N}{1+N*e^2}$$

Where: n = sample Size, N=Total Population: 378 and e=Margin of Error: 0.05

Substitute these values into the formula:

$$n = \frac{378}{1+378*(0.05)^2}$$

$$n \approx 194$$

Thus, the sample size for a total population of 378 graduates at a 95% confidence interval with a margin of error of 0.05 is approximately 194. Stratified and simple random sampling techniques were employed to select participants for the survey. Graduates were grouped by sex, age, academic track, and labor market status to ensure diversity and facilitate comparative analysis. A simple random sampling technique was then used to select samples from each stratum.

Sampling for the qualitative approach involved the selection of participants using a purposive sampling technique. A total of 39 participants were purposefully selected. Among these, 16 interviewees were chosen from two categories of graduates: (a) three graduates who successfully transitioned to work, and (b) thirteen graduates who are still struggling with the transition. Additionally, eight participants for in-depth interviews were selected, comprising four service providers from the Sebeta sector offices including the offices of Job Creation and Skill Development, Labor and Social Affairs, Planning Commission, and Youth and Women's Affairs and four employment providers from the manufacturing, construction, service, and urban agriculture sectors. These sectors are the significant sources of employment for graduates in the study area (Ethiopian Investment Commission, 2019; Tesfaye, 2020; Admasu et al., 2021). Three focus group discussions (FGDs) were also conducted. The first FGD included five academic staff members and leadership from higher education institutions (HEIs), while the second and third FGDs consisted of seven officers each from the One-Window Service of the Job Creation and Skill Development Office at Alemgena and Furi Kebeles in Sebeta City.

3.5. Data Analysis: Quantitative data was analyzed using descriptive statistics. Among the various components of descriptive statistics, frequency tables and percentages were used to supplement the qualitative analysis. A frequency table helps understand how data points are distributed across different categories, (Jahan & Rahman, 2016) while percentages complement frequency tables by offering insights into the relative size of each category compared to the total dataset (Rasmussen, 2009).

The qualitative analysis was employed through thematic analysis. The choice of thematic analysis was supported by the research question and the nature of the data (Bryman, 2012). It was suitable due to its flexibility and ability to explore the multifaceted nature of the school to work transition experience and challenges of graduates. The major steps followed in qualitative data analysis were: Data transcription, coding, categorizing codes into potential themes and sub themes, interpretation and finally story

writing. A decision was made between single and double coding, with double coding employed due to its ability to capture more detailed information from data that may have multiple interpretations and fit into more than one category. The literature suggests that the choice between single and double coding depends on the research objectives, the complexity of the data, and the level of detail required for analysis (Creswell, 2014; Saldaña, 2015).

3.6. Concepts of Key Terms: terms used in this study were conceptualized within the Ethiopian labor market framework. Below are the definitions of these terms:

- First Significant Job: The first job that has a substantial impact on a graduate's career trajectory, providing essential skills, experience, and income.
- Current Job: The job graduates is presently engaged in, regardless of its nature or level of stability
- Informal Jobs: jobs that typically lack formal contracts, benefits, or legal protections.
- Insufficient Employment: Earnings that do not meet basic needs such as food, clothing, and shelter, preventing graduates from achieving a decent life.
- Decent Job: Employment that offers fair remuneration, job security, and safe working conditions, promoting both dignity and personal development.
- School to Work Transition: transitioning to decent jobs, the job characterized as stable and satisfactory
- Stable and Unstable Jobs: Stable jobs are characterized by employment contracts lasting more than 12 months, whereas unstable jobs may be temporary or subject to frequent changes, lasting less than 12 months.
- Satisfactory and Unsatisfactory Jobs: Satisfactory jobs meet the expectations and needs of the graduates regarding pay, working conditions, and other benefits, while unsatisfactory jobs do not meet these expectations.
- The employed: graduates engaged in income generating activities for their own gain at time of the survey.

- Unemployed: Graduate at reference point, that is, during field work is available to job, seeking job, but without any job.
- Prolonged unemployment: A situation where graduates are unable to find a significant job for an extended period, for more than one year, leading to economic, social, and psychological challenges.
- Migrant Population are graduates who have relocated from their areas of origin in search of employment due to a lack of similar local opportunities while non-migrants are graduates who reside within or near the administrative unit of the study area.

4. Results and Discussion

4.1. Demographic and Socio-Economic Background of the Study Participants

This section presents the demographic and socioeconomic characteristics of the study participants. Table 1 shows the demographic characteristics of the survey participants.

Table 1: Graduates by Sex, Age Group, Marital Status, Number of Children, and Migration History

Variable	Category	Percentage
Sex	Female	39.8
	Male	60.2
	15-19	7.4
Age Group	20-24	41.7
	25-29	50.9
Marital Status	Married	32.4
	Single	66.7
	Divorced	0.9
	Widowed	0.0
Migration History	Non-Migrant	25.9
	Migrant	74.1
	1-2	93.3
Number of Children	3-4	6.7
	More than 4	0.0

Correspondingly, data in Table 2 displays the characteristics of in-depth interview participants.

Table 2: Demographic and Socio-Economic Characteristics of In-depth Interview Participants

	Participants							
	Sex	Age	Marital Status	Education	Field of Study	Level of Education	Labour Market	Employment Status
1	M	28	Married	Academic/	Civil Eng./	B.Sc./Level	Employed	Self-
2	F	26	Married	Academic/	Accounting/	B.A/Certifi	Employed	Self-
3	M	27	Married	Academic	Agricultural	B.Sc.	Employed	Government
4	F	18	Unmarried	Academic	Economics	B.A	Employed	Micro
5	F	23	Married	TVET	Textile	Level 4	Employed	Private
6	M	24	Unmarried	Academic	Post-Harvest	B.Sc.	Unemploye	-
7	F	23	Unmarried	Academic	Accounting	B.A	Employed	Self-
8	M	26	Married	TVET	Textile	Level-4	Employed	Private
9	F	22	Unmarried	Academic	Civil Eng.	B.Sc.	Unemploye	-
10	F	24	Unmarried	Academic	Accounting	B.A	Employed	Government
11	M	27	Unmarried	Academic	Urban	B.Sc.	Employed	Micro
12	M	24	Unmarried	Academic	Management	B.Sc.	Unemploye	-
13	M	23	Married	TVET	Drafting	Level 4	Employed	Government
14	M	29	Married	Academic	Mechanical	B.Sc.	Employed	Self-
15	F	21	Married	Academic	Social Work	B.A	Unemploye	-
16	F	23	Unmarried	TVET	Concrete	Level-3	Employed	Private

The sample consists of an equal number of male and female participants (8 each), indicating gender balance in the qualitative data collection. A higher proportion of participants are from the academic track (12) compared to those from TVET (6). Out of the 16 participants, 12 are employed and 4 are unemployed, while the employed are distributed across various sectors: 3 in government, 2 in the private sector, 4 self-employed, and 3 in micro and small enterprises (MSEs). Data on the demographic and socio-economic background of study participants is essential for comprehending the transition experiences among various categories of graduates, given that graduates represent a heterogeneous group (Baah-Boateng, 2016).

4.2. Key Influential Factors of Transitions from Higher Education to Work

Sebeta, the study area of this research, situated on the outskirts of Ethiopia's capital, Addis Ababa, attracts graduates from across the nation seeking employment. This influx of job seekers creates a rapidly blending labor market characterized by high rates of hiring and firing, making the transitions to work challenging. The Findings reveal that graduates' labor market disadvantages and challenges in transitions from education to work stem from a confluence of structural, institutional, and individual behavioral factors discussed in the following sections.

4.2.1 The Structural Factors

Economic Context and Graduates' Employment Outcomes

The opinions from study participants show the investment climate in the study area has significantly impacted graduates' employment prospects and their ability to transition successfully into the workforce. For instance, one of the focus group discussion (FGD) participants, an academic staff member from Sebeta Polytechnic, shared his insights;

> *The investment climate in our town has become increasingly hostile, primarily due to instability in the country. As an academic, I witness how this environment negatively impacts our graduates' job prospects. Employers are hesitant to hire due to uncertainties surrounding the stability of their businesses, and this reluctance left our graduates without viable*

> *employment options. Moreover, the fear of potential conflicts discourages new investors from entering the market, which further suppresses job creation. It's disheartening to see so many capable graduates struggling to find work, and the cyclical nature of this problem only exacerbates their challenges.*

Similarly, FGD discussant from the leadership of Sebeta Polytechnic shared;

> *The persistent conflicts have created an environment of uncertainty that makes an area difficult for businesses to operate effectively. Many of the businesses that could provide jobs are struggling to maintain productivity, let alone expand their operations to hire new employees.*

Opinions of these discussants indicate, a hostile investment environment, exacerbated by persistent conflicts in the area, has hindered graduates' ability to obtain jobs. This finding conforms to the literature from different sources. Mlatsheni (2014) noted that employment creation tends to decline during economic downturns. Similarly, Haider (2016) emphasizes that the state of the economy, coupled with a lack of a business-friendly environment and infrastructure deficiencies, are critical determinants of employment outcomes. The author asserted youth are particularly vulnerable during economic hardships, often being the first to face layoffs. Evidence from African economies consistently shows that inadequate structural transformation limits economic opportunities and weakens employment generation for citizens (Baah-Boateng, 2016; Fox &Thomlin, 2016; Malik & Awadallah, 2013; Elder et al., 2015). Broussard and Tekleselassie (2012) further linked youth unemployment in Ethiopia to the broader economic context.

The impact of economic conditions on employment outcomes, particularly during periods of instability, is well-documented in literature. These documents illustrate that economic fragility could limit job creation. This study adds to the documents by specifically linking ongoing conflicts in Ethiopia to graduate unemployment, providing a localized example that enhances understanding of these dynamics.

Curriculum and the Labor Market Alignment

This section presents the results of in-depth interviews with graduates and the FGD discussants of the HEIs academic staff and leadership. FGD discussants of the Sebeta Polytechnic, one of the training institutions in the study area have shared their experiences about the alignment between curriculum and the labor market in their institution. The institution has implemented several strategies including competency-based training, cooperative training, institutional assessments, COC certification, entrepreneurship education, and the Kaizen philosophy to ensure the relevance and quality of training it offers. The institution has also disaggregated broad economic sectors within the city administration into specific occupational standards aligned with the economic activities and business opportunities available at study areas.

One of the FGD discussant shared, “The disaggregation of aggregate sector into different Occupational standards (OS) aims to enhance the quality of training and create job opportunities across various industries"
However, employers have expressed reservations regarding this approach. For instance, Participant 23 from the automotive sector stated:

> *For me, this is a joke; how can I pay for several employees handling different tasks of vehicle maintenance? It's not cost-effective for us to hire employees who cannot manage all aspects of vehicle service. Customers prefer it when a single worker completes the servicing of their vehicles.*

The opinions shared by interviewees indicate a significant mismatch between the training provided and the actual needs of the labor market. For instance, the automotive industry participant noted the necessity for employees who can perform multiple tasks, suggesting that a more integrated training approach might be beneficial. He argued that hiring multiple specialists is impractical and costly, while academic leadership continues to emphasize the importance of occupational specificity in training programs. The academic staff and leadership of Technical and Vocational Education and Training (TVET) asserted that the disaggregation of economic sectors into specific occupational standards is intended to enhance training quality by producing graduates who are well-

equipped for defined roles within various industries. They emphasized that this disintegration aims to cultivate a skilled workforce that meets the diverse demands of the labor market.

Graduates have also voiced concerns regarding the relevance of their education to labor market needs. For instance, a graduate from the academic track expressed frustration about the lack of alignment between his education and the requirements of the job market, which has contributed to his prolonged unemployment.

He articulated the issue in the following words:

> *After graduation, I found vacant positions in my field of study and applied to various companies, both online and in person. Despite my efforts, I have yet to secure a job. In the agriculture sector, employers prefer plant science graduates or those specializing in general agriculture, not my field* (Participant 6).

He further elaborated on his experiences, stating:

> *Some employers ask me about my qualifications in Post-Harvest Management and the duties I would perform during the harvesting period, rather than responding to my queries. This frustration led me to change my field of study; I am now pursuing a B.A. degree in Economics (Participant 6).*

The frustration expressed by the graduate also shows the disconnection between education and employment opportunities. He attributes his extended unemployment to the irrelevance of his qualifications, noting that employers often prefer candidates from more directly relevant fields. Despite the presence of vacancies related to his studies, he finds that job requirements frequently diverge from his training.

The opinions expressed by TVET staff further reveal significant gaps in the structure of the TVET curriculum and its impact on student readiness for employment. Key complaints identified from the academic staff's feedback include:exclusion of foundational subjects from the curriculum, insufficient instructional hours for foundational subjects, and qualification mismatch of instructors teaching the foundational subjects and soft skills.

Exclusion of Foundational Subjects from the Curriculum**:** TVET staffs involved in FGD express their concern over the exclusion of foundational subjects like mathematics and English from the curriculum though these foundational subjects are critical for students to develop the analytical and communication abilities necessary in today's job market. Literature indicates that, in addition to mathematics and English, a variety of subjects contribute to fostering innovation and creativity among graduates in the workplace. The National Research Council (2012) suggests the importance of STEM (Science, Technology, Engineering, and Mathematics) education. Furthermore, López (2017) discusses the significance of Art and Design, while Nussbaum (2010) emphasizes the role of Critical Thinking. Kuratko (2005) discusses the importance of Entrepreneurship Education, and Eime et al. (2013) examine the contributions of Physical Education.

Insufficient Instructional Hours for Foundational Subjects: There is a complaint about the minimal number of contact hours allocated for essential subjects like Mathematics and English. Academic Staff members feel that the limited exposure to these subjects hinders students' overall competency and preparedness for various tasks in their future careers.In addition to foundational skills**,** the curriculum of TVET allocates minimal credit hours for soft skills such as communication, teamwork, and work attitudes. Given that employers place high value on these skills during the recruitment process, TVET staff believes that this neglect could disadvantage graduates in the job market.The literature regarding this issue presents mixed views. A significant body of research supports the approach of minimum training hours for foundational subjects, arguing that a focus on major skills is essential for meeting immediate labor market demands by equipping graduates with specific vocational skills (Hanushek et al., 2017). In contrast, Ayalew (2015), UNESCO (2018), and Kibret& Melaku (2019) argue that inadequate attention to foundational subjects, such as mathematics and communication, limits students' critical thinking and problem-solving abilities. The findings of this study suggest that a well-rounded education, incorporating both foundational skills and major fields of study, enables graduates to perform better in the labor market and

adapt more easily to changes in technology and today's digital economy. These findings align with those of the World Bank (2020), Fisher et al. (2021), and Kassahun (2022), who advocate for a balanced curriculum that includes both practical skills and foundational knowledge. The debate continues to evolve as the needs of the labor market change.

Qualification of Instructors Teaching Foundational Subjects and Soft Skills: participants from the focus group discussion (FGD) who are academic staff members further shared the idea that primary occupation teachers, who may lack specialized training in subjects like Mathematics and English, are often responsible for teaching these courses. This raises concerns about the quality of instruction and the effectiveness of teaching methods, which could impact students' learning outcomes and their performance in the workplace.

Employers' Expectation and Graduate Employability Skills

The qualitative inquiry through in-depth interviews with graduates and employment providers shows a mismatch between employers' expectations and the employability skills of graduates. Employers indicated that while graduates possess a strong theoretical understanding of their fields, they lack the practical skills necessary for enhancing productivity and problem-solving in the workplace.

Participant 23, an employer from a manufacturing enterprise, expressed this concern: "Graduates are more academically oriented while lacking skills on how the world of work operates."

Participant 21 reinforced this view, stating:

> *We (employers) are more interested in transferable skills essential for job fulfillment than in academic literacy, which often overshadows the practical skills graduates have acquired in higher education institutions. Graduates tend to focus on their academic achievements, which do not align with our needs and expectations.*

Participant 24 similarly echoed these sentiments, noting that while transferable skills attract employer interest, these skills are often lacking among graduates. Employers prioritize transferable skills such as interpersonal communication, emotional intelligence, leadership, assertiveness, and problem-solving, whereas these skills are less

recognized by graduates. Participants 21, 23 and 24 suggested that while graduates possessed theoretical understanding, they often lacked the practical skills, problem-solving abilities, and work-readiness necessary for success in the workplace. Graduates themselves acknowledged the importance of transferable skills, such as communication, leadership, assertiveness, and problem-solving, but expressed a lack of reliance in these areas. They prioritized mastery of their field of study, work experience, and social networking as crucial for labor market success. The feedback from participants show a disparity between the perceptions of employers and job seekers regarding the skills valued in the labor market.
In addition to perceptions and expectations regarding skill requirements, participants' opinions provide insights into the actual job-skill mismatches currently experienced by graduates in the labor market.Interviews with participants 3, 4, 5, 6, 8, 13, and 16 revealed that these individuals were employed in positions that did not correspond with their fields of study or levels of qualification.

The participants' responses reveal a significant discrepancy in perceptions between employers and graduates regarding the essential skills required for the labor market. Employers report that, while graduates possess a broad theoretical knowledge base, they frequently lack the practical skills necessary for effective job performance and problem-solving. Graduates acknowledge the importance of mastery in their fields, work experience, and social connections for securing employment. However, they often underestimate the value of co-curricular and transferable skills, such as interpersonal communication, emotional intelligence, leadership, and problem-solving abilities.

Ultimately, the findings indicate that the misalignment between the curriculum and the labor market is a critical issue affecting employment outcomes and the education-to-work transition of graduates in the study area. This aligns with the literature suggesting that educational systems in many low-income countries fail to cultivate the essential skills required by labor markets (Fox et al., 2016; Baah-Boateng, 2014; Filmer Fox et al., 2014; Grant, 2012). Additionally, this observation supports Jerusalem's

(2016) assertion that a significant proportion of Ethiopian college graduates are employed in positions unrelated to their field of specialization.

Wage Offerings in the Labor Market

The data indicates that while job availability is recognized as a concern, it is perceived as less critical than the issue of low wages. Qualitative data supports this finding, as illustrated in Table 5. When graduates were asked to identify the challenges they face in securing decent jobs, low wage rates emerged as the most significant barrier affecting their transition to better job opportunities, even more so than job loss.

Table 5: The Key Factors Influencing the School-to-Work Transition

Key Factors	Participants															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Access to Finance																
Startup capital to create own job			x		x	x			x		x		x			x
Pocket allowance for Finding Wage Jobs			x		x	x									x	
Business Expansion	x	x					x							x		
Availability of Jobs and Wage Rates																
Unavailability of Jobs				x								x				
Low Wage Rates	x		x		x	x		x	x		x				x	
Job Searching Behavior																
Social Networking			x	x	x	x	x	x	x			x			x	
Entrepreneurial Mindset	x	x	x	x	x			x					x			x
Infrastructural Facilities					x	x						x				x
Roles of school to Work transition Service Providers																
Weak collaboration and Disintegrated Service	x		x			x		x			x	x		x		
Lack of Competency and Integrity	x		x			x						x				
Stereotypes and Discriminations																
Ethnicity and access to job opportunities			x	x	x	x		x	x		x	x			x	
Skill Mismatch																
Job-Skill Mismatch			x	x	x	x		x					x			x

Source: Field Data, 2023

The findings reveal that the labor market challenges graduates face in the study area is more closely associated with the quality of jobs available rather than a mere scarcity of employment opportunities. This observation diverges from existing literature, such as the studies by Mlatsheni (2014) and Browne (2016), which attribute employment challenges primarily to a lack of job opportunities. While the literature focuses on availability of

jobs and wage levels, the current study adds that the quality of available jobs needs urgent attention alongside the creation of more jobs. This dual focus on quality and quantity of employment opportunities is less emphasized in existing literature, which often prioritizes job creation alone. This distinction emphasizes the importance of not only increasing job availability but also enhancing job quality to facilitate a more effective transition for graduates.

4.2.2. Institutional Factors

In addition to structural factors, the study identified institutional factors, such as ethnicity and cultural proximity, which manifest in various forms, weak collaboration among service providers, and a lack of competence and integrity among these providers were a significant barriers for graduates seeking to access decent wage jobs and aspire to establish their own businesses, as discussed in the following section.

Ethnicity and Cultural Proximity

Participant testimonies indicate that stereotypes and discrimination based on ethnicity and language are pervasive in the study area, hindering access to job opportunities. Table 5 illustrates ethnicity and cultural proximity emerged as factors influencing graduates' access to job opportunities. Data shows that participants 4, 12, and 15 reported losing employment opportunities due to their ethnic and linguistic backgrounds.

Participant 12, for instance, emotionally expressed, “Your ethnicity and language play a significant role in finding jobs. If you have an 'X' name, there's no space for you”. He further lamented the prioritization of ethnic identity over qualifications, stating: “Even if you meet the requirements and hold the necessary credentials, getting jobs or establishing your own business is difficult”

Participant 2 revealed experiences of unequal treatment during the job application process, stating,

> *I was called for written exams several times for vacancies in Addis Ababa and surrounding areas, but I always failed the interview for unknown reasons. We receive no feedback on the selection criteria.*

In addition, participants 3, 4, 8, 6, 12, 15, and 16 identified overt and subtle forms of discrimination, particularly in private sector recruitment

practices as barriers to access decent jobs in their localities. The discriminatory practices include favoring applicants with shared socio-cultural backgrounds, relying on subjective selection criteria such as trust and loyalty, reserving higher-paying and leadership positions for those with connections, and relegating individuals from certain backgrounds to low-status, manual jobs. Participants 3, 8, 6, and 16 further emphasized the prevalence of "localism" referred to as "Gotegnet" in Amharic or "Naannummaa" or “Gandummaa” in Afan Oromo, disadvantages job seekers from outside the immediate vicinity, even if they share similar ethnic or linguistic backgrounds. This "localism" creates barriers for those who have migrated to the city administration in search of employment. In general, a large majority of participants perceived ethnic affiliations as more significant barriers than political connections. Only participants 6 and 8 mentioned political affiliation as a significant barrier to accessing jobs, particularly within the public sector.

Evidence from participants’ opinion and feelings disclosed the pervasive nature of stereotypes and discrimination within the study area. Participants reported losing job opportunities due to their ethnic and linguistic backgrounds, even when their qualifications met the position's requirements. This finding aligns with research by Zschirnt and Ruedin (2016) which, through 43 field experiments in OECD countries, demonstrated a clear link between ethnic discrimination and unequal access to employment. Similarly, a study in Côte d'Ivoire by Castilla and Ranganathan (2020) revealed how ethnic and regional biases influence hiring decisions. Adding complexity to the issue of discrimination, the study found that even job seekers from similar ethnic and linguistic backgrounds experienced disadvantages due to a phenomenon termed "localism"- a preference for individuals from the immediate vicinity. This belief shows how deeply ingrained notions of place and belonging influence employment opportunities. This echoes findings by Beaman et al. (2013) in India, where local leaders demonstrated a clear bias towards candidates from their own communities during recruitment.

Collaboration and Integration among Key Sectors

The results revealed a lack of effective collaboration and integration among key stakeholders responsible for addressing employment needs in the city administration. Despite the existence of a coordinating body, specifically the Job Creation and Skills Development Office of Sebeta town, participants 1, 3, 6, 8, 11, 12, and 14 faced substantial challenges in navigating the fragmented system. Graduates encountered bureaucratic hurdles and a lack of coordination among various departments when attempting to obtain necessary support and approvals for starting businesses or joining the Medium and Small Enterprises (MSE) program.

Focus group discussions (FGDs) with academic staff and leadership identified these concerns, emphasizing the disconnection between training institutions and industries. Despite the proximity of Sebeta Polytechnic to numerous industries, opportunities for dual training, industry extension services, and competency-based assessments were found to be limited. Interviews with industry representative participants 21, 23, and 24 expressed concerns regarding mutual cooperation, noting that while some collaboration exists, it is insufficient. They acknowledged the challenges associated with partnerships between training institutions and industry.

For instance, one of the participants representing the manufacturing sector, stated,

> *Enterprises in Sebeta City Administration, including ours are supporters of trainees from Sebeta Polytechnic and universities by providing resources and manpower, yet our contributions receive little recognition from the city administration* (Participant 24).

The opinions of industry representatives indicate that resource constraints, concerns about disclosing company information, and a desire for government recognition and incentives to offset the costs of cooperative training are the primary factors contributing to insufficient collaboration.The findings indicate a lack of effective collaboration and integration among key stakeholders responsible for addressing the employment needs of graduates in the study area.

Competency and Integrity of the Service Providers

In addition to the weak collaboration and integration among key sectors, when graduates were asked about the factors constraining their ability to find decent jobs and establish their own businesses, many identified the incompetence and lack of integrity of service providers as significant challenges in their transition to work (Participants 1, 3, 6, and 12). Participant 3 expressed his frustration, stating: "There are posters of 12 principles of professional ethics displayed in every corridor of the sector office. They merely serve as decoration."

Participant 8 commented:

> *Some leaders tend to exaggerate the success stories of their departments, which often do not reflect reality, while downplaying their unsuccessful stories. This is a challenge I have observed in public sector offices.*

Participant 6 added: "I believe government officials' false reports mask the true challenges graduates face in the labor market"

The responses from participants show a disconnection between the stated principles of professional ethics and their actual implementation in the workplace. The presence of ethical guidelines appears to be more ornamental than functional, suggesting that ethical standards are not genuinely integrated into daily operations. The opinions from the interviews further suggest that leaders in public sector offices tend to inflate their departments' successes while neglecting or minimizing failures. Additionally, the integrity of reports generated by government officials was a serious concern. Participants found that the reports often obscure the struggles graduates encounter in the labor market. Such a distorted presentation may misinform decisions, potentially exacerbating the challenges faced by graduates in securing employment.

4.2.3. Individuals Behavioral Factors

Job Preferences: A Factor Influencing Employment Decisions

Graduates were prompted to articulate their job preferences by asking them about their desired employment since graduation.Qualitative inquiry through in-depth interviews revealed that graduates are actively seeking jobs that offer salaries rather than pursuing entrepreneurial opportunities

available in their surroundings. Additionally, graduates demonstrated a preference for the service sector, particularly in service marketing, over roles in manufacturing, construction, or urban agriculture. For instance, participants 2, 4 and 7 were engaged in service marketing businesses: stationery, mobile accessories sales, and snack bar respectively. Data from the annual performance reports of the Plan Commission of the City Administration shows similar results and trends. It shows jobs such as a petty trade was a primary livelihood strategy for several self-employed graduates every year. Approximately two-thirds of participants expressed that the service marketing sector is more appealing due to its lower barriers to entry and exit.

In addition to expressing their job preferences, graduates were probed to articulate the criteria they employ in selecting the sectors they wish to enter following completion of their education.

The results of survey data indicate a mixed result. The wage expectations are moderate among graduates of both genders; however, female graduates exhibit a greater willingness than their male counterparts to accept lower wages. They prioritize safe and harassment-free working environments over higher salary offerings. Conversely, the majority of male graduates prefer positions that align with their academic qualifications and contribute to their future career development. Findings from in-depth interviews substantiate these survey results, revealing almost similar trends in the criteria influencing sector selection among graduates.

Social Networking and Job Searching Behavior of Graduates

Study participants widely acknowledged the importance of social networking in securing employment, particularly within the public sector. Many believed that personal connections often outweighed qualifications and merit. Participant 10 observed, “To get a job here [study area], you need someone you are affiliated with through religion, ethnicity, or locality” Participant 2 emphasized the role of networking, stating,"An access to job opportunity is highly determined by whom you know."
Participant 3 share his feelings as follows;

> *I was hopeful when I completed my degree, thinking that it would open doors for me. However, I soon realized that many job opportunities seemed to be tied to personal connections rather than qualifications. I often heard about job openings through friends or family members who were already working in certain companies and public organizations. Unfortunately, I didn't have those connections, and I was at a disadvantage position because of that"*

Participants widely acknowledged that personal connections often outweighed merit and qualifications. Data further indicates that the network served graduates in two ways: for some, jobs were generated directly through referrals to employers, while others received information about vacancies. The study recognizes that social networks play a critical role in securing employment for graduates, particularly within the public sector. This finding is consistent with research in Ghana, which identified a strong link between graduates' labor market outcomes and the strength and nature of their social networks (Baah-Boateng, 2014). The reliance on social networks for job searching, as reflected in the literature, indicates the importance of social capital. However, this study offers fresh insights from graduates of higher education institutions.

Entrepreneurial Mindset and Job Creation Behavior

An entrepreneurial mindset emerged as a key factor influencing transitions into the workforce. Insights from graduates, such as Participants 1 and 2 indicate that their success in establishing their own businesses can be attributed to early experiences that integrated academic learning with work. These experiences fostered self-reliance and cultivated essential business expertise, thereby enhancing their entrepreneurial capabilities. Conversely, Participants 3 and 6 attributed their challenges to a deficiency in entrepreneurial experience. This lack of exposure hindered their ability to effectively navigate the complexities of starting and managing a business.

Besides, the opinions from participants show that family support played a crucial role in shaping career aspirations and developing entrepreneurial mindsets. Participants 1, 2, 7, and 14 recognized the positive influence of

their families in encouraging self-employment and providing opportunities to gain work experience while studying.

Moreover, focus group discussants expressed their concerns regarding the entrepreneurial mindset among graduates. They posited that the limited entrepreneurial orientation among Ethiopian youth is closely linked to familial influences on vocational choices.

One of discussant in FGD 1 noted;

> *Ethiopian families often encourage their children and teenagers to aspire to careers as doctors or pilots, rather than guiding them toward understanding contemporary labor market trends and directions*

Another discussant from the same FGD voiced;

> *When asked about their future aspirations, a significant majority of teenagers in Ethiopia express a desire to become doctors, pilots, or engineers, showing a notable preference for civil engineering over mechanical, electrical, or industrial engineering. There is considerably less aspiration toward entrepreneurship, as terms such as "businessman," "innovator," or "entrepreneur" are rarely articulated in their responses. This cultural inclination toward traditional professions largely contributes to a job-seeking mentality rather than fostering a mindset oriented toward job creation.*

Participants' opinions reveal that families often prioritize traditional career paths, such as medicine or engineering, which constrains the exploration of entrepreneurial opportunities.The familial guidance not only shapes aspirations but also reinforces a cultural narrative that undervalues entrepreneurship, ultimately hindering the development of an entrepreneurial mindset among young individuals.

In addition, an entrepreneurial mentality associated with the pursuit of supplementary education and training emerged as a significant advantage. Graduates engaged in additional certifications and training programs alongside their primary degrees reported greater success in securing employment (Participants 1, 2, and 14). This study recognizes an entrepreneurial mindset - a composite of attitudes, skills, and behaviors that empower individuals to identify opportunities, navigate challenges,

and pursue innovative solutions is a key factor enabling transitions into the workforce.

The recognition of an entrepreneurial mindset as a crucial factor enabling transitions into the workforce is supported by a wealth of existing knowledge. Study by Kuratko et al. (2015) suggests that individuals with a strong entrepreneurial mindset are more adept at spotting gaps in the market and developing viable ideas to address them. The ability to build relationships and collaborate effectively is another critical aspect of the entrepreneurial mindset mentioned inthe literature by Kauffman Foundation (2017). Thus, encouraging a shift towards entrepreneurship education and experiential learning can equip the next generation with the tools they need to succeed in an increasingly complex and competitive labor market.

To comprehend important observations from the findings, transitions from education to decent employment are shaped by the interconnections among education, the economy, and labor markets. In addition to this nexus, ethnicity and cultural proximity, collaboration among service providers, infrastructural facilities, and wage rates are key influential factors in transitions to work. The study recognizes that graduates are not hindered by a single challenge, but rather by a complex interplay of structural, institutional, and behavioral factors. The fragmented support systems coupled with persistent stereotypes and discrimination based on ethnicity and languages create significant barriers for graduates entering the labor market. Furthermore, the lack of appropriate skills, including both technical expertise and an entrepreneurial mindset, further limits their opportunities. Navigating this complex landscape is also hampered by a lack of social capital and professional connections, placing graduates at a distinct disadvantage.

The challenges graduates faceare not mutually exclusive, but rather interwoven and mutually reinforcing. Structural barriers, such as discrimination and fragmented service provision, intersect with individual factors, such as skill mismatches and a lack of entrepreneurial mindset, to

create a web of disadvantages. A single factor has vastly different implications for graduates depending on their individual circumstances, including their socio-economic background, gender, migration history, and field of study. The study further observed competing perspectives and controversies surrounding issues such the role of entrepreneurship versus wage employment.

5. Conclusions and Recommendations

Conclusions

Based on the findings, the following concluding remarks are made regarding the key areas of the study.

The transition from school-to-work for graduates is fraught with significant challenges that are intertwined and multifaceted. The key factor is that opportunity is often influenced by personal connections rather than merit, creating inequities within the job market. The "localism" fosters preferential treatment for local candidates, disadvantaged graduates from outside the area. Access to decent jobs and the potential for MSEs has been stunted due to various factors such as nepotism, incompetence, and lack of integrity among service providers and the disconnection between the skills acquired through education and the requirements of labor markets.

The challenges graduates face in the labor market are not isolated; rather, they form a complex network of interrelated barriers. The intertwined factors necessitate comprehensive strategies that take into account the diverse backgrounds and experiences of graduates. Furthermore, competing viewpoints exist regarding the nature and impact of the key factors. These differing and competing perspectives indicate the need for targeted, context-sensitive solutions for all graduates.

Theoretical, Practical, and Policy contributions and Recommendations

The researcher believes the findings have several important implications and contributions to existing knowledge, policymaking, practitionersand target populations. The case study findings contribute to the existing body of knowledge by providing a contextualized understanding of the school-

to-work transition (SWT) dynamics and challenges, going beyond generalized explanations. The findings provide a more holistic view of the complex realities of HEI graduates 'in their transition to the labor market. The study not only enhances academic discourse but also provides actionable insights for policymakers and practitioners, specifically, Ethiopia's Ministry of Job Creation and Skill Development in addressing the employment needs of graduates and enhancing their school-to-work transition.

The findings suggest a comprehensive, multi-stakeholder approach that addresses the complex and contextual nature of the key factors influencing SWT. It addresses a need for stronger collaboration between academia, industry, and policymaking to bridge the gap between education and employability. The findings emphasize graduates are not a homogeneous group; they have different needs, interests, and capabilities. Therefore, interventions and support programs should be designed to address the specific needs, opportunities and challenges of graduates based on their background characteristics.

Finally, the complex, non-linear and multifaceted nature of the challenges graduates face in trajectories of school to work transition presents opportunities for deeper academic research to better understand the underlying factors and dynamics at play

Limitations of the Study and Future Focuses

The study relied on a limited sample size and lacked diversity in terms of geographic representation that may not fully capture the breadth of challenges faced by all graduates. A more comprehensive approach with a larger, more varied sample could provide a clearer picture of the issues at play. Variability in local economic conditions, cultural factors, and labor market structures means that conclusions drawn may not reflect the experiences of graduates in different contexts.

In addition, the study may lack adequate consideration of the global and regional current labor market situations, economic changes, technological

advancements, and shifts in educational policies that limit the applicability of the findings to future contexts. The research primarily concentrates on graduates, potentially overlooking the experiences of non-graduates. Understanding the broader youth employment landscape, including informal sector workers, could provide a more holistic view of the labor market.

Thus, the future research could focus on:
Comparative studies across different geographic locations of the country to identify commonalities and differences in graduate SWT prospects and challenges.
Longitudinal studies would allow tracking changes in the labor market over time, providing insights into how economic fluctuations, educational reforms, and other factors affect graduate employment. This would help in understanding trends and predicting future challenges.

Expanding the focus to include non-graduates and those in informal economies regardless of educational attainment would provide a more comprehensive view of youth labor market outcomes in general.

Finally, given the increasing importance of the digital economy, future research could investigate effective digital skills training programs and their impact on employability. This would be valuable for educators and policymakers.

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

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The Governance of Urban Productive Safety Net Program in Lideta Sub City, Addis Ababa, Ethiopia

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Abstract

Ethiopia has been implementing and operationalizing the productive safety net program in rural and urban areas since 2005 and 2016, respectively, as an indispensable social protection initiative with the objective of ensuring food security, supporting livelihoods and building resilience. The program stands out as Africa's most significant social protection initiative due to its extensive nationwide coverage and substantial number of beneficiaries. The study was conducted with aim to explore the implementation of the urban productive safety net program and assess its alignment with the pillars of the good food security governance framework for food security established by the Food and Agriculture Organization of the United Nations. A qualitative research approach and case study research design were employed based on their appropriateness for addressing the research objective. Thematic analysis, supported by Maxqda software, was used for the data analysis. The findings of the study analyzed through the good food security governance framework revealed that the practical operation of urban productive safety net program exhibited notable strengths in governance principles including participation, accountability, transparency, equality, and fairness. Some of the key indicators include active beneficiary involvement in decision-making, awareness of rights and duties, and availability of program's information. However, limitations were identified concerning the rule of law, efficiency and effectiveness, and responsiveness. Some of the manifestations include discrimination instances, inadequate startup capital and support after graduation, absence of public work compensation insurance and the average response time to beneficiary requests, highlight areas that require improvement for better governance of the program. Therefore, to enhance the successful operationalization of the program, the government should improve

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targeting processes to ensure equality and fairness by addressing instances of bias that exclude the poor. Moreover, increasing the startup capital in line with inflation indices and providing ongoing follow up and support after graduation will conclusively help graduates establish sustainable livelihoods. Furthermore, implementing health insurance for beneficiaries and ensuring timely responses to their requests will strengthen the program's responsiveness. Furthermore, the overlooked good food security governance principles such as accountability, rule of law, and participation shall be incorporated into the urban productive safety net program implementation manual as recommended by the Food and Agriculture Organization.

Keywords: Productive Safety Net Program, Food Security, Good Food Security Governance, Maxqda, Lideta sub city, Ethiopia

1. Introduction

Social safety nets have been essential in ensuring food security, particularly for people experiencing poverty and hunger(World Bank, 2018). The World Bank's particular intervention in social safety nets program in the 1980s in response to global food insecurity crisis contributed for its advancement worldwide(Wereta& Ahmed, 2024; World Bank, 2011). Because of this remarkable engagement by the World Bank, safety nets have increasingly come to be acknowledged as social welfare programs that support people from low-income families impacted by structural adjustments and economic transitions and such policies had been implemented in countries including the former Soviet Union, Poland, and Ukraine(Subbarao et al., 1997).

According to (Patel, 2018), safety net programs in Africa received more attention and funding in the early 2000s.In Africa, social safety net programs have been gaining importance as governments expand their coverage to enhance food security and resilience for vulnerable communities, despite challenges remain in scaling and ensuring their effectiveness(Beegle et al., 2018).The World Bank's thorough assessment of twenty-two African countries indicated safety net programs in Africa emerged as a direct response to the global economic crisis. This assessment

emphasized how important safety net programs in alleviating poverty across Africa (Patel, 2018).

According to the 2024 UNDP's report, 1.1 billion people are living in severe poverty worldwide. Out of this number, 553 million live in Sub-Saharan Africa, and 402 million are in South Asia(UNDP, 2024). Africa South of the Sahara are the world regions with the highest hunger levels, with Global Hunger Index scores of 27.0, indicating serious hunger and malnutrition(FAO, 2023; Global Hunger Index, 2023).

Ethiopia has also been regarded and recognized as one of the most vulnerable countries to food insecurity and mostly impacted by famine (Global Hunger Index, 2023; Mohamed, 2017). 86 million people are living in poverty in Ethiopia and the country is ranked third in the world with the largest impoverished populations(UNDP, 2024). This poverty situation in the country urged the government to introduce a proactive social protection program to address food insecurity rather than relying solely on emergency food aid(Gebresilassie, 2020).

After constructive discussions between the Ethiopian government and its development partners, the country realized the implementation of the Productive Safety Net Program in 2005 with initial 5.5 million beneficiaries in 262 Woredas and as of June 2024, there have been 8 million reported beneficiaries[3] in 489 chronically food-insecure Woredas(Wereta& Ahmed, 2024). One notable gap in the implementation of the productive safety net program was its exclusive focus on rural areas. However, following the recommendations of the 2014 National Social Protection Policy, the government approved the Urban Food Security and Job Creation Strategy on May 8, 2015, to support over 4.7 million urban poor living in 972 cities and towns. Then, the Urban Productive Safety Net Program was launched in 2016 in 11 selected large cities including Addis Ababa, Adama, Assayita,

[3] JRIS-Newsletter-May-June-2024 pdfas accessed on 20th of February 2025

Asosa, Dessie, Dire Dawa, Gambella, Hawassa, Harari, Jijiga, and Mekele(Gebresilassie, 2020).

In the first phase of the urban productive safety net program, about 604,000 beneficiaries were benefited across 11 cities through a gradual roll-out plan during a five-year period. On October 27, 2020, the Ethiopia government launched the second phase of the urban productive safety net project by expanding the beneficiaries' coverage from 11 to 83 cities. The project is supposed to support 798,500 beneficiaries in the second phase.[4]

Given the large size of Addis Ababa and the relatively high poverty rates it records, about three-quarters of the urban beneficiaries were from this city(Gebresilassie, 2020; World Bank, 2015). Because of which 170,000 program beneficiaries were supported and finally graduated from the initiative which began in 2016. After this successful achievement, Addis Ababa as a city launched the second phase of its Urban Productive Safety-Net Program (UPSNP) on January 3, 2022, targeting 110,000 vulnerable residents below the poverty line who are living in 120 Woredas in the capital. However, Addis Ababa was late to launch the second phase of the program because it started the first phase later than many other cities. Of the 170,000 program beneficiaries in the first phase, 33,181 were from Lideta sub city.[5]

Coming to the governance of the Urban Productive Safety Net Program (UPSNP), it is designed to alleviate urban poverty through a multi-level organizational structure that encompasses federal, regional, city, Woreda, and kebele levels, each with specific responsibilities. At the federal level, the Federal Job Creation & Food Security Agency (FJC & FSA) manages and coordinates the program. This is done by in collaboration with the Ministry of Labor and Social Affairs (MoLSA). The Urban Good Governance & Capacity Building Bureau (UGGCBB) and the Project

[4]Ethiopian News Agency as accessed on the 20th of February 2025. The data are available at: https://www.ena.et/web/eng/w/en_18002

[5]Ethiopian Monitor as accessed on 20th of February 2025, the data are available at: https://ethiopianmonitor.com/2022/01/03/addis-ababa-launches-second-phase-safety-net-program/

Coordination Unit (PCU) support these efforts by focusing on capacity development and financial management(Ministry of Finance and Economic Cooperation, 2016)

At the region level, the Bureau of Urban Job Creation & Food Security oversees implementation, while technical committees handle specific components like public works and livelihoods. At the city level, city councils and the City Urban Safety Net Coordination Committee (SNCC) manage annual plans and coordinate various technical aspects. The Woreda Chief Executive is responsible to supervise the project management and planning processes, while the local councils approve beneficiary lists and oversee grassroots implementation(Ministry of Finance and Economic Cooperation, 2016).

The latest implementation manual of the urban productive safety net program which was issued in 2020 incorporated 13 principles including: goal-oriented, strategy-based, fair and transparent, non-discrimination, timely, predictable, and appropriate transfers, integration with local plans, proximity, gender equity, avoiding dependency syndrome, confidentiality, clients' access to information, best interest of the beneficiary, and respect and dignity(Ministry of Urban and Infrastructure, 2020). On the other hand, good food security governance framework is built on seven key principles which include: efficiency and effectiveness, equality and fairness, *accountability* , responsiveness, transparency, participation, and the rule of law(FAO, 2011b). As clearly evident, the principles of the urban productive safety net program demonstrates a partial alignment with the principles of good food security governance framework through its emphasis on *equality and fairness* (via non-discrimination, gender equity, and fair and transparent processes) and *transparency* (by clients' access to information). The program's focus on goal-oriented and strategy-based actions demonstrates the governance principle of *effectiveness*, while timely and predictable transfers align with *responsiveness* in addressing immediate needs of beneficiaries.

However, there are critical gaps evident in program's adherence to the good food security governance framework. First, *accountability* mechanisms are

absent: there are no provisions for independent audits, grievance redress systems, or public reporting, raising risks of mismanagement. Second, the program neglects *the rule of law,* failing to anchor operations within legal frameworks which weakens enforceability and rights protection. Third, despite the program emphasizes operational *responsiveness* (timely transfers), it lacks adaptive mechanisms to adjust to systemic shocks like inflation. Finally, *participation* is overlooked. These omissions from the program implementation manual of the urban productive safety net program is against the recommendation of Food and Agriculture Programme which undermine its ability to address structural drivers of food insecurity(FAO, 2011c).

The implementation of the productive safety net program in both rural and urban areas has brought good examples of progress. For instance, Ethiopia's 2000 Global Hunger Index score was 53.3 indicating an extremely alarming hunger level. However, the country has now made progress since then and achieved reduction of 26.1 between its 2000 Global Hunger Index scores (53.3) and the 2024 Global Hunger Index scores is (26.2).6 These reductions by 26.1 in hunger are particularly impressive given the challenges facing the world and the stagnation in hunger levels at the global level in recent years, specifically in the year 2023(Global Hunger Index, 2023). Another study indicated that the productive safety net program has played a significant role in building and safeguarding household assets, as well as in providing infrastructure(Workneh, 2008). Other figures also indicated that the Ethiopia's PSNP meaningfully reduced drought impacts by 57% while simultaneously lowering the national poverty rate by 2% (SPEC, 2021; Tareke, 2022).

Despite the Ethiopian Government and donors' consortium led by the World Bank launched PSNP to ensure food consumption and prevent asset depletion among food-insecure households in chronically food insecure

[6] Global Hunger Index Scores by 2024 GHI Rank as reviewed on 10th of February 2024, It is available at: https://www.globalhungerindex.org/ranking.html

areas, its operational implementation has been hampered by considerable number of challenges which include; ineffective geographical, administrative, community targeting, clients dependency syndrome; stakeholder disengagement; poor project manual implementation; gender bias; premature and an unrealistic emphasis on graduation as a measure of success and financial and infrastructure problems(Messay et al., 2022; MoUDH, 2016; Wordofa, 2019). However, this study has not found premature graduation as a challenge for urban productive safety net program operational implementation.

Many of the operational challenges observed during the implementation of the Productive Safety Net Program (PSNP) can be attributed, in part, to the lack of a comprehensive integration of good food security governance principles in both the program's implementation manual and its practical implementation. These principles include: the rule of law, participation, transparency, responsiveness, accountability, equality and fairness, and efficiency and effectiveness. These principles are not fully incorporated into the recent program implementation manual of the urban productive safety net program, as it overlooks aspects of accountability, rule of law, and participation, leading to systemic gaps that hindered the program's overall effectiveness.

Moreover, there is a research gap indicating the good food security governance of the Urban Productive Safety Net Program (UPSNP) in Ethiopia, particularly in Addis Ababa. Despite the program's importance in addressing urban poverty and food insecurity, no adequate studies have systematically examined the governance frameworks underpinning the Urban Productive Safety Net Program (UPSNP) in Ethiopia. This gap in the literature necessitates the need for research to explore how governance mechanisms are incorporated into the program's design and implementation. The objective of this research is, therefore, to examine the governance practice of urban productive safety net program through the lens of the good food security governance framework established by the United Nations Food and Agriculture Organization (UNFAO) by considering Lideta Sub city of Addis Ababa City Administration as a case study.

1.2 Literature review

1.2.1 Theories of governance and social protection

***Collaborative governance theory*.** Collaborative governance is collective decision-making process by the involvement of the concerned stakeholders to address various public issues like food insecurity(Ansell & Gash, 2008; Keping, 2018). The theory focuses on joint efforts among diverse stakeholders to achieve common goals and enhance governance efficiency(Keping, 2018). The collaborative theory to governance offers important lessons for enhancing food security by integrating diverse perspectives from various stakeholders including governments, Civil Society Organizations, Non-Governmental Organizations, and Community Leaders, which in turn, leads to responsive policies tailored to local needs(Ansell & Gash, 2008).

Participatory governance theory. Participatory governance theory emphasizes the inclusion of citizens, communities, and stakeholders in decision-making processes to address societal challenges (Asare-Nuamah et al., 2023). When applied to food security, it focuses on empowering marginalized groups, fostering collaboration between governments and civil society, and creating locally relevant solutions to hunger, malnutrition, and food system inequities(Canton, 2021). Participatory governance directly strengthens food security governance by ensuring that policies and programs addressing hunger, equity, and sustainability are shaped by the communities they impact. By prioritizing inclusivity, it amplifies the voices of marginalized groups such as smallholder farmers, women, and indigenous communities who possess critical knowledge of local food systems but are often excluded from decision-making. Transparency in food policy processes builds trust and reduces corruption, ensuring resources reach those in need. Accountability mechanisms, such as community-led monitoring of food distribution programs, hold institutions responsible for equitable outcomes(World Bank Group, 2020)

Social protection theory. Social protection theory is a framework that emphasizes the role of governments and institutions in providing support to vulnerable populations to reduce poverty, inequality, and food insecurity. In

the context of food security and productive safety net programs, social protection theory provides a lens through which to understand how interventions like cash transfers, public works, and livelihood support can enhance access to food, improve nutritional outcomes, and build resilience among vulnerable households(World Bank, 2018). Social protection theory also asserts that a comprehensive system of social safety nets and related policies are vital for reducing poverty and vulnerability, enhancing food security, and promoting economic resilience(FAO, 2012).

1.2.2 Empirical literature review on urban productive safety nets program

Conducting an empirical literature review is a cornerstone of rigorous and evidence-based research because it systematically synthesizes data-driven studies to ground research in verifiable evidence, thereby ensuring objectivity and validity while identifying gaps, inconsistencies, and trends in existing research(Creswell & Creswell, 2017; Snyder, 2019). Based on this understanding, a rigorous literature review has been conducted to mainly identify the research gaps so as to avoid redundancies and ensure this study addresses new issues rather than duplicating existing studies(Snyder, 2019)

The study, titled "Monitoring and Evaluating Ethiopia's Urban Productive Safety Net Project (UPSNP)," was commissioned by the World Bank in 2017. The research aimed to assess the progress of the Urban Productive Safety Net Project (UPSNP) in Ethiopia. The study concluded that the UPSNP was well-targeted to poor households and it brought a positive impact on household income and food security(Franklin et al., 2017).

The study by Abdulahi et al., (2024) titled "Impact of Urban Productive Safety Net Program on Poverty Reduction and Food Security: Evidence from Major Cities of Eastern Ethiopia (Dire Dawa, Harar, and Jigjiga) explored the factors that affect a household's decision to participate in the program. The study found that UPSNP has a positive impact on poverty reduction and food security. They also found that the likelihood of participating in the program is affected by several factors, including age of household head, number of children, savings, home ownership, employment status, and economic shocks. The authors conclude that the UPSNP is effective in reducing poverty and food insecurity and recommend that the

program be expanded to other urban areas in Ethiopia. They also recommend that the program should focus on creating sustainable income opportunities for its participants(Abdulahi et al., 2024).

Another study by Amosha and Abi (2023) titled "The Effects of Urban Productive Safety Net Program on Household Food Security Status in Gulele Sub-city, Addis Ababa" aimed to investigate the impact of the Urban Productive Safety Net Program (UPSNP) on food security among urban households. The study found that participation in the UPSNP had positive effects on food security levels among households. It revealed that a significant percentage of the sampled households faced various levels of food insecurity, and factors such as the age of the household head, family size, and savings influenced food security. Although the program contributed to improved food access, it did not significantly enhance asset accumulation or overall livelihood improvement. The study recommended that local governments at the sub-city and Woreda levels should focus on activities that would reduce food prices and stabilize household food security. It emphasizes the importance of creating job opportunities and increasing cash transfers to Urban Productive Safety Net program (UPSNP) beneficiaries, which would help poor households generate more income and improve their ability to purchase food items. Furthermore, enhancing the savings culture among participants and adjusting cash transfers based on current living conditions are highlighted as measures to ensure better food security for urban poor households(Amosha& Abi, 2023).

The study titled "Impact of Ethiopia's Urban Productive Safety Net Program on Households' Food Insecurity: The Case of Mekelle City, Tigray, Ethiopia." aimed to evaluate the effect of Ethiopia's Urban Productive Safety Net Program (UPSNP) on the food insecurity of urban households. The study found that the UPSNP has a considerable effect on the income earnings and consumption spending of program beneficiary households. The study recommended that the program should be expanded to other urban cities in Ethiopia.

The article titled "Public works and cash transfers in urban Ethiopia: Evaluating the Urban Productive Safety Net Program" by Abebe et al.,

(2018), assessed the effects of the Urban Productive Safety Net Program (UPSNP) in Addis Ababa, Ethiopia. The study aimed to understand the program's impact on household income and labor supply, changes in non-public-works labor force participation, household welfare, gender roles, community outcomes related to public goods, and perceptions of welfare influenced by the program. Findings indicate that the UPSNP effectively targets urban households to enhance income and reduce vulnerability, enrolling approximately 18% of households, with 30% receiving direct support and 70% participating in public works. According to the study, the program provided significant economic benefits, improving household wellbeing(Abebe et al., 2018).

The study by YH Gebresilassie (2020) which focused on the Urban Productive Safety Net Program (UPSNP) and its effects on food security status in Mekelle, Tigrai, Ethiopia. The study findings indicated that Urban Productive Safety Net Program (UPSNP) has helped improve access to food for many households, but there were still challenges such as lack of resources and skills training programs.

The study, titled "Impact of Urban Productive Safety Net Program on Urban Households' Asset Accumulation and Food Consumption Rate in Dessie City, South Wollo Zone, Amhara Region, Ethiopia," was conducted by Alem-meta Assefa (2024) and published in PLOS ONE. The research found that beneficiary households of the UPSNP exhibited higher home asset accumulation, community asset accumulation, and better consumption and food security status compared to non-beneficiary households. The study concluded that the UPSNP has a positive impact on asset accumulation and consumption rates in Dessie City(Assefa, 2024).

The study by Amsalu Tadesse (2021) examined the implementation efficacy of Addis Ababa's Urban Productive Safety Net Program (UPSNP) and its consequential impact on household food security within the Arada sub-city. His research revealed that while UPSNP has made significant contributions in supporting food access through cash transfers and public works, persistent challenges including resource constraints and inconsistent skills

training impede the Program's overall effectiveness. The study advocated for an expanded, multi-sectoral social protection framework to enhance sustainable food security outcomes and he recommended targeted improvements in beneficiary selection, stakeholder collaboration, and the provision of timely and adequate support to mitigate dependency and foster long-term self-sufficiency among participants(Tadesse, 2021).

1.2.3 Justifications for novelty

Despite extensive empirical research on the Urban Productive Safety Net Program (UPSNP) in Ethiopia, no prior studies have specifically examined the governance frameworks underpinning the program's implementation. Existing literature (e.g., Franklin et al., 2017; Abdulahi et al., 2024; Amosha& Abi, 2023; Abebe et al., 2018; Tadesse, 2021) has predominantly focused on evaluating the UPSNP's socioeconomic impacts (e.g., poverty reduction, food security, asset accumulation) and implementation challenges (e.g., resource constraints, skills gaps, beneficiary targeting). However, critical governance dimensions such as decision-making processes, accountability mechanisms, collaborative coordination, or stakeholder roles in program design and delivery remain unexplored. None of them explored the UPSNP implementation process through the lens of the good food security governance framework established by the Food and Agriculture Organization.

Although existing studies highlight what the UPSNP achieves, they do not address how governance structures enable or hinder these outcomes. For example, Tadesse (2021) notes challenges in beneficiary selection but does not analyze the institutional policies or administrative processes driving these inefficiencies. So, by shifting the focus from outcomes to governance processes, this study tries to address a critical gaps in the literature and offers insights into systemic drivers of success or failure that previous UPSNP evaluations have overlooked. This positions our work as foundation for future policy reforms and academic inquiry. While existing studies have extensively documented the socioeconomic impacts of Ethiopia's Urban Productive Safety Net Program (UPSNP), there is a notable absence of

research examining the governance frameworks that shape its implementation.

1.3 Conceptual and analytical framework for governance for food security

The concept of governance is a very old one; it can be traced back in the works of Aristotle, who referred to good governance to describe a state ruled by an ethical and just governor(FAO, 2011c). In contemporary discourse, good governance is intrinsically linked to democracy, as it can only be realized within a free and democratic political system, whereas autocratic systems, even at their optimal best, may achieve good government but inherently lack the conditions necessary for good governance, which is contingent upon the presence of freedom and democratic principles. As a result of which, good governance becomes an inevitable consequence of democratization (Keping, 2018).

In the context of food security, governance refers to the formal and informal rules, processes, and collaborative mechanisms through which public and private stakeholders express their interests, make decisions, and implement and sustain actions to achieve food and nutrition security at local, national, regional, and global levels(FAO, 2011a). In this study, the operational definition of good governance for the urban productive safety net program entails the integrated application of quality dimensions of the seven good food security governance principles namely efficiency and effectiveness, equality and fairness, accountability, responsiveness, transparency, participation, and the rule of law. So the analytical framework for good governance for food security involves these seven quality dimensions as proposed by the Food and Agriculture Organization(FAO, 2011a). When all of the principles of good governance are followed and their true implementation is ensured, governments and systems are seen to be well governed(Aurangzeb, 2022).

Effective food security governance is anchored in clear, participatory, and responsive planning, decision-making, and implementation across the four pillars of food security namely: availability, access, utilization, and stability(FAO, 2011a). The goal of achieving food security for all is at the heart of FAO's engagement defined as:*all people, at all times, and should*

have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. This vision is grounded in four interconnected pillars of food security: availability (adequate food production, distribution, and trade systems), access (affordability, equitable resource allocation, and poverty reduction), utilization (optimal nutrient absorption through food safety, dietary diversity, and health practices), and stability (resilience against shocks to sustain the other three dimensions over time). Achieving food security requires harmonizing these four pillars simultaneously, which underpins the FAO's twin-track approach which integrates immediate support for vulnerable populations with long-term investments in agricultural production and productivity, governance, and inclusive policies(FAO, 2011b).

In this study, good food security governance principles such as *efficiency and effectiveness, equality and fairness, accountability, responsiveness, transparency, participation, and the rule of law* are critical independent variables in addressing the four pillars of food security namely;*availability, access, utilization, and stability.* The interplay between governance principles and the pillars of food security forms a dynamic, mutually reinforcing system. The food security governance principles operate as independent yet interdependent entities, each strengthening specific pillars of food security while collectively creating a cohesive system that transforms food security from a theoretical goal into a tangible reality, as visualized in the conceptual framework linking governance actions to food security outcomes.

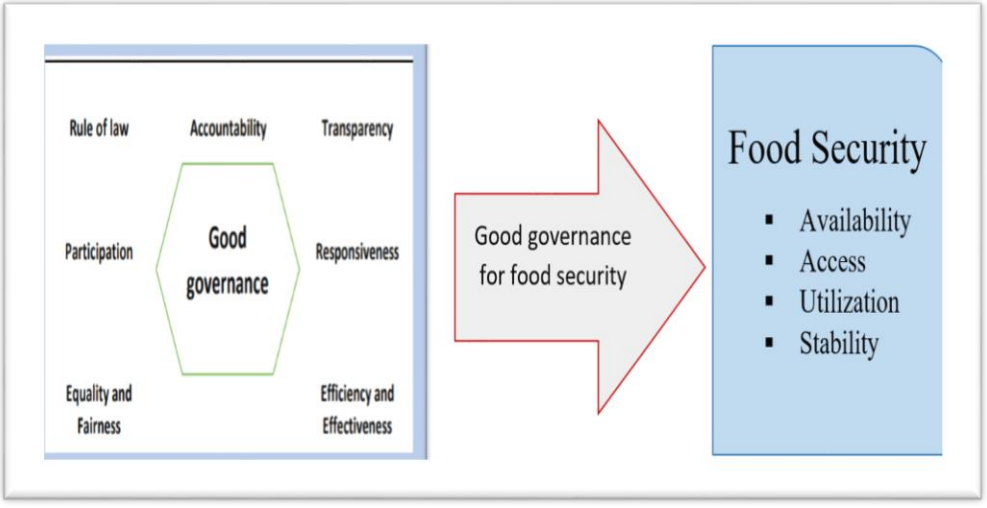

Figure 1: Adapted conceptual framework of governance for food security based on (Ali, 2015; Aurangzeb, 2022)

2. Research methodology

2.1 Description of the study area

The study is conducted in Lideta Sub-city, Addis Ababa, Ethiopia. The nature of the sub-city is cosmopolitan and one of the eleven sub-cities of Addis Ababa and is home to an estimated population of 277,876 (CSA, 2021). Its geographical area is 9.18 square kilometers. The sub city is located at the heart of the capital and situated in a latitude of approximately **9°0'41.76" N** and a longitude of **38°44'3.84" E. It**is bordered on the north by Addis Ketema sub city, on the south by Nifas Silk-Lafto sub city, on the east by Kirkos sub city, and on the west by KolfeKeranio Sub-city. The Sub-city is divided into ten administrative Districts or Woredas in Ethiopian context(Addis Ababa City Administration, 2020). The relevant study data was collected from the shaded Woredas[7] on the study map (Woreda 03, 06, 07, 08, 09 and 10) where the UPSNP was implemented during the time of data collection. At Addis Ababa city administration level, about 170,000 beneficiaries have graduated from the UPSNP after acquiring financial and

[7] In Ethiopian context, Woreda has an equivalent meaning with district. Addis Ababa City Administration has three hierarchical levels: the city administration is at the top, the sub-city in the middle, and the Woreda is at the bottom.

vocational skills. Of these numbers, 33,181 beneficiaries or 9400 household heads were from Lideta sub city[8].

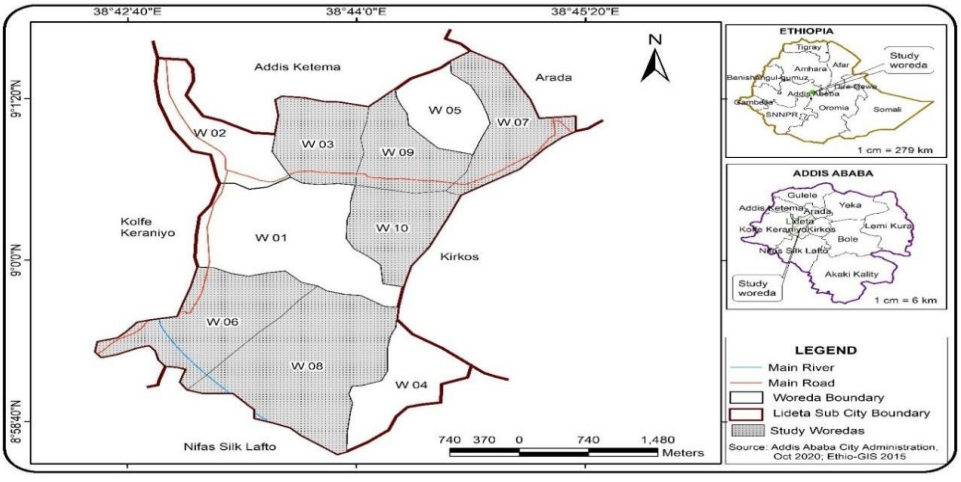

Figure 2: Study map of Lideta sub city

2.2 Research design and approach

This study used a Case study research design (Creswell, 2013). The research approach used in this study was qualitative due to its persuasive applicability for addressing the research objective(Morse, 1991).

2.3 Data sources, methods of collection and tools

The research methodology employed in this study was intended to collect and analyze primary and secondary data sources to enlighten participants' views on the governance for UPSNP in Lideta Sub city. Hence, both primary and secondary data were collected to enrich the study with the intention of triangulating the methods of the research. An interview guide was the most important data collection tool mainly used in this study. To assure the study's authenticity and credibility, a variety of data collection methods were used including desk reviews, focus group discussions, key informant interviews, and field observations. The data collected in these tools were triangulated carefully in order to remove the likelihood of bias

[8]https://ethiopianmonitor.com/2022/01/03/addis-ababa-launches-second-phase-safety-net-program/as accessed on 25th of December 2024

and prejudice regarding the instrument's limitations coming from unregulated sources.

2.3.1 Desk reviews

The document or related literature review comprises a review of journals, edited books, treaties, reports of relevant organizations, national legislations including the FDRE Constitution of the 1995, policy papers, development initiatives, and reports on their implementation. The researchers used this materials in examining and analyzing the current state of governance of food security with a particular emphasis on UPSNP implementation in Lideta Sub-city. As noted by Yeshewas (2019) the globalized environment has made it possible for the researchers to acquire relevant data from all corners of the world.

2.3.2 Focus group discussions

A series of six FGDs were conducted among participants who were randomly selected from six study Woredas mentioned above. To ensure triangulation of the data collection, three different groups of FGDs were purposively organized. The three groups include UPSNP beneficiary, UPSNP graduate and UPSNP waiting list. Here, purposive sampling was used to organize the three groups of FGDs and simple random sampling was used to select FGD participants from each Woreda. It was possible to conduct only one FGD for one group but to get more data for the study, two FGDs were conducted with participants of the same group. So three different groups multiplied by two FGDs for each results a total of six FGDs for the study. As a result, the first two FGDs were conducted among households who were beneficiaries of the UPSNP in the sub city during the time of data collection. These beneficiary participants were randomly selected from each Woreda. So that one Woreda was represented by one beneficiary in the first two FGDs each. At the same time, the subsequent two FGDs were carried out among households that have already graduated from the UPSNP in the sub city. These graduated FGD participants were also randomly selected from each Woreda. The last two FGDs were conducted among households who are not yet beneficiaries of the UPSNP but are on the waiting list and have been classified as experiencing food insecurity by the sub-city. All the six FGDs were conducted face-to-face using a voice recorder and transcribed verbatim afterwards. Data collection

using the FGD method was conducted between May 30, 2023 and June 03, 2023. The figure below shows the three strata of FGDs and the coding system of each FGD discussed in the research.

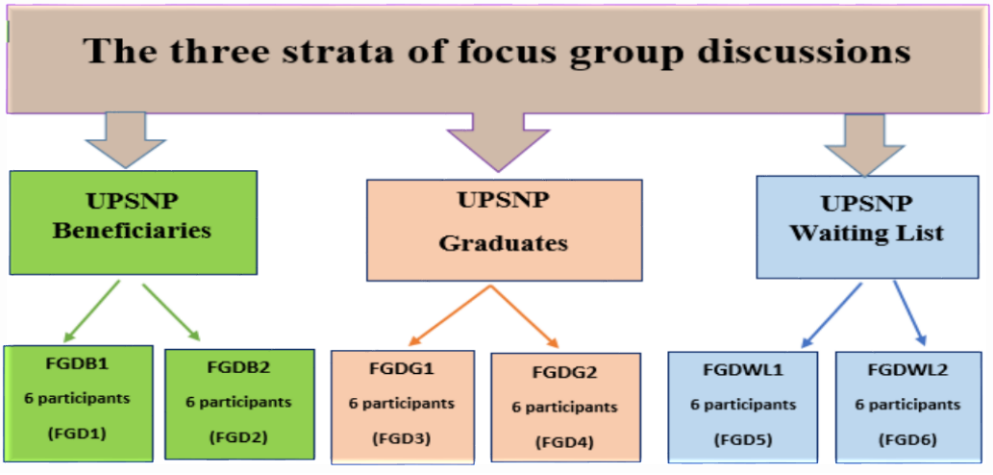

Figure 3: The focus group discussion map of the study

2.3.3 Key informant interview

The research utilized the data triangulation technique, which involved conducting interviews with government authorities and comparing the results. Semi-structured and open-ended interview questions were used to extract as much perspectives as possible about the subject, allowing for the introduction of fresh questions in response to the informant interviewees' replies. The interviews were generally guided by a sequence of approximately ten questions. In this study, interviews were conducted with authorities of the Lideta Sub City Food Security and Job Creation Office (coded as KII-LSFSJC), the Addis Ababa City Administration Food Security Coordination Directorate(coded as KII-AAFSCD), the FDRE Human Rights Commission (coded as KII-EHRC), and the FDRE Ombudsman Institution (coded as KII-Ombudsman). Their consent was secured before the interview and it lasted about 50 minutes on average. Additionally, all interviews were conducted face-to-face using a voice recorder and transcribed verbatim afterwards. The use of a recording device during the interviews enables taking of observational notes. Data collection using the interview method was conducted between August 17, 2023 and December 7, 2023. The duration of data collection via KII was extended due

to the busy schedules of the authorities and professionals involved in the key interview process.

2.3.4 Observation in the field and personal experience

The study was primarily supplemented by data collected through FGDs, and interviews, and document analysis. However, incorporating field observations and firsthand experiential data further enhanced the study's richness, authenticity, and trustworthiness, ensuring a more comprehensive and grounded analysis.

2.4 Sample size determination and sampling techniques

As clearly announced on the objective, the goal of this study to examine the governance practice of urban productive safety net program through the lens of the good food security governance framework established by the United Nations Food and Agriculture Organization (UNFAO) by considering Lideta Sub city of Addis Ababa City Administration as a case study. Therefore, Six Woredas (Woreda 03, 06, 07, 08, 09 and 10) were purposively selected out of ten (10) where the UPSNP was being implemented during the time of primary data collection between May 30, 2024 and June 03, 2023. Lideta sub-city was chosen as the focus of this case study for four compelling reasons. First, Lideta accounts for the highest concentration of the poor with a headcount index of 53 percent(Netsanet, 2009). Second, the poverty gap index, (which shows the amount of resources needed to lift up the poor to the poverty line level), indicates that Lideta sub-city is the most deprived one. Third, LidetaSub-city takes the lead with 80 percent of the sample households experiencing a poverty situation at least once in the period from 1995 to 2008; fourth, the complex and multi-faceted nature of urban poverty like Lideta Sub city demands a deeper understanding for both knowledge generation and practice; however, urban poverty has been a neglected area in both research and poverty reduction policies Maxwell D 1999 cited in(Degefa, 2010).

2.5 Authenticity and trustworthiness of the research

In qualitative research, authenticity and trustworthiness are central to preserving the integrity and ethical-epistemic rigor, as they safeguard the objectivity and credibility of the inquiry Daymon & Holloway 2002 cited in(Yeshewas, 2019). The traditional notions of validity and reliability are

often associated with quantitative paradigms but qualitative research prioritizes **authenticity** i.e. the extent to which findings accurately reflect the lived realities of participants and contexts and **trustworthiness** encompasses credibility, transferability, dependability, and confirmability (Tekeli & Bozkurt, 2022; Yeshewas, 2019). To maintain the study's authenticity and credibility, relevant and appropriate research design and research approach was utilized. Additionally, data triangulation was made using multiple data sources like desk review, FGDs and interview. This helped to minimize bias and substantiated the credibility of research findings. Furthermore, common understanding or rapport was reached about the objective of the study among the data collectors and the study participants which helped to collect authentic and credible data for the study.

2.6 Consideration of ethical issues

To get the desired data from any individual or organization, being ethical and creating rapport is the most important precondition. All the research participants in this study were appropriately informed about the purpose of the research and their willingness and consent was secured before the commencement of the FGDs and interviews. Regarding the right to privacy of the respondents, the study maintained the confidentiality of the identity of each participant. In all cases, names were kept confidential thus collective names or codes were used. Moreover, the proposal and all the data collection tools were reviewed and approved. Moreover, ethical clearance was finally issued by the Institutional Review Board(IRB) of Addis Ababa University on March 20,2023 with reference number 009/03/2023 and Addis Ababa Health Bureau on April 19, 2023 with letter reference number A/A/H/B/12074/227. In this context, significant focus was given to presenting the research findings while maintaining their reliability and adhering to ethical standards as the issues studied are presented in impartial manner.

2.7 Data Analysis techniques

Thematic analysis techniques and MAXQDA2020 qualitative data analysis software have been applied in this research, which facilitated the systematic data analysis. MAXQDA is a popular software registered trademark of VERBI Software Consult Berlin/Germany(MAXQDA, 2020). The process

of data analysis using MAXQDA followed a series of structured steps. Initially, the data was prepared for import into MAXQDA. Subsequently, MAXQDA2020 was installed and launched, and a new project was created by selecting "New Project" from the file menu. The transcribed FGDs and interviews, saved in MS Word format, were then imported into the newly created project. Subsequently, coding and coding system were established in a hierarchical structure. After coding, the patterns, themes, and relationships within our data were analyzed because the software provides various tools for data exploration including word frequency, and code matrix analysis. Moreover, the data was visualized to support interpretation and present findings. Word clouds, charts and other visual representations were created. Finally, the findings were interpreted based on the analysis conducted in MAXQDA.

2.7.1 Thematic Analysis

This study employs thematic analysis (TA). TA is a technique for systematically identifying, organizing, and providing insight into patterns of meaning (themes) in a dataset(Braun & Clarke, 2012). TA allows the researcher to see and make sense of collective or shared meanings and experiences by focusing on meaning across a dataset. The goal of TA is not to identify unique and idiosyncratic meanings and experiences found only within a single data item. This method, then, is a way of identifying and making sense of what is common to the way a topic is discussed or written about. Thematic analysis is a flexible method that allows the researchers to focus on the data in numerous different ways. With TA one can legitimately focus on analysing meaning across the entire dataset, or one can examine a particular aspect of a phenomenon in depth. One can report the obvious or semantic meanings in the data, or can interrogate the latent meanings, the assumptions and ideas that lie behind what is explicitly stated(Castleberry & Nolen, 2018).

In qualitative research, providing detailed explanations for themes and subthemes has considerable number of advantages. These advantages include improved understanding of the issues under investigation, contextualization, and transferability. Moreover, explanations boost transparency and credibility, place research findings in a larger context, make it easier for finding to be transferred, and advance knowledge. In

general, explanations provide qualitative research more depth, consistency, and clarity, which increases its value and usefulness for both researchers and readers (Creswell & Creswell, 2017). As a result of which, the following explanations are provided for the main themes and subthemes used in this research so that it paves the way for clarity and contextualization. The main theme is the good food security governance framework. FAO explains good food security governance as an essential factor for sustained economic growth, sustainable development, poverty and hunger eradication, and for the realization of all human rights including the progressive realization of the right to adequate food (FAO, 2005a). The sub-themes are explained based on the FAO's good governance framework, UPSNP project implementation manual and the Ethiopian food and nutrition security policy (FAO, 2011c; FDRE, 2018; MoUDC et al 2020).

Main theme	Sub themes	Explanations
Good food security governance framework	Rule of Law	The rule of law ensures that the UPSNP adheres to established rules and regulations. This includes ensuring that program implementation is transparent, beneficiaries' rights are safeguarded, and resources are used lawfully. Maintaining the rule of law improves the program's effectiveness, trustworthiness and accountability.
	Participation	To ensure food security through UPSNP, communities must actively participate and take control. The term participation describes the proactive engagement and involvement of all pertinent stakeholders in the UPSNP's execution and implementation. It places emphasis on the need to involve a range of viewpoints, stakeholders, and impacted parties in order to guarantee that the UPSNP is carried out successfully and that the benefits are shared fairly.
	Transparency	In order for the UPSNP to be transparent, details regarding its goals, requirements for eligibility, selection procedures, and distribution of resources must be made available to the public. Transparency is required in the planning, targeting, implementation, and graduation. All UPSNP clients, anytime they make a request, should have access to the data that is kept about them and their families.
	Responsiveness	Responsiveness is the ability of program coordinators and implementing government organs to adjust and react to the changing requirements and challenges faced by the UPSNP clients. This entails responding quickly to new requests shovel, emergency helmet overalls.
	Accountability	Holding governmental organizations, program managers, and other stakeholders accountable for their actions and choices is the essence of accountability in the UPSNP. This entails handling Program resources in an open and transparent manner, making sure the funding is used wisely and effectively, and setting up procedures for handling beneficiary complaints or grievances. Accountability upholds the integrity of the program, fosters good governance practices, and supports in development trust.
	Equality& Fairness	All program beneficiaries shall be treated equally. There should not be habit of treating one person or group of people unfairly or poorly in comparison to others. Gender equity should be introduced to address the specific needs, interests, and capacities of men and women, ensuring that they benefit equally from the program.
	Efficiency & Effectiveness	Efficiency and effectiveness in the governance of the UPSNP involve optimizing the use of available resources and achieving the desired outcomes. A predetermined transfer or payment schedule should also be followed by a timely transfer and this on time payment will only satisfy household needs.

3. Results and discussions

3.1 Demographic data analysis

During the study, interviews were conducted with three distinct groups of FGD participants namely UPSNP beneficiaries, graduates, and waiting list[9]. The data obtained was analyzed qualitatively using thematic analysis and Maxqda software. First, a table was developed to present the demographic data of the FGD participants who were identified as P1, P2, P3,P36. The participants' perspectives in the FGDs were then categorized using an identified coding system based on the analytical framework. The data for the study were evaluated thematically. Visual data analysis techniques like word frequency, and Code matrix analysis were also used to assess all of the data collected from the field, and the most frequently occurring terms were identified and shown in a word cloud.

Out of the total 36 FGD participants involved in the study, 25 or 69% were identified as female. The rest 11 or 31% were male. The participants' ages ranged from 24 to 77. First, the data gathered from FGDs and KIIs were transcribed in a verbatim manner so that every single word from an audio recording was captured in writing exactly as it was pronounced in the original speech. Then, the verbatim transcription was translated into English and the files were loaded as a project into the MAXQDA2020 software. The primary themes, sub-themes, and particular codes were developed for the software. After this process, six major themes, twenty-one sub-themes, and one hundred thirty codes were identified. The primary theme, the Good Food Security Governance framework covers a wide range of topics or sub-themes, including the rule of law, participation, transparency, responsiveness, accountability, equality, and fairness, effectiveness, and

[9] *The first two FGDs were conducted among households who were beneficiaries of the UPSNP in the sub city during the time of data collection. These FGDs are coded as FGDB 1 and 2. So the FGD participants here are coded as FGDB1P1-P6 and FGDB2P1-P6. The subsequent two FGDs were carried out among households that have already graduated from the UPSNP and coded as FGDG 1 and 2. Each participant is coded as FGDG1P1-P6 and FGDG2P1-P6. The last two FGDs were conducted among households who are not yet beneficiaries of the UPSNP but are on the waiting list and have been classified as experiencing food insecurity by the sub-city and coded as FGDWL 1 and 2. Each participant is also coded as FGDWL1P1-P6 and FGDWL2P1-P6*

efficiency. These sub-themes are the established principles of good food security governance framework.

3.2 Word cloud frequency analysis

The themes and sub-themes introduced into the MAXQDA software underwent colorful analyses. The pillars of good food security governance framework were already identified and finally underwent through the software. To conduct a word frequency analysis, every statement spoken by each participant was examined. However, some terms like (is, was, it, and, or, etc.) were found unnecessary and were finally excluded from the dataset. After the words were combined and the stop list was applied, a total of 15,701 words were found on the uploaded documents to the MAXQDA software.

Figure 4: Word cloud for the good governance framework for urban productive safety net program

Some words had far greater frequencies than others did, and these words with the highest frequencies were visually represented in the largest size in the word cloud. In this study, which examined the perceptions of participants on the good food security governance principles, UPSNP beneficiaries, graduates from UPSNP, the waiting list and KII from relevant offices had participated. Out of the data collected from these groups of participants, 75 most frequently repeated words were determined to be visualized in a word cloud. Some of the words like food, right, government,

etc. appeared larger than others. This was related to the frequency of the word in the uploaded documents. In other words, the size of words is directly related to its frequency.

Table 1: Word frequency table of word cloud

Word Cloud: Word frequencies

In 10 documents (15701 words total) 2457 Words (TTR = 0.1565)

Display top ranks

Word	Word length	Frequency	%	Rank	Documents	Documents %
food	4	408	2.60	1	10	100.00
right	5	380	2.42	2	10	100.00
government	10	366	2.33	3	10	100.00
Participant	11	258	1.64	4	6	60.00
safety	6	184	1.17	5	9	90.00
eat	3	144	0.92	6	7	70.00
money	5	106	0.68	7	9	90.00
society	7	103	0.66	8	9	90.00
human	5	86	0.55	9	9	90.00
job	3	86	0.55	9	9	90.00
life	4	83	0.53	11	7	70.00

Source: Maxqda20 word frequency table produced for the study (April 2024)

The word frequency table clearly indicated the most top ten words with the highest frequency which include; food (408 times), right (380 times), government (366 times), participant (258 times), safety (184 times), eat (144 times), money (106 times), society (103 times), human and job (86 times) and finally life (83 times) as depicted on the Table 1. Since the study focused on the governance for food security, words like food and food rights, as well as the government's involvement in securing these rights has been repeated more frequently than others by the study participants. The word cloud was applied to ascertain the frequency of high-frequency word repetitions. Table 1 illustrates the word frequency of terms that are repeated in the 15,701 total words uttered by the study participants, alongside the respective ranks in the frequency analysis table. The implications of the top three frequently repeated words are discussed as follows:

3.2.1 Food (mentioned 408 times):

As witnessed from Table 1, the term food has repeatedly been spoken than any other word in the dataset signifying the fundamental focus of the study on food security aspects. It is understood that obtaining food is mandatory

as one cannot survive without it. An UPSNP beneficiary in the first FGD noted the following perspective which supported the aforementioned reality;

> *Food is essential for survival. It is a fundamental necessity without which no individual can survive. From my point of view, I have been working in the urban productive safety net program just to get money from the public work engagements and support my children and myself cognizant of our inability to survive in its absence (FGDB1P1).*

Throughout the discussion on the issue under the study, UPSNP beneficiaries in the FGDs manifest diverse perspectives. Some of them underlined that securing food is the ultimate responsibility of the individual and hard work is the only means to achieve individual and household food security. They underscored that food is something obtained through personal endeavors and efforts. Another participant from FGDB1 emphasized that food is acquired through individual endeavors and hard work.

> *In my personal opinion, it is my responsibility to ensure my own food security. I am now working hard diligently within the urban productive safety net program plus other income generating activities and ensuring it through my own efforts but some individuals may ensure their food needs through donation from various aid agencies (FGDB1P6).*

During the KII, authorities from Lideta sub city underlined that first and for most, citizens should work hard and bring change on their food security. However, some of the FGD participants from the UPSNP beneficiaries believed that the government is responsible to secure food security as per the orientation of human rights based approaches. They emphasised that UPSNP is an essential tool to support food security endeavors of the government in general and the urban poor in particular. Participant 1 from among beneficiaries in the first FGD said the following:

> *The Ethiopian government is basically responsible for meeting the food needs of its citizens; however, due to considerable number financial constraints, it cannot afford food to everyone. The citizens who have the ability to engage in any lawful and productive economic activities shall be supported by the government to start business and then secure their food needs. The young citizens shall get job opportunities and work hard. It would be useful to conduct research on the topic of sustainable support to be provided for the young citizens, which will help them to start business.*

Overall, the aforementioned discussions emphasized the importance of food as a basic necessity for human survival, as well as the complex connections among individual endeavors, government support, and the right to food.

3.2.2. Right (Mentioned 380 times):

The frequency of the word right in the dataset suggests that an important focus was given to the right to food, or entitlements within the governance to food security context. It also demonstrates that most of the discussions is all about the right to food and entitlements including its access, distribution, or affordability. The UPSNP beneficiaries who participated in the FGDs uttered wonderful ideas about the right to food. An old woman during the FGDs said the following idea:

> *In my opinion, the right to food is the right to work and manage families. For me, the right to food is the right to work not the right to be fed. Some people may get food stuffs in terms of donation from different philanthropic organizations, but I am working in the urban productive safety net program and then receiving my salary and manage my family using the transferred payment in return to public work activities (FGDB1P3).*

In this regard, Article 25 Sub Art 1 of the UDHR underscores that everyone has the right to a standard of living, including food (UN General Assembly, 1948). The International Covenant on Economic, Social and Cultural Rights (ICESCR) under Article 11 Sub Art 1 underlined that the States Parties to the covenant recognize the right of everyone to an adequate standard of living for himself and the family, including adequate food. The same covenant says that the State Parties will take appropriate steps to ensure the realization of the right to adequate food (UN General Assembly Resolution, 1966). Since 1948, the issue of food security has become the agenda of the global community and the 1996 World Food Summit defined food security as:

> *Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life(FAO, 1996).*

From the aforementioned international covenants, it is possible to easily understand that everyone should have access to an adequate and nutritious

food for an active and healthy life and to this success a concerted effort is required at all levels; local, national and global.

3.2.3. Government (mentioned 366 times):

It is evident that the role of the government in ensuring food security is irreplaceable. This suggests a focus on governmental institutions, food security policies, and activities concerning the urban productive safety net program. It underlines the role of the government in addressing food security and supporting those in need of its emergency support during the time of food insecurity crisis. It also points out the endeavors and concerns about the level of adequacy of government measures and interventions to ensure food security. However, participants noted that there were delayed responses to food insecurity situations. A woman from the first FGD noted the following:

> *The Ethiopian government provides emergency support to citizens after foreigners arrive and start supporting the affected citizens by the crisis. This leaves me wondering how an individual or organization from outside intervene and starts providing emergency food assistance to the needy prior to the arrival of my government. In my view, the Ethiopian government seems to respond to crises only after receiving attention from foreigners (FGDB1P2).*

Basically, the government has three legal obligations in connection with the right to food, which include the duty to respect, protect, and fulfil. This means that the government must respect people's current access to food, protect against interference by outside parties, and proactively facilitate people in exercising the right to food in time of natural and manmade disasters(Gizachew et al., 2023). However, the participants of the study have vividly expressed their view about the failure of the government to carry out its duty of fulfilling the right to food. They noted that governments are expected to provide direct support to needy people when they face uncontrollable circumstances that impede their ability to access food by themselves. In this context, a beneficiary of UPSNP from FGD2 has expressed her discontent as follows:

> *When you provide advance notice to the government authorities prior to the occurrence of accident, no one will respond to you and there is lack of quick response even after the emergence of the disaster. I am telling you the truth that the nearby neighbors are much better to cooperate with*

> *you, provide you food and clothing, and support you in times of loss of property due to fire or any similar accident.In my opinion, it is the duty of the government to take care of me. However, when I faced a difficulty, the neighbors are the most easily available source of support (FGDB2P5).*

According to FAO's food right guidelines, State Parties are required to promote good governance as an essential factor for sustained economic growth, sustainable development, poverty and hunger eradication and for the realization of all human rights including the progressive realization of the right to adequate food(FAO, 2005). Moreover, Article 2 Sub Art 1 of the ICESCR stated that each State Party should undertake steps, individually and through international assistance and co-operation to the maximum of its available resources, with a view to achieving the progressive realization of the rights recognized in the Covenant by all appropriate means, including particularly the adoption of legislative measures(UN General Assembly Resolution, 1966). As per the spirit of the aforementioned covenants, government bears the primary responsibility to ensure food security for its citizens at all times by all possible and legitimate means within the limits of the country's resources.

3.3 Analysis of the qualitative data using the good food security governance framework

As noted earlier, the good food security governance refers to the formal and informal rules and processes through which public and private actors articulate their interests and make, implement and sustain decisions aimed at achieving food and nutrition security (FAO, 2011a). FAO proposed seven principles in the working analytical framework for governance for food security. These principles include the rule of law, participation, transparency, responsiveness, accountability, equality and fairness, and effectiveness and efficiency. It also recommends that these seven dimensions for the governance framework for food security are all possibly relevant, although in differing dosage and combinations. It was suggested to replace efficiency and effectiveness with professionalism, quality and evidence-based decision; to replace the principle of equality and fairness with gender equity, and to add empowerment as deemed necessary (FAO, 2011a). As indicated at the methodology of the study, the FAO's governance framework for food security was used as an analytical framework to assess the Ethiopian food security endeavors through the

UPSNP. All the seven elements of the analytical framework for governance for food security are discussed as follows in comparison with the issues discussed during the sessions with study participants.

3.3.1 Rule of law

UPSNP beneficiaries who participated in focus group discussion reflected diverse opinions regarding the presence of rule of law in the practical implementation of the UPSNP. One of the participants expressed that there was a problem with the practice of the rule of law, which was manifested in the inclusion of the rich and the exclusion of the poor during the targeting process. Another participant from FGDB1 indicated that the presence or absence of discrimination in the targeting process differs from committee to committee. Some committees are doing their jobs in a good and lawful manner whereas others are biased (FGDB1P6). Moreover, a KII participant from the FDRE Ombudsman institution noted that efforts are made to include the relevant committee members from the community and names of the targeted or selected UPSNP beneficiaries are usually posted publically. However, the authorities confirmed that people who should not be beneficiaries of the UPSNP were found selected to be beneficiaries (KII-Ombudsman). During the KII with authorities of the Ethiopian Human Rights Commission, they underlined that:

> *Discrimination is not acceptable by any means and the government must fulfill minimum obligations accordingly and it shall take the necessary steps like formulating relevant laws and policies to curve the problem of targeting (KII-EHRC).*

In this regard Messay*et al*., (2019) agreed that high non-poor households were included in the process of targeting. Additional study result also concurred that the PSNP's implementation process has been facing various challenges including bias in area selection, the exclusion of the poor in favour of the rich (Fekadu & Ignatius, 2009; Gizachew et al., 2023). Another research indicated that about 71% of non-beneficiary households who have experienced food shortage were excluded from the PSNP(Assefa, 2008). Furthermore, another study indicated that there was inclusion and exclusion of households for socio-political reasons(Rahmato et al., 2013). Additional study on the issue indicated that exclusion was emerged as the first cause for appeals and complaints across all the regions and

respondents strongly stressed that they felt they were excluded, despite having met the targeting criteria of the PSNP (Hoddinott et al., 2011). One can easily understand that the findings of this study align with the previous studies in that there were problems in the targeting process manifested by inclusion of the rich and exclusion of the poor.

3.3.2 Participation

The Lideta Sub city food Security and Job Creation authority during the KII denoted that the community is mandated with 100% freedom to participate in the targeting process. No government authority intervenes in the targeting process and the targeting committee is diversified consisting of women, physically impaired and aged people in the community (KII-LSFSJC). A participant from the FGDB1 has substantiated the idea of the sub city authority by saying following:

> *Yes, certainly! There is participation in our case. Throughout our engagement in the urban productive safety net program, we actively participated and contributed ideas to the issues raided in different times. We voluntarily provided updates to the program coordinators about workloads and tasks that required more attention. We participate in substantive discussions with the program coordinators beyond the mere submission of work done data/report. When we go to work, the Woreda representatives usually accompany which provides a forum for productive discussions. We both share valuable knowledge to each other throughout these discussions, creating a learning atmosphere that benefits both (FGDB1P1).*

With regard to participation, almost all the beneficiaries and graduates of UPSNP who participated in the four FGDs unanimously agreed that there is active participation and consultation with program coordinators. The UPSNP beneficiaries noted that there are meaningful discussions and strong culture of participation with the supervisors. They denoted that they received answers to their requests within reasonableperiod of time. Some others said their participation is highly appreciated and valued. A beneficiary from FGD2 expressed it as follows:

> *I personally attended various meetings at different levels by raising not only my own issues but also those of my colleagues and in fact, the issues we raised during meetings were beneficial for the later round of discussions, so our participation was remarkable. For example, we raised questions about the delayed distribution of shoes, gloves, and overalls, and the issue was immediately addressed (FGDB2P5).*

According to the findings of DessalegnRahmato, the acquisition of both new assets and skills by the study participants stemming from their participation in the PSNP but there was poor level of involvement of beneficiaries in the PSNP in making decisions about the specific type of public work activities(Rahmato et al., 2013). Another research study revealed that there were variations in the implementation of the PSNP, especially in terms participation(Dejene, 2019). There appears to be considerable variation in the extent of community involvement in the selection of public works programs(Cochrane & Tamiru, 2016).

3.3.3 Transparency

During the KII, the authority from Addis Ababa City Administration Food Security Coordination Directorate indicated that there were problems of reaching the intended population by the time when the UPSNP was launched in 2017. At the beginning, there was a predetermined plan to address 70% of the urban community regarding the commencement of the program. However, the food security office later recognized that a considerable number of the urban community in the city remained uninformed about the announcement of the UPSNP, although the program's commencement announcement was being aired on Television. As a result, the office began using other alternative means of communication like using the nearby Woreda administrations in all sub cities to disseminate the information.

On the other hand, the authority from the Lideta Sub City Food Security and Job Creation office emphasized presence of transparency in the implementation of the UPSNP because the selection and targeting committees responsible for identifying the UPSNP beneficiaries were established by the community itself. Moreover, the selected beneficiaries by the targeting committees were posted on the notice board at each village and reviewed by the community. The authority further substantiated his idea by highlighting the presence of financial transparency within the implementation of the UPSNP. As explained, the payment process has been designed to minimize direct physical cash contact. What was being done was that the program finance officers check the attendance and uploaded it in the Urban Payroll Attendance System (UPAS) then, the money was transferred to each beneficiary bank account on the 25th day of each month.

Finally, the beneficiaries go to the bank and withdraw 80% of it after leaving 20% voluntary savings. The rest of the FGD participants asserted the presence of transparency from the targeting to the graduation process of the UPSNP.

In this regard, a study by Messay*et al*., (2022) concurred that financial transparency and accountability activities are carried out for the program budget, and reports are delivered on time and with an acceptable standard. However, another study indicated that there were delays in payment as witnessed by both implementers and beneficiaries which adversely affected the implementation of public works and the benefits of program participation(Rahmato et al., 2013). One of the core principles of the safety net is fair and transparent client selection. In all of the communities, current clients and graduates voiced concern regarding the lack of transparency and clarity about client selection and graduation (Cochrane & Tamiru, 2016)

3.3.4 Responsiveness

Responsiveness is one of the fundamental manifestations of the presence of good governance in the practice of government activities. This entails responding to requests, complaints, and criticisms on time (Grossman & Slough, 2022). The participants in FGDB1 have a variety of opinions about how responsive the program coordinators were in the implementation of the UPSNP. For example, Participant 1 from the FGDB1 stated that that they were given shoes and gloves, with a plus an additional pair, when they joined the UPSNP. However, Participant 2 indicated that their request for shoes did not have immediate response and there were not enough gloves and they were wondering why they have not given the necessary public work requirements; Participant 3 stated that their request had been delayed at the sub city level as their supervisor had already reported the issue to the sub city office. According to participant 4, they did not receive timely delivery despite the shoes have arrived at their center. Additionally, Participant 5 stated that they had made a request for gloves and shoes that have not yet been fulfilled. Lastly, Participant 6 recalled that they were told to get the necessary equipment but they have not received them yet (FGDB1P1-P6). It is evident from the discussion that the majority of the participants in the discussion tending towards the government's lack of responsiveness to their demands.

Like in FGD1, the participants in FGD2 provided a variety of perspectives on the government's responsiveness to UPSNP implementations. Some of the participants stated that the government responds to demands immediately and that they have received timely support, especially when it comes to addressing shortages of resources like gloves and facemasks. While some other participants stated that they were satisfied with the government's responsiveness. However, a few of them emphasized the need for additional support, like the provision of shoes. The FGD3 participants reported that, both during and after their participation in the program, they have been requesting the government to solve them various challenges they have been facing. For example, Participant 1 in FGD3 stated that when requests were made, they were promptly addressed. However, after graduation, there was frustration with the unresponsive nature of the government as Participant 2 expressed it. According to Participant 3, the COVID-19 pandemic has created a challenge to start a business. Consequently, they were forced to consume their capital, which was planned to start business after graduation. There was a hot discussion whether the program had made significant changes in the lives of the program graduates and beneficiaries or not. Some participants thought that the program brought significant changes, while others said it was nearly hard to make such a claim. For example, Participant 4 claimed that the majority of the people have undergone positive changes but many of the UPSNP graduates who participated in the discussion were found jobless and they wanted to rejoin the program despite there is no platform to entertain their aspiration due to inadequate resource (KII -LSFSJC).

During the FGDB2 session, participants discussed the benefits of the trainings provided to them by the program and the impact it brought on their lives. For example, participant 1 highlighted the value of the trainings provided freely (because the training cost is covered by the program), which empowered individuals who could not afford to pay for such trainings. The participants agreed that the safety net program had contributed to building their capacity and increasing their economic capacity, particularly through access to food. Participant 3 mentioned that they had benefited from the UPSNP, and Participant 4 expressed gratitude for the program's support in meeting their financial needs. Participant 5 also shared that she has

benefited from the training program in terms of building life skills. Participant 6 emphasized the benefit of the training on time management and punctuality as she becomes self-disciplined after graduation.

During the FGD5 and FGD6 discussion sessions, one of the participant from the waiting list of individuals who will be joining the UPSNP indicated the inclusion and significance of extra provisions like workplace health insurance to guarantee access to medical services. She expressed as follows:

> *What should be addressed and included as an additional scheme in the UPSNP is the health insurance for public workers in the event of the workplace accidents. When the program beneficiaries face an accident while sweeping the cobblestone in the field or digging the ground for urban greenery activities, they will fall sick, and without health insurance, they may lack adequate money to cover the treatment facility expenses at the health centers (FGDWL1P3).*

Previous studies concurred that the responsiveness of appeals mechanisms at the Woreda and kebele level is generally slower than it should be((Sharp et al., 2006)

3.3.5 Accountability

Accountability is one of the foundations of the concept of good governance; without which, no government in the world could aspire to be a good government (Fallon Jr, 1997). One of the programs of the government which requires the principles of accountability is the UPSNP. As a result of which, FGDs were held among the study participants with the need to get their reflections about accountability in the actual implementations of the UPSNP in theLideta Sub city. In general, the UPSNP beneficiary participants who took part in the FGD1 unanimously agreed that accountability is important for the success of the program in general and for their individual life in particular. They discussed about the practice of accountability in the implementation of the program in the Lideta Sub city and stated that they believed in the presence of accountability in the UPSNP operational implementations and expressed their commitment in reporting any misconduct activities even committed by their supervisors. One of the participant in the discussion said:

> *We have the responsibility to get our rights respected and obligations carried out, so if there are problems of misconduct in the operational implementation of the UPSNP, we will go to the concerned office and request them to fix the problem. Even in the situations that our superiors*

> *commit any act of misconduct, we are aware that a higher authority will hold them accountable upon our report (FGDB1P6).*

FGD2 participants' discussed the significance of accountability, both at individual and within the hierarchical structure of the UPSNP, andrecognisedthe support they receive from their superiors. The participants in the discussion stated several aspects of accountability within the UPSNP. They stated that 90 days' absence from public work would be followed by cancellation of the beneficiary from UPSNP. They noted that such harsh measure also applies to their superiors as they would be held accountable for their actions if they did something wrong.

Participants in the FGD3 stated that there was accountability in the operation of the UPSNP, and any arbitrary absence would result in warnings and salary deductions for the days missed. The participants indicated strong confidence in the accountability system, and they were prepared to hold their superiors accountable for any wrong actions or decisions. They also discussed the necessity of accountability and transparency, as well as the role of superiors in sustaining an accountability-driven work environment in the UPSNP's actual operations. In FGD4, participants extensively discussed on the essence of accountability that prevailed in the UPSNP operation at their time and how everyone was accountable for any misconduct, regardless of the position they assumed in the program's structural hierarchy. Furthermore, participants in FGD5 and 6, those on the waiting list, expressed their desire to hold everyone accountable for unacceptable behavior. Additionally, they stated that they are mindful of the consequences of being cancelled from the UPSNP due to workplace misconduct.

Previous studies in this regard showed varied results in that the degree of accountability in PSNP targeting varies throughout Woredas; in certain Woredas and kebeles, the targeting processes have gained substantial support from the community and are largely transparent. Conversely, targeting processes have been more disputable ambiguity, and top-down in some Woredas and Kebeles but in the second year of the program, there has been a noticeable improvement in the targeting process, accountability and transparency in nearly all instances(Sharp et al., 2006).

3.3.6 Equality and fairness

UPSNP beneficiary participants in FGDs 1 and 2 discussed on the significance of empowerment and what it means for supporting women in overcoming their limitations and realizing their potential. They spoke about the value of receiving life skill trainings through the UPSNP and how it gave them the tools they needed to make positive changes in their own lives. They also raised concerns about practical challenges, like limited resources to startup businesses. The UPSNP graduates emphasized that there was no act of discrimination during their time of engagement in the program. They underlined that the trainings had a significant impact on their lives. They recognized and appreciated the role of the UPSNP in enhancing economic empowerment and capacity building for the graduates.

The FGD participants from the waiting list discussed about the objective of the UPSNP, which is to enable low-income people to better their lives and make them food secure. However, there were differing views on the presence of justice and equality. While some participants thought that variations in leadership caliber might prevent equality from being completely realized, others thought that the program is just fair. Given the PSNP resource limitations during the first years of the PSNP, almost all regions exercised a partial family targeting approach(Hoddinott et al., 2011)

3.3.7 Effectiveness and efficiency

The program beneficiaries namely the participants of FGDs 1 and 2 emphasized the importance of the efficiency and effectiveness to the practical operation of the UPSNP. They were grateful to the introduction of the program and its administrators and funders. However, many of them were concerned about the inadequacy of the startup capital and working premises after graduation. One the other hand, the graduates of the program were resentful of their fate as Covid19 was declared as a global pandemic immediately after the release of the startup capital following their graduation. Consequently, many of the graduates were not able start business instead they were forced to consume the released working capital due to the closure of business activities due to *stay at home campaign* to protect Covid19 and some of them bought fixed asset like television and furniture by expending the startup capital. The demographic data also indicated that the absence of efficiency and effectives of the program with

the referenceof the graduates of the UPSNP in Lideta sub city as many of them were jobless at the time of data collection.

During the discussion, many of them noted that they wanted to re-join the UPSNP despite there is limited resource to entertain their request and there are people on the waiting list to join the program for their first time. In this regard, the program has failed to avoid dependency syndrome. As per the previous studies, the cause of appeals that were repeatedly mentioned is related to the delay of transfer and payments. Despite some improvements in this regard, respondents expressed their frustration with the delay of transfer of payments(Hoddinott et al., 2011). This is a contrasting result discussed so far in this study findings.

4. Interpretation of results

In the key informant interview conducted with the sub city authority confirmed that the beginning of the UPSNP has brought considerable number of achievements which include work culture improvement, increased females' participation, and the creation of strong social interaction among the community, clean and green environment and improved income generation of the graduates (KII-LSFSJC). Messay*et al*. (2022) also identified a number of achievements of the program it has brought to the program beneficiaries including consumption smoothening; reduced risk of famine-induced deaths and forced migration; environmental conservation; infrastructure development and asset protection. Other studies identified that the Ethiopian PSNP meaningfully reduced drought impacts by 57% while simultaneously lowering the national poverty rate by 2% (SPEC, 2021; Tareke, 2022). Prior studies identified a considerable number of challenges for the governance for food security in Ethiopia in general and in Addis Ababa in particular (Messay*et al.,* 2022). This study also identified a number of challenges facing the governance for urban productive safety net program in Lideta Sub city of Addis Ababa City Administration.

One of the challenges facing the UPSNP graduates is the absence of working premises. Prior to 2023, the urban poor in general used tent shelters and mini-shops commonly known as Ye-ArkebeSukoch[10] as a working

[10] Ye-Arkebe Sukoch or Arekebe Shops refer to the shops built in the city during the reign of Arkabe Oqubay as a Mayor of Addis Ababa City Administration from 24 January 2003 – 9 May 2006

premise. However, in 2023, the city administration removed all the tent shelters from all areas of the city for the reason of beautifying Addis Ababa City as it is the home for African Union, Economic Commission for Africa and many embassies and diplomats of the international community(FAO, 2023) These demolished tents have been used as a working premise for many graduates of the UPSNP in particular and the urban poor in the city in general. As far as food right is concerned, the researchers acknowledged the importance of exploring an alternative working premise before dismantling of the tent shelters. During the KII with the city and sub city authorities, the issue was discussed and they replied that permanent shed or working premise would be built in different areas of the capital city like the one in Akaki and Kolfe sub-cities.

The other challenge, which affected the governance for urban food security, is the presence of conflict in the country. The closure of main roads leading to Addis Ababa and the hostage of truck drivers many times limited the mobility of primary food items. This, in turn, raised the price of consumer goods that make it unaffordable by the urban poor in general and the study subjects in particular. The absence of follow-up after graduation is also the other challenge. In an interview with the Ethiopian Ombudsman Authorities, they said that they conducted assessment on the UPSNP and proved by their own assessment of the inadequate support after graduation and the inconsistent training as the challenges for the governance for food security. In this regard, the Authority of the Addis Ababa City Administration Food Security Coordination Directorate said that there is improvement in training delivery as the World Bank has already signed agreement with an international organization to change the training frequency from once in a month to twice in a i.e. in every 15 days.

Maladministration is the other great challenge for the UPSNP operation. There has been bias in targeting the beneficiaries manifested in terms of inclusion of the rich and exclusion of the poor. There were also problems with the targeting committees as they commit bias to exclusively benefit their families. The community members were also the other sources of the problems as they hide their household utensils and furniture to be assumed extremely poor and then to be targeted or selected to the program. Dependency syndrome is also another visible challenge as confirmed by the

sub city food security and job creation authority and the program graduates themselves. During the interview, the sub city authority said:

> *Due to the high range poverty in the city, the dependency syndrome is very high, as a result, many UPSNP graduates wanted to re-join the program but due to limited resource such request was not entertained by the sub city (KII-LSFSJCO).*

The idea that since the payments are so low, the government is effectively fostering dependency since no one is actually able to 'graduate' and overcome food insecurity based on their participation in the program(Zerai et al., 2019).

Another challenge, which threatened the UPSNP, is working capital inadequacy and budget diversion of the training. In an interview with the authority of the Ethiopian Ombudsman institute, they noted that the budget of the training of the UPSNP was usually diverted to other activities of political in nature. In addition to this, the program graduates use the startup capital to buy fixed assets than using the fund for the desired objective. In this respect, the city and sub city food security authorities stated that the primary challenge they faced in the governance of the UPSNP is the inadequate amount of grant provided to the graduates from the program which is six hundred dollar (USD600). Considering the current cost of living, this startup capital is equivalent to birr 34,127.70 (calculated based on the exchange rate as at April 24, 2024, which is 56.8795 birr per USD) is truly insufficient and challenging to start business using it (KII- LSFSJCO & KII-AAFSCD).

Covid-19 also posed another challenge on the effectiveness of the UPSNP. The Ministry of Health announced that the first victim of Corona virus was reported in Ethiopia on 13 March 2020(MoH, 2020). In fact, constructive measures which were taken by the city administration to reverse the challenge of Covid 19 has saved the lives of many program beneficiaries. However, many of the graduates of the UPSNP were forced to stay home and consuming the working capital granted to them to start business. Due to this reason, many of them became jobless and their tendency to re-join the UPSNP is increasing from time to time. In addition to this, Covid-19 forced the city administration to extend the 2020 UPSNP beneficiaries graduation by 3 months.

5. Conclusions

By recognizing food security as essential to human existence and a fundamental human right, the study underscores that the government and individuals alike have a responsibility to combat systemic food insecurity. Despite the study participants unanimously agreed food as a basic necessity, their perspectives diverged regarding its provision. Because some of them emphasized that individual effort is the means to achieve it while others stressed it is the obligation of the state under international human rights law like UDHR and ICESCR. The role of the Ethiopian government in facilitating food security through the UPSNP remains critical despite there are still operational challenges, including biased targeting, delayed responses to crisis, and weak post-graduation support and follow-up.

The research findings disclosed tensions between empowerment and dependency which are exacerbated by structural barriers such as the impacts of Covid-19, budget diversion and insufficient startup capital. Some beneficiaries reported benefits in skills and income through UPSNP initiatives, yet others emphasized how inadequate capital and demolished workspaces perpetuate reliance on aid. These contradictions underscore the need for governance reforms to strengthen transparency, accountability, and responsiveness.

External shocks like COVID-19 and ongoing conflict further expose vulnerabilities in the UPSNP underscoring the need for adaptive social protection schemes. Integrating emergency funds, health insurance for public workers, and real-time adjustments to transfers linked to inflation or pandemic-related lockdowns would enhance resilience. In order to bridge the gap between systemic support and individual autonomy, sustainable livelihoods must replace dependency. Food security would be reinforced as the result of both individual effort and systemic justice in equitable transfers and secure working conditions were implemented concurrently. Boosting startup funds in conjunction with post-graduation consistent followup and technical support can help beneficiaries overcome financial obstacles.

Eventually, institutionalizing all principles of good food security governance is critical to transforming the UPSNP. Revising its implementation manual to embed FAO-endorsed frameworks including efficiency and effectiveness, equality and fairness, accountability,

responsiveness, transparency, participation, and the rule of law would facilitate the program's successfulness. The current program implementation manual of the UPSNP overlooked to incorporate accountability, rule of law and transparency which are critical to its full-fledged success.

6. Recommendations

To address systemic challenges and transform the Urban Productive Safety Net Program into a sustainable initiative, the overlooked good food security governance principles, endorsed by the Food and Agriculture Organization, such as accountability, rule of law, and participation shall be incorporated into the urban productive safety net program implementation manual as. This can be achieved by establishing independent audits and public expenditure tracking systems to curb corruption and empowering communities through oversight committees and participatory feedback mechanisms. Strengthening institutional alignment with national legal frameworks will further safeguard beneficiaries' entitlements and reinforce the rule of law, fostering trust in the program's fairness and effectiveness.

Building resilience requires integrating adaptive social protection systems that anticipate and respond to shocks such as inflation, pandemics like Covid-19, or conflict. Incorporating emergency funds, health insurance for public workers, and dynamic payments including startup capital adjustments tied to real-time inflation indices can ensure continuity of support during disruptions. Such measures not only protect vulnerable populations but also enhance the program's capacity to adapt to evolving risks without compromising long-term goals.

Transforming beneficiaries from dependency to sustainable livelihoods demands a focus on empowerment activities. This requires not only increasing startup grants to match current living costs but also pairing financial assistance with vocational training, mentorship, and post-graduation monitoring and followup.

Finally recognizing the right to food as inseparable from the right to decent work is critical for guaranteeing food security. Program reforms and revisions should consider the current socioeconomic dynamics, safe labor conditions, equitable access to UPSNP and ensuring beneficiaries' dignity. Embedding these issues into the program's revision process reinforces its

role in advancing both immediate food access to beneficiaries and broader social justice.

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Conflict of interest

The authors declare no conflict of interest that could have appeared to influence the work reported in this study.

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Spatiotemporal Rainfall Variability in the Borena Zone, Southern Ethiopia, and Its Linkage to Large-Scale Climate Oscillations: Implications for Food Security Among Pastoral Households

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Abstract

This study focuses on daily extreme climate indices and their underlying causes, rather than traditional average climate investigations. The primary aim is to effectively strategize adaptation measures for climate extremes and ensure food security. The research was conducted in the Borena Zone, an area that has experienced recurrent extreme weather events, particularly droughts, over the past few decades. Utilizing daily rainfall and temperature data sourced from the National Meteorological Agency (NMA) spanning from 1981 to 2020, the study examines the variability of climate extreme indices within the Borena Zone.In addition to mean maximum and mean minimum temperatures, six extreme temperature indices and five extreme rainfall indices were employed for a comprehensive analysis. The results from temporal analysis indicate that maximum daily maximum temperature (TXx), maximum daily minimum temperature (TNx), minimum daily maximum temperature (TXn), and maximum daily minimum temperature (TNn) exhibit significantly increasing trends ranging from 0.016 to 0.053°C/year. Conversely, the extreme temperature indices for cool days (TX10) and cool nights (TN10p) show decreasing trends ranging from 0.058 to 0.406%/year.The spatial analysis of extreme indices also reveals an overall increase in temperature across the zone, confirming a higher warming trend in the area. Among the extreme rainfall indices, the total precipitation (PRCPTOT) shows a very significant increasing trend ($p = 0.006$) of 3.65 mm/year. The number of very heavy rainfall days (R20mm) and the number of very wet days (R95p) also exhibit significant increasing trends, ranging from 0.05 to 2.044

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mm/year. Conversely, continuous wet days (CWD) show a decreasing trend, while continuous dry days (CDD) demonstrate an increasing trend. The spatial analysis of rainfall indices corroborates the findings from the temporal analysis.Correlation analysis of daily rainfall with global indices such as Sea Surface Temperature (SST) and Sea Level Pressure (SLP) reveals a significant positive correlation with consecutive dry days (CDD) and a negative correlation with consecutive wet days (CWD). The results of this study indicate warming trends in the area, accompanied by erratic rainfall patterns that significantly affect evaporation rates and various key sectors, notably rainfed agriculture, leading to increased drought conditions.

Keywords:Climate indices, extremes, drought, temporal, spatial, Borena, Ethiopia

1. Introduction

Since the onset of the Industrial Revolution, climate extremes have increasingly affected various regions globally (McMichael, 2017). The impacts of global warming and other anthropogenic climate extremes have varied, causing significant harm to both the environment and human well-being (Shivanna, 2022). Tropical regions are particularly vulnerable due to their geographic location and limited technological advancements to mitigate hydro-meteorological hazards (Sahani et al., 2019). Developing countries like Ethiopia have seen a marked increase in climate risk, driven by exceptional weather events and low adaptive capacity (World Bank, 2021). Due to its heavy reliance on rain-fed agriculture and natural resources, Ethiopia is among the nation's most sensitive to climatic variability and change. Future projections indicate that hydro-meteorological hazards and temperature extremes will become more frequent and intense (Beyene et al., 2022; Adem & Amsalu, 2021; Damtew et al., 2022; Dendir& Birhanu, 2022). Rising temperatures, both currently and in the future, are attributed to excessive greenhouse gas emissions from various sources. For instance, the global average surface temperature is projected to rise by 2.6 to 4.8°C by the end of the 21st century, following an increase of 0.3 to 0.6°C during the 20th century (IPCC, 2007). Extreme weather and climate events negatively impact livelihoods and contribute to

the overall decline of ecosystems. The most significant shifts in surface temperature are expected to occur in Africa (IPCC, 2013).

The sub-Saharan region has seen a significant increase in heat wave occurrences in recent years, with studies indicating a rise in frequency and intensity due to climate change (Lelieveld et al., 2022). These heat waves have profound impacts on the environment and public health, exacerbating existing vulnerabilities in the region. Increases in surface temperature can disrupt the hydrological cycle, affecting critical processes such as evapotranspiration and precipitation patterns. Recent literature highlights that climate change is leading to altered rainfall distributions and increased evaporation rates, which in turn affect water availability and agricultural productivity (Zhou et al., 2023; IPCC, 2023). This disruption poses significant challenges for food security and sustainable development in the region.

The hydro-meteorological risks in the Horn of Africa are closely linked to the El Niño Southern Oscillation (Liebmann et al., 2014; Nicholson, 2017). Extreme climate events such as droughts and floods lead to severe consequences, including landslides, erosion, and reduced agricultural yields and water resources. Ethiopia's most crucial economic systems are increasingly vulnerable to climate variability and extreme occurrences, such as large floods and droughts, which severely impact people's lives, property, and natural resources (Adger et al., 2018). Significant portions of the nation, particularly the semi-arid and desert regions, are prone to high levels of climatic fluctuation and periodic droughts. Recent data indicate that the Borena Zone is one of the most drought-prone areas in Ethiopia (Ambelu et al., 2017; Bogale and Erena, 2022).

When assessing the variation and trends of temperature and rainfall extremes, it is essential to understand the relationships between rainfall variation and global-scale climate indices (Sillmann et al., 2017), which are key drivers of regional climate variability. For example, the development of global climate indices can trigger atmospheric-oceanic anomalies in the tropical Pacific, affecting climate parameters worldwide, particularly rainfall patterns (Unal et al., 2012). In Ethiopia, rainfall variations are

primarily influenced by the seasonal migration of the Intertropical Convergence Zone (ITCZ) and the global climate system (Camberlin, 2009; Fazzini et al., 2015; Gleixner et al., 2017; Korecha and Barnston, 2007). While previous studies (e.g., Alhamshry et al., 2020; Diro et al., 2011; Segele et al., 2009) have reported associations between SST and Ethiopian rainfall, they often had limited temporal coverage and did not focus on the rainfall extremes in southern Ethiopia.

To address this gap, this study aims to investigate the association of various global climate indices with the variation of daily extreme rainfall indices in the Borena Zone, which is located in southern Ethiopia and frequently experiences extreme events and prolonged drought. In climate research, several studies have predominantly used annual and monthly mean average data, which can obscure significant variables that characterize extreme indices responsible for extreme events (Zhang et al., 2019).

Therefore, extreme indices derived from daily climate data aim to provide unbiased insights from weather observations, enhancing our understanding of extremes that significantly impact various ecosystems. Unlike previous studies, this research offers new insights into the trends of daily extreme temperature and rainfall indices for the study area, utilizing an extensive climate dataset from 1981 to 2020. Accordingly, the main objective of this study is to evaluate recent changes in the temporal variation and trends of daily temperature and rainfall extremes, as well as the impacts of extreme climate change in the area. Additionally, it explores the teleconnections between local rainfall and global indices. The results could provide essential scientific information on historical climate change, which is valuable for the management of water resources and hydrological systems in the region.

2. Materials and Methods

2.1. Theoretical Framework

The study of daily extreme temperature and rainfall indices is anchored in a robust theoretical framework that integrates various climate indices, statistical methodologies, and climate models to assess the impacts of climate change on weather extremes. This framework is vital for

understanding how climate variability manifests through extreme weather events, particularly in vulnerable regions such as Ethiopia. Climate Extremes Indices serve as the foundation for this framework. These standardized indices quantify temperature and precipitation extremes, allowing for meaningful comparisons across different geographical areas and time periods. According to the World Meteorological Organization (WMO), essential climate indices include metrics for extreme temperatures, such as the number of warm days or cold nights, and for precipitation, such as the frequency of heavy rainfall events (WMO, 2011). These indices help researchers to systematically evaluate changes in climate extremes over time.

Statistical Methods play a crucial role in analyzing trends associated with these climate indices. Techniques such as linear regression analysis, time series analysis, and non-parametric tests are commonly employed to discern significant patterns and anomalies in extreme weather data (Mann, 1977; Wilks, 2011). By applying these statistical approaches, researchers can identify trends that may correlate with broader climatic shifts, thereby enhancing the understanding of how extreme events are evolving in response to climate change. Climate Models, including Regional Climate Models (RCMs) and General Circulation Models (GCMs), are integral to projecting future climate scenarios. These models simulate potential temperature and precipitation patterns under various greenhouse gas emission scenarios, providing insights into how climate extremes may change over time (IPCC, 2013). By utilizing these models, researchers can assess not only the likelihood of extreme weather events but also their potential impact on local ecosystems and human livelihoods.

Another critical aspect of the theoretical framework is the examination of teleconnections. These are the climatic links between global climate indices, such as the El Niño Southern Oscillation (ENSO), and local weather patterns. Research has shown that these teleconnections significantly influence rainfall variability and temperature extremes in regions like the Horn of Africa (Nicholson, 2017; Liebmann et al., 2014). Understanding these relationships is essential for predicting extreme weather events and

preparing for their impacts. The framework also encompasses the impact assessment of climate extremes on socio-economic systems. This involves examining how shifts in temperature and precipitation extremes affect agricultural productivity, water resources, and public health (Mastrorillo et al., 2016). Vulnerability assessments are particularly important, as regions that rely heavily on rain-fed agriculture, such as Ethiopia, are more susceptible to the adverse effects of climate variability (Bogale & Erena, 2022).

Finally, the theoretical framework emphasizes the need for developing adaptation strategies to mitigate the impacts of climate extremes. Effective adaptation measures may include improving water management practices, enhancing agricultural resilience through diversification, and implementing early warning systems for extreme weather events (Sahani et al., 2019). By integrating these strategies into policy and planning, communities can better prepare for and respond to the challenges posed by climate change. In summary, the theoretical framework for studying daily extreme temperature and rainfall indices is multifaceted, combining climate indices, statistical analysis, climate modeling, and socio-economic assessments. This comprehensive approach is essential for understanding the complexities of climate extremes and informing effective adaptation strategies in vulnerable regions.

2.1. Data Source and Quality Control

This study made use of gridded daily precipitation maximum and lowest temperature data from the National Meteorological Agency (NMA) within a period of the years 1981 to 2020. This gridded dataset combines locally calibrated satellite-derived data with integrated quality-controlled station data from the National Observation Network. This combined dataset employed the combined product shows improved quality over regions of the country where stations are sparsely distributed (Dinku et al., 2014; Esayas et al., 2018). Because it resolves a significant discontinuity seen in station data during a brief period, this data is recommended for use.

In this study data quality control process of each time series was tested using RClimDex 1.1(Zhang and Yang, 2004). The quality control involves checking errors such as (i) days with negative or greater than 500mm rainfall amount, (ii) minimum temperature equal to or greater than maximum temperature, and outliers, which are values plus or minus four times standard deviation. Accordingly, a station with the best value data quality is considered in the study. After the quality control, the data was used for extreme analysis.

2.1.1. Trend Analysis of Rainfall and Temperature

The Mann-Kendal test was used to evaluate the trend of temperature and precipitation extremes indices. Mann Kendal (Mann, 1945; Kendall, 1975) is the most robust tool for detecting trends because the method is less sensitive to outliers and skewed distributions within time series data (Wang and Swail, 2001). In this study, the Mann-Kendal test was applied for temperature and precipitation data which are not always normally distributed (Yue and Wang, 2004). The trend was tested by computing p-value at a 95% confidence level. The slope of temperature and rainfall extremes were determined using the non-parametric Sen's slope estimator (Sen, 1968). It uses the median slope to assess the trend over time. Sen's slope estimator is widely applied to quantify the slope of rainfall and temperature time series data. Both the Mann-Kendall test and Sen's slope estimator were used to compute trends in hydro-meteorological series. Detailed descriptions of Mann–Kendall and Sen's slope estimation can be found in the related studies (Li et al., 2018; Worku et al., 2019).

$$S = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} sgn(x_j - x_i)$$

Where N is the number of data points. Assuming$(x_j - x_i) = \theta$, the value of $sgn(\theta)$ is computed as follows:

$$sgn(\theta) = \begin{cases} 1 \; if \; (x_j - x_i) > 0 \\ 0 \; if \; (x_j - x_i) = 0 \\ -1 \; if \; (x_j - x_i) < 0 \end{cases}$$

Where: -Seasonal and annual values in years j and $i, j > i$, respectively.$(x_j - x_i)$ is the signum function. The test statistic (S) has been assumed to be asymptotically normal, $E(S) = 0$. The equation indicates the increasing and decreasing trend of the data(M.G. Kendall, 1975).

The variance statistic is also calculated as follows: -

$$V(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{k=1}^{g} t_k(t_k-1)(2t_k+5)\right]$$

where n is the number of data points, g is the number of tied groups (a tied group is a set of data having the same value), and t_k is the number of data points in the k^{th} group. The standard test statistics Z is calculated as follows.

$$Z_s = \begin{cases} \dfrac{S-1}{\sqrt{Var(S)}}, S > 0 \\ 0, \quad S = 0 \\ \dfrac{S+1}{\sqrt{Var(S)}}, S < 0 \end{cases}$$

The Z_s Value is used to evaluate the significance of the trend variation in terms of decreasing and increasing trends. In the two-sided test under a significant α level, if $|Z_s| < Z_{\left(1-\frac{\alpha}{2}\right)}$, the hypothesis that the sequence X_i has no trend is accepted, but if $|Z_s| > Z_{\left(1-\frac{\alpha}{2}\right)}$, the hypothesis is rejected and the sequence has either an increasing or decreasing monotonic trend.$Z_{\left(1-\frac{\alpha}{2}\right)}$is the standard normal distribution value when the probability exceeds $1-\frac{\alpha}{2}$. In this study, a significance level of $\alpha = 0.05$ was adopted; thus,$Z_{\left(1-\frac{\alpha}{2}\right)} = 1.96$.

2.1.2. Sen's slope estimator

Sen's slope estimator the direction and its magnitude (Kocsis et al., 2017) in meteorological time series (Chattopadhyay and Vennila,2015;Pal et al., 2017). It is the non-parametric method that can calculate the change per unit time. This method is used to determine the linear trend of the time series (Pal et al., 2017b). In this method, the slopesT_i of all data pairs are calculated as follows:

$$T_i = \frac{x_j - x_i}{j - i}$$

For i =1, 2,…, N

Where $x_j and\ x_i$ are data values at a time j and $i(j > i)$, respectively. If there are n valuesx_j in the time series and obtained N=n(n-1)/2 slope

estimates S_i.The median of these N values of T_i is Sen's estimator of slope, which is calculated as

$$T_{Med} = \begin{cases} T_{\frac{N+1}{2}} & N\ is\ odd \\ \frac{1}{2}\left(\frac{T_N}{2} + \frac{T_{N+2}}{2}\right) & N\ is\ even \end{cases}$$

A positive value of Ti indicates the is an increasing and a negative value of Ti gives a decreasing trend in the time series (Mondal et al., 2012).

2.1.3. Evaluation of Extreme Indices

A statistical examination of variations in the dependent climatological characteristics, including time series analysis and comparison, extremes, and trends, is made possible by extreme climate indices. The RClimDex 1.1 software package was utilized to assess the extreme indices of daily rainfall and temperature time series, focusing on their trend and variance. The Expert Team on Climate Change Detection Monitoring Indices (ETCCDMI), among other worldwide research organizations, created the analysis package for trend and variability evaluation of time series temperature and rainfall data (WMO, 2009). You can get RClimDex, an easily navigable R-based program, from http://etccdi.pacificclimate.org/. Shanghai et al. (2011). Out of the 27 core indices that RClimDex computes daily, the most pertinent 10 temperature indices and 10 precipitation indices for this study.

Table 1: List of temperature and rainfall indices

	Index	Indicator name	Definition of the Index	Units
Rainfall extremes	R20mm	The Number of very heavy rainfall days	Annual count of days when PRCP ≥ 20 mm	Days
	CDD	Consecutive dry days	Maximum number of consecutive days with RR < 1 mm	Days
	CWD	Consecutive wet days	Maximum number of consecutive days with RR ≥1 mm	Days
	R95p	Very wet days	Annual total PRCP when RR > 95th percentile	Mm
	PRCPTOT	Total wet-day rainfall	Annual total PRCP in wet days (RR ≥ 1 mm)	Mm
Temperature	TXx	Max. T_{max}	Annual maximum value of daily maximum temperature	^{0}C
	TNx	Max. T_{min}	Annual maximum value of daily minimum temperature	^{0}C
	TXn	Min. T_{max}	Annual minimum value of daily maximum temperature	^{0}C
	TNn	Min. T_{min}	Annual minimum value of daily minimum temperature	^{0}C
	TN10p	Cool nights	Percentage of days when TN <10th percentile	%
	TX10p	Cool days	Percentage of days when TX < 10th percentile	%

Max. = maximum, Min. = minimum, T_{max} = maximum temperature, T_{min} = minimum temperature, PRCP = precipitation, and RR=daily precipitation.

2.1.4. Global-climate indices

Several large-scale ocean-atmospheric indices have been identified to have teleconnections with the variability of rainfall in Ethiopia (Degefu and Bewket, 2017; Zeleke and Damtie, 2016). Among these climate indices, Sea level pressure (SLP) is increasing/ decreasing in atmospheric pressure at sea level, which can disclose useful information on atmospheric circulation, bringing about wetter and drier conditions. Changes in Sea Surface Temperature (SST) can also generate a difference in the heat-flux field, bringing about anomalies in atmospheric circulation and rainfall patterns (Copsey et al., 2006). This study selected the most important global climate indices to estimate their association with local precipitation indices. These are: -

a) The global SST anomalies, including the Dipole mode index (DMI), the anomalies of SST between the Western (10°S-10°N and 50°-70°E) and the Southeastern (10°S-0° and 90°-110°E) the equatorial Indian Ocean. The Pacific Decadal Oscillation (PDO) index is the leading principal component of Northern Pacific monthly SST variability (poleward of 20°N in the Pacific Basin), El Niño–Southern Oscillation (ENSO) represented by averaged Niño SST indices, Niño 1+2, Niño 3 (90–150°W and 5° N–5° S), Niño 3.4, and Niño 4 (150°W– 160°E and 5° N–5° S), and

b) Atmospheric pressure at sea level or sea level pressure (SLP), including the Southern Oscillation Index (SOI), and the North Pacific Index (NPI), are the area-weighted SLP over the region 30–65° N, 160° E–140° W, the Trans-Polar index (TPI), and the North Atlantic Oscillation (NAO).

The data were obtained from the National Oceanic and Atmospheric Administration (NOAA) http://www.cgd.usar.edu.cas/catalog/climate/TNI_N 34 index .html.

2.1.5. Correlation of daily extreme indices with global atmospheric circulation

In this study, the Pearson Correlation Coefficient (r) was used to evaluate the link of daily rainfall extreme with global atmospheric indices at a 95% confidence level. Pearson correlation was used to evaluate linear association

between two variables x_i and y_i.The Pearson correlation (r) is given by: To prove the formula for the correlation coefficient, we start with its definition and derive it accordingly,

$$\mathrm{Cov(X,Y)} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

$$\mathrm{Var(X)} = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})\,2$$

$$\mathrm{Var(Y)} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})2$$

$$r = \frac{\{\mathrm{Cov}\}(\mathrm{X,Y}}{\sqrt{Var\ (X).Var(Y)}}$$

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2(y_i - \bar{y})^2}}$$

Where n is the number of observations,x_i,and $y_i$the variable and $\bar{x}$ and $\bar{y}$ are their mean, respectively.

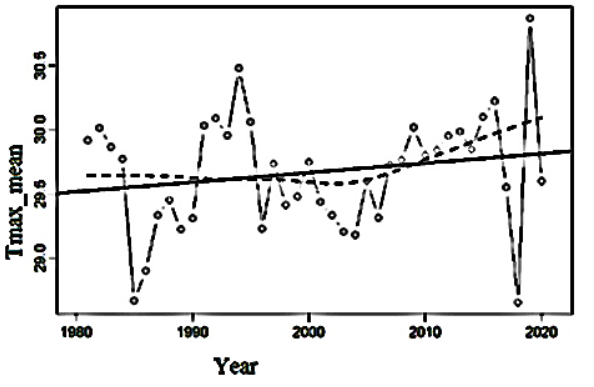
- If X and Y are perfectly positively correlated, r = 1
- If there is absolutely no association, r = 0
- If X and Y are perfectly negatively correlated, r = -1
- Thus $-1 \leq r \leq 1$.
- The closer r is to +1 or -1, the greater is the strength of the association (Freedman, et al., 2007).

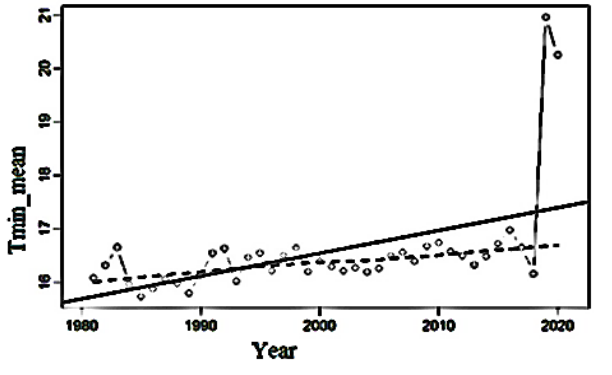
3. Results and Discussion

3.1. Temporal and Spatial Trends of Daily Extreme Temperature and Rainfall Indices

3.1.1. Temporal Trend of Daily Extremes Temperature Indices

Fig.1 depicts, the Borena Zone underscores the complex of maximum and minimum temperatures, the dynamics, and their increase of them.


Tmax_mean
30.5
30.0
29.5
29.0
1980
1990
2000
2010
2020
Year


Tmin_mean
21
20
19
18
17
16
1980
1990
2000
2010
2020
Year

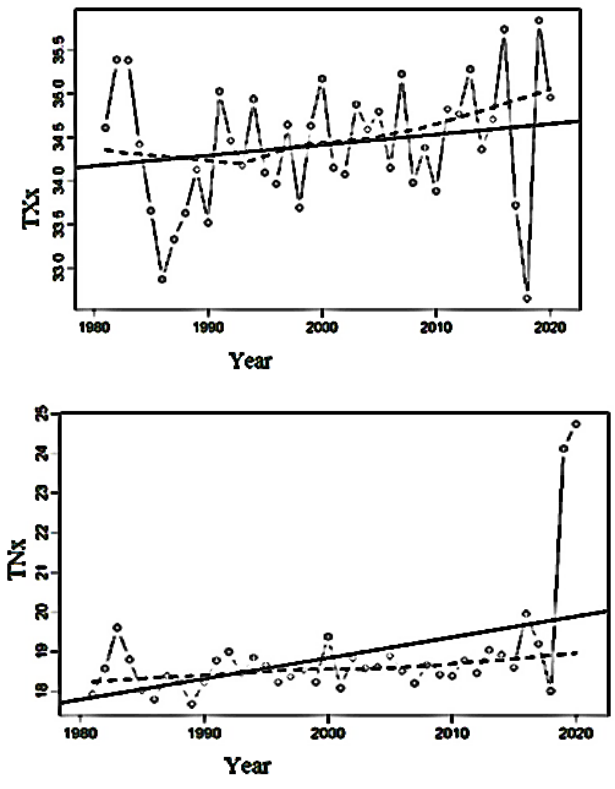
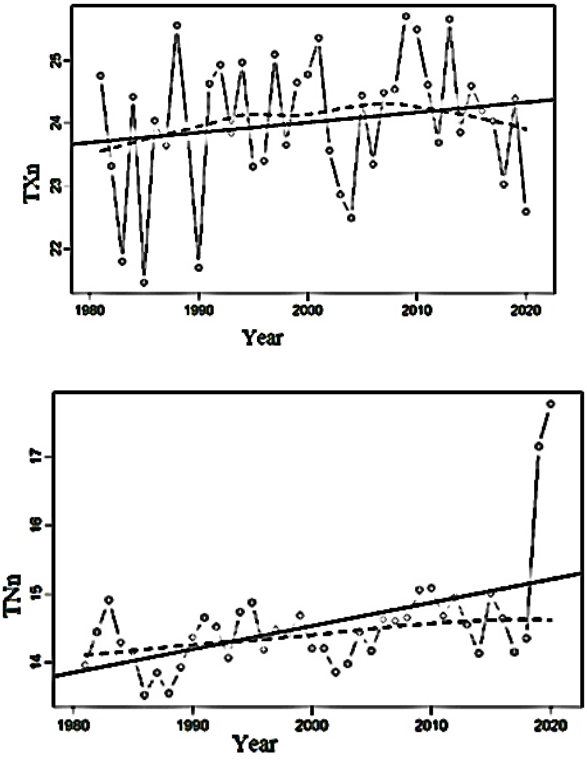


Figure 1: Extreme temperature indices of (T-max mean and T-min mean)

The straight solid line in the figure is the linear trend for each variable for the basin, whereas the dashed line is the moving average. The mean maximum temperature of the area observed an increasing trend with a positive slope, and the annual TMAX-mean increased by 0.057^0C/year. The moving average also depicts the higher variation or anomalies of the maximum temperature in the area from 1981 to 2020. This consistent upward trajectory suggests a shift in climatic conditions that may have profound implications for local ecosystems and agricultural practices. Similarly, the mean minimum temperature in Borena also exhibits a notable upward trend, particularly exaggerated from 2010 onwards, with an annual increase of 0.043°C per year throughout the study period. This annual result is more analysis taken from daily extreme values. Accordingly, the daily maximum temperature (TXX) of Borena shows an increasing trend. The moving average also shows an increasing anomaly except for 1986 and

2018. These anomalies may reflect the influence of specific climatic events or fluctuations that warrant further investigation. The daily minimum temperature (TNX) trend of the area showed that increasing trend and the anomaly also observed an extreme increase, particularly in 2018. In agreement with this study's results' researchers (Asfaw et al., 2018; Belay et al., 2021; Mengistu and Haji, 2015) done on the area reported the highest increase of both maximum and minimum temperatures. These studies corroborate the observed warming trends in current and future temperatures in the region, emphasizing the urgency of addressing climate change impacts.



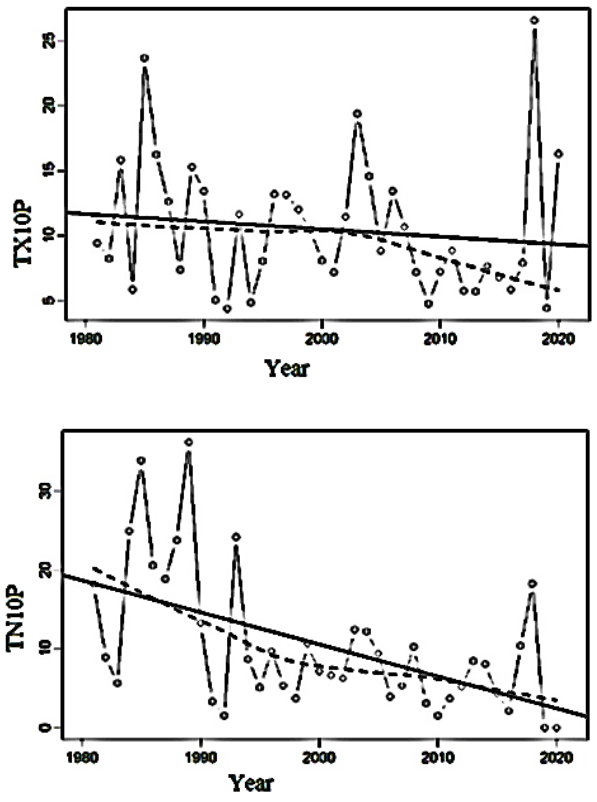


Figure 2:Extreme temperature indices of (TXn, TNn, TN10p and TX10p)

Figure 2 presents the extreme temperature indices, including the monthly minimum value of daily maximum temperature (TXn). The straight solid line in the figure is the linear trend for each variable for the basin, whereas the dashed line is the moving average. The Monthly minimum value of the daily maximum temperature (TXn) observed an increasing tendency, and the moving average shows a decreasing trend. This discrepancy suggests that while the coldest day temperatures are generally rising, there may be periods of fluctuation that require closer examination. Thus, the TXn or the coldest day significant variation has been observed or considerable anomalies recorded in the study area (Fig.2). Similarly, research done by (Mekasha et al., 2014) noted a similar trend as both increasing and decreasing trends have been recorded. The coldest night (TNn) showed a very significant increasing trend, and the anomalies of the moving average

observed a significant increasing trend, particularly in the 2019 year. Esayas et al. (2018) reported a similar result that shows an increase in the coldest day (TNn) in southern Ethiopia. Both cool day (TX10P) and Cool night (TN10P) depicted a very decreasing trend that agreed on the increment of warm night and warm day. This trend underscores a broader shift towards warmer nighttime temperatures, which can have critical implications for nocturnal ecosystems and energy consumption patterns. Supporting these findings, Damtew et al., (2022) stated the decline of cold extreme temperature indices in cool days (TN10p) and cool nights (TX10p). These extreme climate events make people suffer from continuous drought (Dejene et al., 2023).

Overall, these results highlight the pressing need for adaptive measures to mitigate the impacts of increasing temperature extremes, particularly in vulnerable regions like Borena. Understanding these trends is essential for developing effective climate adaptation strategies that can enhance resilience among local populations.

3.1.2. Spatial Trend of Daily Extremes Temperature Indices

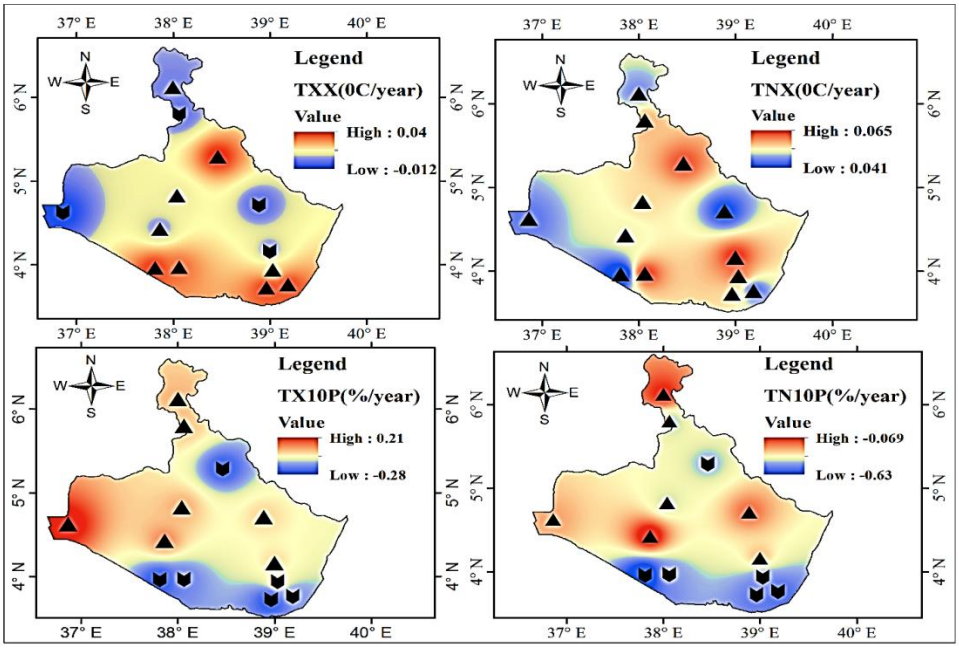
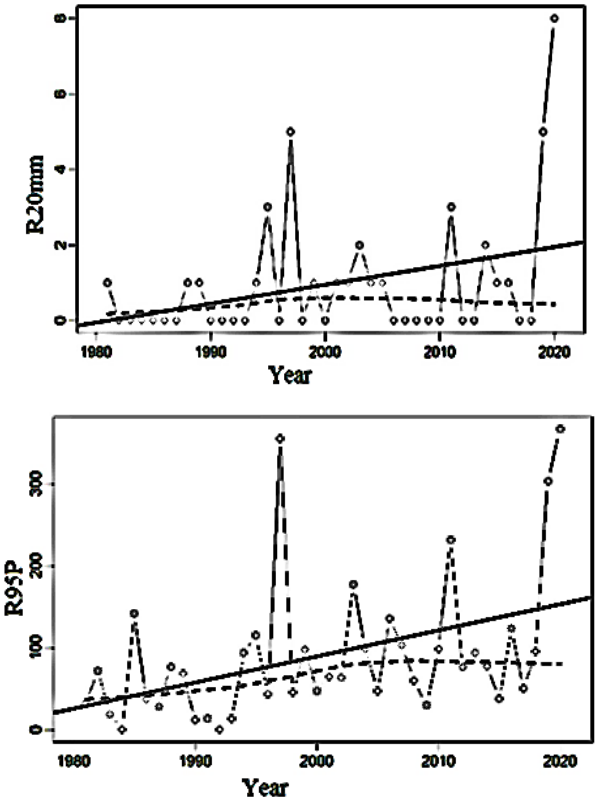


Figure 3. Spatial variations of extreme temperature indices of TXx, TXn, TNx, and TNn trends in °C/year of Borena for the years 1981-2020.

The triangles and the down-arrow in the pictures indicate significant increasing and decreasing trends at the 5% level, respectively. In the northern humid and central moist part of the zone, the maximum value of the maximum temperature (TXx) shows a decreasing trend with 0.0120c/year. This decline may be influenced by localized climatic factors, including land use changes and variations in precipitation patterns. Conversely, in the central, the west semi-arid, and the east arid regions TXx trend value increased significantly ($p<0.05$) with 0.04^0C/year. The trend for the maximum daily minimum temperature (TNx) across the study area reveals an increasing pattern ranging from 0.041°C to 0.065°C per year. Such increases in TNx are critical, as they suggest a general warming trend that affects not only daily temperatures but also nocturnal ecosystems. The regional trends of the two indices, TXx and TNx, show stout increases trend. The percentages of cool days (TX10p) and cool nights (TN10p) showed strong variability that depicts the increasing and decreasing trend; however, both showed decreasing in the southern area in common (Fig.3). This decline in cool extremes is particularly concerning, as it may lead to reduced agricultural resilience and increased vulnerability to heat-related stress among local populations. Previous studies (Esayas et al., 2018; Mekasha et al., 2014; Mohammed et al., 2022) on temperature extreme indices in the area confirmed the result obtained in this research. Increasing trend of warm extreme indicesand decreasing trend of cold extreme indices (TN10p and TX10p) were observed. The consistency of these results across different studies highlights the reliability of the data and the urgency of addressing the implications of these temperature changes. The trends in mean annual maximum and minimum temperatures, along with various extreme temperature indices, confirm a pronounced warming trend in the area. Overall, the daily extreme temperature trends in the eco-environments of the study area indicate a rise in warm extremes and a decline in cold extremes. These shifts necessitate immediate attention to adaptation strategies that can mitigate the impacts of changing temperature patterns on local ecosystems and communities.

3.1.3. Temporal Trend of Daily Extremes Rainfall Indices



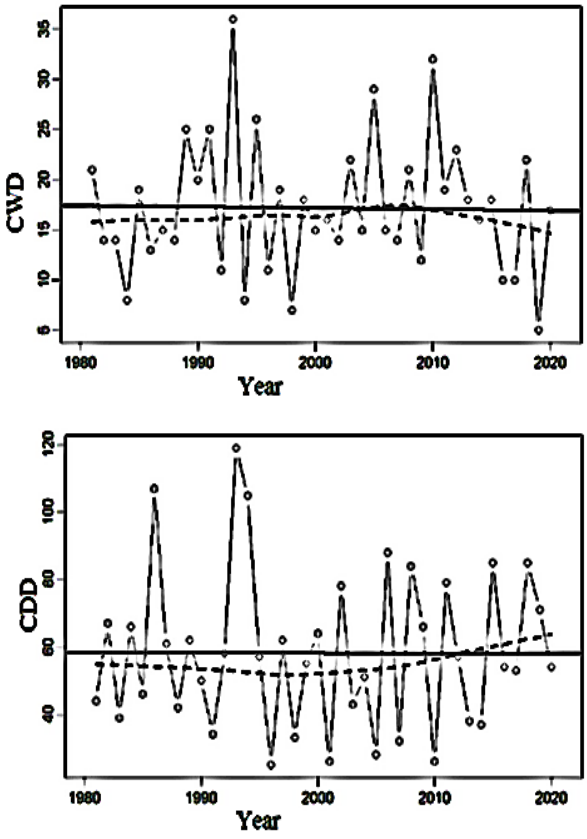


Figure 3: Extreme rainfall indices of (R20mm and R95p, CWD, CDD)

Figure 4 illustrates the extreme rainfall indices, presenting both the linear trend and moving average for each variable in the basin. The number of very heavy rainfall days (R20mm) shows an increasing trend with a slope of 0.05 mm/year. This upward trend indicates a potential shift in rainfall patterns, suggesting that heavy precipitation events may become more frequent in the region. However, the moving average showed the highest fluctuation of anomaly and almost below-average value except for the higher increase shown in 2018. The very wet day (R95p) observed a significant increasing trend of 2.044mm/year. This substantial increase may enhance the risk of flooding and soil erosion, particularly in vulnerable landscapes. The moving average depicted the strongest variation anomalies, and mainly in 1998 and 2018, it showed the highest value above the average. Continuous wet day (CWD) value in the study period never showed an increasing or decreasing

slope; however, the moving average showed a variation and a decreasing trend since 2010. This decline in continuous wet days may have serious implications for water availability and agricultural productivity. On the contrary, the value of continuous wet days observed a decreasing trend of 0.013 mm/year. The value of continuous dry days (CDD) also showed an increasing trend with considerable anomalies, particularly since 2016, when it was above average (Fig.4). The increase in CDD is particularly concerning as it suggests prolonged dry spells, which can exacerbate drought conditions in the region. Similar to these results, the study done by Dendir and Birhanu (2022); Kiros et al.(2017); Mohammed et al.(2022) in the same agroecological zone found the increment of R20mm, R95p, and the decrease of CWD as well as the increment of CCD in southern Ethiopia The emphasis on the recent increases in CDD and declines in CWD highlights the growing concern for drought occurrences in the area, necessitating urgent adaptive measures to mitigate adverse impacts on agriculture and water resources.

3.1.4. Spatial Trend of Daily Extremes Rainfall Indices

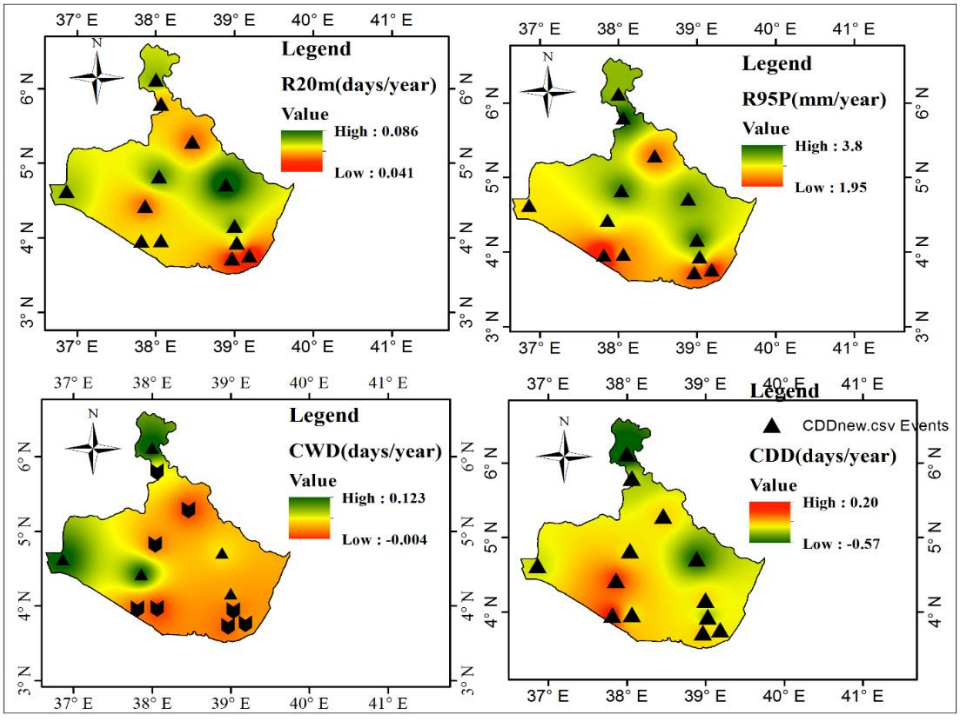


Figure 4: Spatial variations of rainfall extreme indices trends of R20mm (days/year), R95P(mm/year) both in mm/year, trends in CWD (Days/year), and trends in d CDD (days/year) of Borena for the duration of 1981-2020.

Figure 5 illustrates the spatial trends of the extreme rainfall indices R20mm, R95p, CWD, and CDD across the Borena Zone. The triangles and the down-arrow in the pictures indicate significant increasing and decreasing trends at the 5% level, respectively. The spatial trend of R20mm, R95p, CWD, and CDD in Fig.2.5 showed very different values in humid, moist, semi-arid, and arid regions of the Borena Zone. Accordingly, the R20mm value showed a significant (p=0.03) increasing trend in most parts of the study area with 0.05mm/year. This trend suggests a potential enhancement in heavy rainfall events, which could impact local water management and agricultural practices. However, there is an insignificant decreasing trend observed in the southeast (arid) part of the zone.

The R95p index demonstrates a significant ($p = 0.006$) increasing trend of 3.183 mm/year throughout the zone. Such an increase in extreme precipitation could exacerbate flooding and soil erosion risks, particularly in vulnerable landscapes. The continuous wet-day index (CWD) shows a decreasing trend of 0.013 days/year, with exceptions noted in the western semi-arid and northernmost regions, indicating localized variability in wet-day patterns.

In contrast, continuous dry days (CDD) exhibit an increasing trend, except for the central moist regions. This increase in CDD points towards prolonged dry spells, which are concerning for water availability and agricultural productivity in the region.

In line with this result, studies done by (Adem and Amsalu, 2021; Amsalu and Adem, 2009; Gemeda et al., 2022) found the erratic rainfall and the increment of warming conditions of the area caused extreme drought and other climate hazards. These findings underscore the urgent need for adaptive strategies to mitigate the impacts of these climatic changes on local communities and ecosystems.

3.2. Correlation of daily extreme indices with global atmospheric circulation

Regional climate change, particularly the variation and change of daily extreme rainfall, is significantly influenced by global atmospheric climate indices such as Sea Surface Temperature (SST) and Sea Level Pressure (SLP) (Kebede and Bewket, 2009).

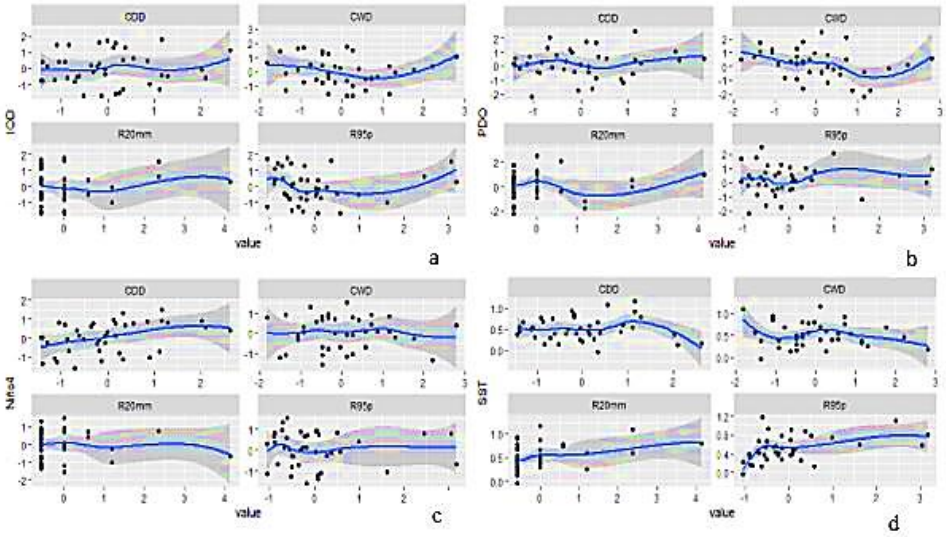


Figure 5: The correlation of global indices (IOD, PDO, NINO 4, and Global SST) with daily extreme rainfall CDD, CWD, R20mm, and R95sp) of the Borena zone in the period of 1981 to 2020.

Fig.7 shows the correlation between SST groups, which include IOD, PDO, NINO 4, and Global SST itself. Hence, Nino 4 and global SST had a negative correlation with CWD and showed a significant positive correlation with CDD (r=0.36 and 0.41) with a 95% confidence level. This suggests that as warm ocean temperatures increase, the occurrence of continuous wet days decreases, leading to dryer conditions. The remaining large-scale climate indices, IOD and PDO, showed almost the same pattern: There was a negative correlation with CWD and a negative correlation with extreme daily rainfall indices. This result exhibits a negative correlation with wet days, suggesting the decreasing extreme rainfall in the area. These findings indicate a concerning trend towards decreased wet days, suggesting

a decline in extreme rainfall events in the area. The positive correlation between CDD and the negative correlation with CWD showed the warmed or drought tendency of the study area. This pattern observed a tendency towards warming or drought events. This analysis of SST groups depicts the connotation between extreme rainfall indices and global climatic factors in the Borena zone showed different patterns. It observed a warming tendency as NINO 4 and global SST clearly correlate with more dry spells and fewer wet days. Furthermore, highlighting the trend toward warmer or drier conditions in the study area, IOD and PDO also contribute to this pattern by demonstrating negative associations with CWD and daily rainfall extremes. In agreement with these findings, studies done by Beyene et al.(2022), Degefu et al.(2017), and Tashebo et al.(2021) stated that the recent global SST variation has led to a severe extreme impact in lowland pastoralist areas, including the Borena zone.

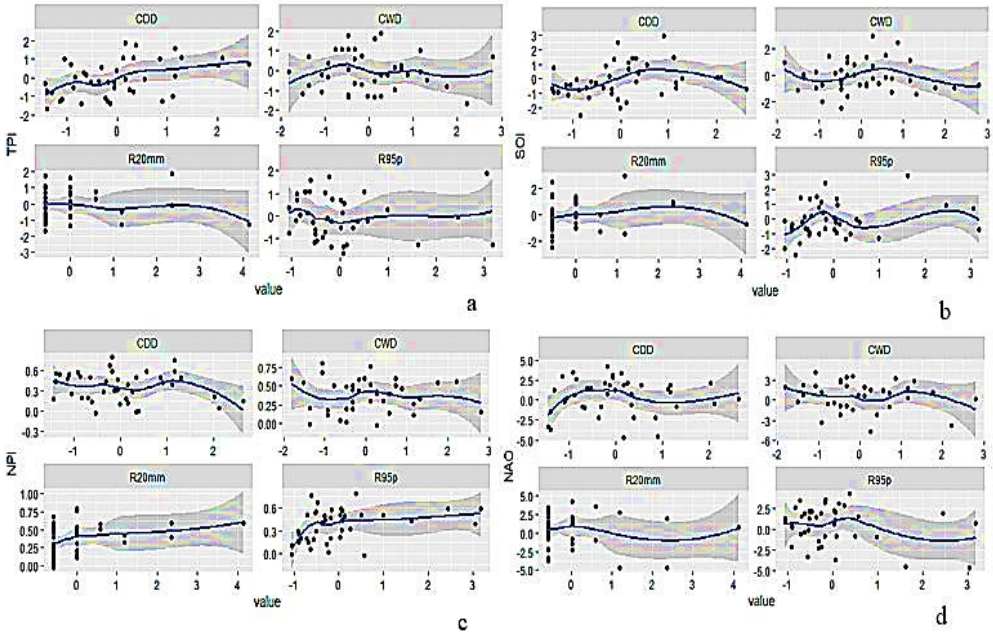


Figure 6: The correlation of global indices (TPI, SOI, NPI, and NAO) with daily extreme rainfall CDD, CWD, R20mm, and R95sp) of the Borena zone in the period of 1981 to 2020.

Figure 7 shows the correlation of sea level pressure (SLP), including TPI, SOI, NPI, and NAO. Accordingly, TPI had a negative correlation with

R20mm and R95p and made a positive significant correlation with CDD (r=0.435), which is responsible for the drying of the area. The SOI has a negative correlation with CWD and made positive correlation with CDD, R20mm, and R95p. The NPI had a negative correlation with CWD and made a positive correlation of R20mm and R95p. The NAO presents a positive correlation with CDD while correlating negatively with other daily extreme rainfall indices. This finding observed SOI, TPI, and NAO correlation values with daily rainfall indices of the area associated with prolonged dry spells, leading to warming (drought). It confirms the complex correlation between global climate indices and extreme daily rainfall indices that affect the wet and dry spells in the area.The correlation analysis of sea level pressure (SLP) indicators, including TPI, SOI, NPI, and NAO, with daily rainfall indices provides useful insights into their influence on precipitation extremes in the research area. The negative correlations of TPI, SOI, and NPI with cumulative wet days (CWD) imply a decline in wet day occurrences during periods of high index values, pointing to a drying trend. Conversely, the positive correlations of these indicators with heavy rainfall and consecutive dry days (CDD) indices (R20mm and R95p) suggest an increased likelihood of extended dry spells and severe rainfall events during those periods. In summary, the findings align with previous research by Anose et al.(2022) and Hou et al.(2023), which highlights that SLP anomalies are closely associated with climate conditions in the southern regions, contributing to prolonged dry spells and fewer occurrences of heavy rainfall.

4. Conclusion

Evaluating the temporal and spatial trends of temperature and precipitation extremes at a fine resolution is crucial for effective management and decision-making across various sectors, particularly in water resource management and agriculture. This study examined the daily extreme indices in the Borena Zone from 1981 to 2020, revealing significant increases in both temporal and spatial extremes of temperature. Notably, while the mean maximum and minimum temperatures exhibited substantial upward trends, the indices for cool days (TX10p) and cool nights (TN10p) showed only slight increases, further exacerbating the region's warming situation. The analysis of spatial and temporal trends indicates a concerning pattern: a

decrease in continuous wet days (CWD) alongside an increase in continuous dry days (CDD). These findings suggest a shift towards more prolonged dry spells, which have significant implications for local ecosystems and agricultural practices. Additionally, the evaluation of the correlation between daily extreme rainfall indices and global climate indices revealed that large-scale atmospheric patterns, such as Sea Surface Temperature (SST) and Sea Level Pressure (SLP), significantly influence regional climate variability. Specifically, the positive correlation of SST and SLP with CDD indicates an increasing likelihood of extended dry spells, while the negative correlations with CWD highlight a decline in wet day occurrences, suggesting a trend towards aridity.

Understanding the relationships between regional climate variables and large-scale climate indices is essential for developing effective adaptation strategies in response to these climatic changes. The findings underscore the urgent need to address the impacts of extreme temperature and rainfall events, which pose challenges to infrastructure, agricultural productivity, and water resource availability. Furthermore, the documented erratic rainfall patterns and rising temperatures in the Borena Zone call for further research to quantify the magnitude of these extreme events and their implications for climate variability in the region.

In conclusion, proactive measures must be implemented to mitigate the risks associated with these climatic phenomena, ensuring sustainable management of resources and resilience in the face of ongoing climate change.

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The Impacts of Public Expenditure on Sustainable Environmental Development in Sub-Saharan Africa

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Abstract

This study examined the impacts of public expenditure on sustainable environmental development (SED) in sub-Saharan African countries using the annual data of 35 countries during the period of 2008--2022. This study is needed because previous studies failed to consider a significant share of sustainable environmental development goals, and their findings were inconsistent. The study employed Dynamic Panel, two step-System-Generalized method of Moments (GMM) estimation techniques to test the effect of military, agricultural, health, and education expenditure on the sustainable environmental development. The results indicate that changes in public spending in the military, health and agriculture positively and significantly affect sustainable environmental development in SSA, whereas education expenditure has a positive but insignificant effect. For agricultural, health and education expenditures, sustainable development theory is valid, whereas for military spending expenditure, ecological modernization theory is valid, and sustainable development theory is not supported. To realize SED development in sub-Saharan Africa, policy makers in sub-Saharan African countries have suggested increasing expenditures on defense technology to improve environmental development sustainability; investment in sustainable farming practices, promoting organic agricultural practices that reduce waste, pollution, and the use of renewable energy using technologies; and incentivizing programs that increase public awareness of ecological quality and upsurge

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investment in the health sector to improve the health status of people by so doing enhance SED.

Keywords: Development, Environment, Government Expenditure, Sustainability

1. Introduction.

1.1. Background of the study

In Sub-Saharan Africa (SSA), 1.21 billion (15%) of the world's population resides. However, countries in the region are facing numerous challenges, such as environmental crises, high rates of unsafe and unskilled jobs (ILO, 2022),low infrastructure(Thusi, 2023), extreme poverty and natural resource depletion(United Nations, 2023), high risk of debt sustainability and persistent climatic shock (Estevão, 2022). Furthermore, in 2022 in SSA, many countries never achieve a significant portion of sustainable environmental development goals. For example, apart from Mauritania and Seychelles, 46 states failed to achieve SDG6 (clean water and sanitation), except Namibia; 47 countries did not achieve SDG15 (life on land), and no nation recorded significant progress in SDG14 or life below the water goals of the SDGs (Sachs et al.,2023). In general, counties in a region are unable to achieve immense SDGs (AfDB, 2022; UN, 2023). These problems can be attributed to weak development policies, the incorrect allocation of public resources(Lin & Chen, 2020) and the inability of governments to allocate resources appropriately to the SDGs((Gaghman, 2020).Moreover, many states in SSA are still unable to provide sufficient resources for education, influencing the quality of education, which in turn affects sustainable development (IMF, 2019;World Bank, 2021). In addition, in SSA, government spending on healthcare most often falls below the required amount of funds to meet the desires of escalating populations, driving poor health care services (McKinsey & Kenner, 2020).

To revert these crises and achieve the SDGs, the government in SSA is required to increase its expenditures (IMF., 2023). However, in the region, public expenditure as a percentage of GDP has fallen in one period and stagnated in the other in the past 3 decades (World Bank., 2024). In additions, to realize sustainable development, fiscal policy in general and

effective public expenditure management in particular are vital instruments that the government employs. Public expenditures are aggregate resources allocated by the public body or authority (IMF, 2014). However, there are multifaced public expenditure allocation and management problems in SSA that significantly influence the performances sustainable development goals. One of the main problems is the extravagance and inadequacy of budgets (United Nations, 2020), the lack of a precise link between policy, effective planning and expenditure allocation(Pearson, 2022), the gap in resource allocation in pro-poor sectors(Singh & Chudasama, 2020) and the agricultural sector's impact blind budgeting(FAO, 2021).

In this context, scholars have argued that realizing the SDGs is recognized as a public development agenda demanding strong integration of fiscal policy and development goals (Veselovská., 2017). In the domain of fiscal policy, the political economist Maynard Keynes played an extensive role and laid a foundation for research on public spending. According to Keynes (1936), public spending during economic slumps induces economic growth. In support of him, institutional and structural economists state that the government must spend on infrastructure, human capital and institutional quality to foster development (Veblen., et al,1889). Similarly, other theorists argue that public spending on education, health and infrastructure positively contributes to long-term economic growth and development (Becker & Barro, 1988).Likewise, peace dividend theory argues that reducing public expenditure on the military can be used to shift resources to sustainable development agendas, leading to environmental development (Radelet& Sachs,1998), and ecological modernization theory posits that technological advancement can lead to efficient utilization of resources. The theory states that public expenditure can be in line with environmental development goals (Mol &Spaargaren, 2000). The theory suggests that military activities could improve sustainable practices such as deployment of clean technologies within defense activities to reduce the negative impacts from their operation. Moreover, investment in defense modernizations could be focused toward creating eco-friendly technologies, such as power-efficient armaments, low carbon emission defense automobiles, or waste management schemes that are more environmentally friendly through the use of dual-purpose technologies viz., the technologies using energies from renewable resources

and waste management tools which can be used for both civilian and military sectors.

According to the reviewed theoretical literature, traditional economic theories emphasize increasing short-term economic output and ignore its long-term adverse effects on environmental development. Generally, theories lack sufficient consideration of the relationship between SEDs and public spending practices. These factors make the theories poor in addressing how fiscal policies interact with the complex conditions of SED, leading to disorganized analysis. Hence, a comprehensive theory (theory of sustainable development) is critically important in examining the impacts of public expenditure on sustainable environmental development in SSA. According to sustainable development theory (World Commission for Environment and Development [WCED,1987]), public spending is viewed as a tool for inclusive and sustainable social, environmental and economic development.

In this context, understanding the impacts of public resource allocation on environmental sustainability is a top priority for allocating valuable public funds. To grasp how public expenditures on the military, agriculture, health, and education impact the sustainability of environmental development in SSA, numerous global, regional and local empirical studies have been reviewed. However, the empirical findings are diverse across continents, countries and scholars because of the lack of exhaustiveness of the environmental development indicators used by researchers. In addition, previous studies overlooked the impacts of agricultural, health and education expenditures on the sustainability of environmental development in SSA. Additionally, the unilateral (single country based) studies in SSA examined environmental impact of military expenditure, but the study results are inconsistent and they have used only CO_2 emissions as a proxy of environmental development while real sustainable environmental development is the result of wide-ranging SDGs such as clean water and sanitation (SDG6), climate action (SDG13), life below water (SDG14) and life on land (SDG15). To seal this empirical vacuum in terms of the impacts of public expenditure on SEDS, conducting comprehensive development analysis using the United Nations' sustainable environmental development goals (SDGs) is at the top of the urgent list for empirical studies on the

impact of public expenditure on the sustainable environmental development of Sub-Saharan Africa. Thus, this study examines how public spending in Sub-Saharan Africa impacts sustainable environmental development.

1.2 Hypothesis:

The hypothesis is a tentative declaration subject to verification (Kothari., 2004).On the basis of theories and reviewed empirical literature, the study hypothesizes the following:

$H1_1$: Government military expenditure significantly affects sustainable environmental development in SSA.

$H1_2$: Government agricultural expenditure significantly affects sustainable environmental development in SSA.

$H1_3$: Government health expenditure significantly affects sustainable environmental development in SSA.

$H1_4$: Government education expenditure significantly affects sustainable environmental development in SSA.

2. Theoretical and Empirical Reviews

2.1 Theoretical Review

In Africa, agriculture and sustainable agricultural practices, as pillars of numerous economies, particularly in pastoral areas, aid the SDGs by alleviating food insecurity. It contributes to natural resource development and sustainability by improving soil fertility, preserving water, and reducing greenhouse gas emissions (Taylor., 2020). In addition, implementing methods that reduce CO2 is vital for managing climate shocks (Davis et al., 2022). In addition, education plays a key role in nurturing consciousness and empowering people to take informed action concerning sustainability. It prepares individuals with the skills and knowledge required to resolve ecological challenges (Smith, 2020). Moreover, sustainable health care schemes are indispensable for resilience against diseases and natural calamities, which can threaten economies and hamper development (Johnson & Miller, 2018).

A central objective in examining the impact of public spending is to understand the role of the government in the welfare of citizens (Hyman., 2011). Public finance is an effort to develop standards by which public resource mobilization and spending ought to be measured (Musgrave & Peackok., 1967;Nemec., 1999). Public spending is an outlay of financial

resources by the government to provide public goods and services, and it provides insight into the size of government across states (OECD., 2023). The Keynes (1936), English economist and philosopher insisted that increasing public spending during economic downturns induces economic growth. Similarly, other theorists have hypothesized that optimized public spending on education, health and infrastructure positively contributes to long-term economic growth and sustainable economic development. An opponents of Keynes theory stated that better development can be achieved with limited government size (amount of public spending), a free market system (Smith.,1776), and individuals' (market participants') rational economic decisions (Jevons.,1888;Walras., 2014). Additionally, Battaglini and Coate (2008) argued that public spending in areas other than health, education and infrastructure must be controlled.

Nevertheless, the mentioned theories emphasize only economic growth and development. The public goods theory proposed by Samuelson (1954) posits that since markets often struggle to efficiently provide public goods, government intervention becomes essential. Under public goods theory, public expenditure on environmental protection, conservation, and sustainable development is justified as a means to address market failures and ensure long-term ecological sustainability. Furthermore, the Environmental Kuznets Curve Hypothesis, also states that the impact of public expenditure in military sectors (nonproductive expenditure category) on development depends on the type of military armament, disposal mechanism and environmental policies of a specific country(Kuznets, 1959).The theory calls an inverted U-shaped bond between GDP and environmental degradation. In the early stages of development, industrialization and economic expansion lead to increased pollution and environmental harm. As income levels rise, societies initiate prioritizing environmental protection, investing in cleaner technologies, and implementing stricter regulations. At higher levels of economic development, economies transition toward more sustainable growth models, leading to a decline in environmental degradation.

The traditional economic model (theories), for example, classical theory, focuses on saving (capital accumulation) and economic growth. This approach mainly emphasizes increasing economic output and ignores future

adverse effects on environmental development. Above all, economic theories and models suggest diverse views on how to manage short-term development challenges, with varying focuses on the role of public intervention, the monetary system, and market forces. These factors make traditional economic theories inadequate for addressing how fiscal policies interact with the complex conditions of sustainable environmental outcomes. This can be further translated into inadequacy when these economic models are used to examine the sustainable development implications of government spending decisions. Resource curse theory claims that states with plenty natural resources conducts extensive extraction of resources and prioritizes militarization over the protection of natural resources, which can exhaust natural capital as the resources take out and assigned for military sectors (Auty., 1993). In this regard, natural resources governance institute, NRGI (2015) stated that though one might assume to see good growth after states realize natural capitals, resource-rich nations tend to have higher rates of war and dictatorship. The institute also argued that, resources rich countries less likely to spend in productive sectors and they fight for control of resources. The natural resources are sources of conflict and public spending from this source is inefficient due to volume and price volatility of resources leading to weak public institution, environmental and social problems.

The states that intend to achieve economic growth and environmental development simultaneously tend to invest in sustainable urban development and climate change management. This tendency underlines the increasing understanding that public spending on sustainability is not a waste of resources but an opportunity for sustainable economic, social and environmental development. Additionally, public expenditure is vigorous in addressing universal sustainability challenges. The World Bank and the International Monetary Fund (IMF) have increasingly recommended that countries align their public resources with the goals and principles of SD (World Bank, 2020). Moreover, Brollo et al. (2021) stated that to realize the SDGs, public expenditures, especially health and education expenditures, need to be intensified. In addition, the fiscal monitoring statement of the IMF (2023) argues that wisely managing government expenditures in pro-poorer areas, e.g., healthcare, educational services and infrastructures,

improves overall sustainable development. Additionally, in the green growth and sustainable development framework, public spending in productive sectors is viewed as a tool for socioeconomic and environmental development sustainability (WCED, 1987).

In contrast, the theory of SD advocates that public military spending can have adverse influences on SD, mainly by diverting funds away from crucial areas such as social wellbeing, ecological development, and sustainable growth in national output. High military expenditure is usually observed as inconsistent with the SDGs, as it naturally cuts existing public resources for investments in key socioeconomic and environmental development sectors (Sachs, 2015). Moreover, augmented defense spending can aggravate ecological destruction through the manufacturing and use of defense technologies, worsen pollution, contribute to the depletion of natural capital, and disrupt socioeconomic sustainability (Muradian et al., 2012). SD theory highlights the advantages of reallocating defense expenditures in the direction of SDGs (Barbier, 2011). However, politicians in many developing countries ignore public choice theory and what, how and why public goods and services should be provided; instead, they prioritize public investment on the basis of their own interest (Buchanan & Tullock., 2017).

There are significant disputes surrounding economic theories on the impact of public expenditure. These theories also overlook environmental aspects and the complex conditions required for sustainable development. Furthermore, the theoretical arguments of sustainable development have yet to be empirically tested in Africa. Thus, this study examines how public spending impacts sustainable environmental development.

2.2 Empirical Reviews

From the reviewed economic theory, it is evident that theoroticians have multifaceted views on the effects of public spending on economic, social and environmental development. In the past 3 decades of government expenditure, the percentage of GDP (% of GDP) has fluctuated frequently in SSA. In an attempt to examine the feasibility of the proposed theories, various scholars have conducted studies using regional, national, continental and global data and explored the effects of these ever-fluctuating public

expenditures in different countries on various environmental development goals and targets.

Environmental impacts of military expenditure

The findings from Intercontinental studies that in Asia, America and Australia on the effects of defense spending on environmental development support the treadmill theory of destruction. The researchers claim that the intensification of public spending in the military leads to an increase in CO_2 emissions, in turn increases environmental degradation(Isiksal, 2021;Tarczyński et al., 2023)**.** Additionally,Habibullah et al. (2023) noted that an increase in defense spending deepens the depletion of biodiversity. In the next eleven (N-11) countries, militarization worsened environmental degradation(Zhu et al., 2023). However, this is not true for BRICS economies; in these states, spending on the ecological footprint is determined to be insignificant (Zhu et al., 2024). A study of the top 20 military powers possessed by nations in the period 1991--2020 revealed that spending on the defense crowding-out effect on green capital formation in eight states contributed positively to eco-friendly investment in the rest of the states (Das & Hussain., 2023). A recent study revealed that in the member countries of Organization for Economic Cooperation and Development (OECD) nations, an increase in defense spending diminishes renewable supply(Kilinc-Ata etal, 2024)**,** which is incompatible with the green growth of OECD members (Ahmed et al., 2021). In industrialized Mediterranean countries, defense also intensifies the environmental crisis and escalates carbon dioxide emissions (Erdogan et al., 2021). The United States of America is also suffering from rising carbon dioxide emissions due to increased spending defenses. In addition, NATO was organized to protect member states from foreign aggression. However, being affiliate with NATO does not rescue member states from environmental degradation (Pata et al., 2022)

In an attempt to understand the impacts of ever-increasing defense spending on the environmental development of Africa, Africa-wide and unilateral (country-specific) studies have been conducted. Researchers have reported that although African countries have no gun (weapons) manufacturing

industries, they are deadly affected by carbon dioxide (CO_2) emissions and nitrous oxide (N_2O) due to intensified defense expenditures (Ngounou etal., 2024). In South Africa, the study findings rejected the treadmill theory of destruction. The results revealed that in the short run, an increase in military expenditure was found to be positive but insignificant, whereas in the long run, an immense reduction in CO2 emissions (Saba., 2023).. A similar study in sub-Saharan Africa revealed that defense expenditure increases CO_2 emissions in the region (Asongu & Ndour, 2023).

Environmental impacts of agricultural expenditure

Sustainable development theory posits that as the state allocates resources to sustainable farming practices (organic farming and agroforestry), they can drive greater environmental development (WCED,.1987; Pretty.,2008). Additionally, innovation and diffusion theory states that public investment in agricultural research and development can accelerate the implementation of ecologically friendly technologies, improving production efficiency and sustainability (Rogers., 2003). Studies on the impacts of public agricultural expenditure in India have shown that amplified agricultural investment, especially when focused on sustainable practices, has a constructive effect on environmental development, as measured by soil health (Lal., 2015). Additionally, Gurr (2016) reported that government agriculture expenditures reduce land degradation and improve water quality in Brazil. Furthermore, a study by the FAO (2013) revealed that in Bangladesh, the public resources allocated to farmers help them adjust to dynamic climate settings, which can lessen the risk of ecological degradation. Furthermore, studies in Ethiopia and Kenya and South Africa by Pretty, (2018) and Niles (2019) revealed that government expenditures on agricultural extension and agricultural infrastructure improved environmental development, whereas research by Dey (2022) revealed that in some developing countries, public investment in agricultural development positively impacts the environment but negatively affects other states.

Environmental impacts of health and education expenditures

Environmental sustainability aims to increase human well-being through the safeguarding of natural wealth (e.g., land, air, water, and minerals). Africa has encountered historic ecological challenges, including land degradation, desertification, loss of biodiversity and dangerous vulnerability to weather

and climate change (United Nation Environmental Program., 2024). Public expenditure on education can have several environmental impacts. The construction of educational facilities involves the consumption of natural resources and can lead to environmental degradation and greater CO_2 emissions. In addition, schools need energy for light, laboratories (heating and freezing), and electronic devices. When energy is produced from renewable sources, it can deteriorate the environmental quality (Gough & Scott, 2007). On the other hand, trained and equipped people are more likely to implement eco-friendly actions, such as recycling, saving energy, and supporting natural resource protection efforts (Sterling, 2004; Tilbury, 2011).

A global study by Ozbay et al. (2022) on "the role of education on environmental quality and renewable energy" revealed that a lower educational level significantly intensifies CO2 emissions and vice versa. In addition, Wu et al. (2023) argued that environmental education can increase ecological importance via green consumption and by controlling smog. Moreover, research by Ahmed. et al.(2021) in Pakistan on the impact of educational expenditure on environmental development has shown that educational expenditure has no long-term effect on environmental development. Furthermore, a study by Yang and Fang (2024) in China on "The impact of education expenditure on environmental innovation" indicated that in addressing the sustainability challenges of the environment, educational expenditure plays a critical role in harmonizing the human and environmental relationship.

Some studies have been conducted in SSA on the environmental impacts of general public expenditure. Osuji and Nwani1(2020) conducted research in Nigeria to determine whether government expenditures affect the SDGs. Researchers have concluded that government expenditure hurts environmental development. Furthermore, Furthermore, Khurshid et al.(2023) explored the effect of education expenditure on environmental sustainability in Pakistan and reported that the effect was negative. According to Bird et al. (2016)Ethiopia's expenditure on climate change activities is comparable to nearly half of the countrywide expenditure on primary schooling and has achieved significant results.

The empirical gaps in studies on the impacts of public expenditure

Empirical studies have one thing in common: carbon dioxide intensifications due to increases in military expenditures. However, these studies focused only on carbon dioxide emissions and greenhouse gas (GHG) emissions, whereas sustainable environmental development is the result of a wide range of actions, such as ensuring Clean Water and Sanitation (SDG6), Climate Action (SDG13), Life Below Water (SDG14) and Life on Land (SDG15). To express this in an imperative manner, earlier global, regional, and national empirical studies overlooked (ignored) multiple sustainable environmental development goals when examining the environmental impact of public military expenditure. Furthermore, the most important problem of earlier studies on the environmental impacts of government expenditures on agriculture was that they failed to take into account the compressive sustainable environmental development goals suggested by the United Nations. For example, to measure environmental development, Lal (2015) employed organic farming in India, Gurr. (2016) used only soil degradation in Brazil, Niles. (2019) in Kenya employed only ecofriendly agriculture.

3. Research Methodology

The purpose of this research was to examine the impact of military expenditures, agricultural expenditures, health expenditures, and education expenditures on SED in SSA. The environmentally sustainable development index was computed using (SDG 6, 13, and 15) because data were not available for SDG14 (life below water). The world bank research group members Sachs et al (2023) have computed general sustainable developments index score using linear average of 17 SDGs. In this study the similar technique of creating SED index followed using 3 sustainable environmental development goals(SDG 6, 13, and 15) out of 17 SDGs.

$$\text{SED index}_{i,\,t} = \frac{1}{N}\sum_{n=1}^{n} SDGi, t$$

Where: SED index $_{i,\,t}$ =sustainable environmental development index of country i, at time t, SDG_{ij} =Sustainable environmental development goal j of country i, at time t. SDGi= *(SDG 6, 13, and 15)*

Using an aggregate index for development is a good guide for policy decision making and implementation, as it portrays the components behind it (Stiglitz., 2009).The data for the dependent variable (sustainable environmental development) were collected from the World Bank database,

which is computed by Sachs et al. (2023), and the public expenditure data were collected from the World Bank, the IMF and the Ministry of Finance and Central Bank of some countries. In practical analyses, sustainable environmental development is proxied by an aggregate of sustainable environmental development goals computed by Sachs et al. (2023) for 193 states since 2000 by considering seventeen United Nations' sustainable development goals. For example, in 2016, for the index score of SDG6 for country i, 52.5% means that a country has realized (performed) 52.5% of SDG6 (Clean Water and Sanitation), which is measured by the indicators of SDG6. The rationale behind considering agriculture, health and education expenditures is pro-poor, but their misallocation has been criticized for misallocation, extravagance and inadequacy of these expenditures (IMF, 2019;United Nations, 2020; AfDB, 2022; Singh & Chudasama, 2020; World Bank, 2021), and the agricultural sector's impact overlooked budgeting practice (FAO, 2021), while their impact on sustainable environmental development is open for empirical debate. Furthermore, military expenditure in SSA has increased for a decade in the absence of clear empirical evidence of its impact on environmental development. Expenditures are measured as a percentage of GDP because they can yield information on multinational comparisons and generate prominent information for policy makers to make conversant decisions on taxing and spending (Pettinger, 2019).

The countries in Sub-Saharan Africa have unique socioeconomic and environmental settings in Africa, consisting of 48 countries, whereas according to a World Bank research group Sachs et al. (2023), SDG data are not maintained by five states (i.e., Eritrea, Equatorial Guinea, Guinea-Bissau, São Tomé and Príncipe, and Seychelles). Hence, these patients were excluded from the study. Moreover, owing to the absence of sufficient (required) public expenditure data on the mentioned dependable data source, 8 (eight) states were not considered in the study; consequently, the study considered 35 countries with sufficient sustainable environmental development indicators and public expenditure data from credible sources. With respect to the required number of observations for dynamic panel data analysis, where the dependent variable is a regressor in a model, Roodman (2006) suggested that in dynamic panel estimation, the cross-section(N) >20

and time series(T) is a continuous observation >4. In determining the required time series data for a dynamic panel data model, Greene (2007) insisted that when the lagged value of the dependent variables is an explanatory variable in a model, a minimum of three consecutive period observations is needed. Additionally, Roodman (2006) suggested that for generalized methods of moments (GMMs), the panel data analysis time period (T)<15, but there is no fixed limit. This is why the most recent 15 years (2008--2022) of observations were used. In line with this condition, the study used 15 years of balanced and consecutive SDG and public expenditure data from 2008--2022.

Model Specification

In the initial stage of analysis, to gain a general understanding of the empirical relationship between public expenditures and sustainable environmental development, the baseline regression model was important, but the model assumes that the beta coefficients of all explanatory variables are similar for each cross section or country (Dunne et al., 2004). The pooled OLS model is presented below.

$$Y_{it} = \alpha + \beta' X_{it} + \varepsilon_{it}$$

In the equation above, *Xit*denotes the vector of predictor variables, while t signifies the time and i stands for the dimension of the country. There are also other intricate methods of analysis available for understanding the associations between the explanatory and the outcome variables. When the time period is long and endogeneity is not a problem in a model, using fixed and random effects models is the right choice for analysis. This study examined the impacts of public expenditure on sustainable environmental development and how the lagged level of sustainable environmental development impacts current performance. Moreover, analyzing the impacts of lagged values of the outcome variable in traditional fixed and random effects estimation models leads to incorrect and unpredictable estimates (Pesaran, & Smith, 1995). Hence, dynamic panel estimators are used when the lagged outcome variable is regressor in a model (Roodman.,2006). Additionally, Arelleno and Bond (1991) insisted that the generalized method of moments (GMM) is the right choice for panels with endogeneity problems, correlations of the error term with the explanatory variable, large cross-sections (N>25) and small time series (T<15). When the lagged value

of the outcome variable included in a model as a regressor variable and fixed effect exist, the coefficients of the explanatory variables are vulnerable to Nickell bias (the correlation of the lagged value of the dependent variablewith the fixed effect) and drive unreliable parameter estimates (Nickell,1981). In these situations, fixed effect estimates never suitably address such correlations (Roodman.,2006)). Additionally, Arellano and Bond (1991) argued that fixed effect analysis runs against the assumption of exogeneity required for consistent estimates. To mitigate the misleading effects of fixed effects in the dynamic panel data model, the transformation (differencing) of the data is a critical measure (Blundell & Bond,1998). Hence, in this study, the second lagged values of SED are employed as instrument variables to substitute for the endogenous variable to overcome the endogeneity problem.

Sustainable development theory suggests that the variance (change) in the dependent variable (i.e., SED) at time *t* is subjected to change in response to the change in the observed value of public expenditure at time *t* and its own lagged values:

The dynamic panel model is presented below shows the typical system-GMM specification in levels and first difference respectively presented to examine how government spending affect the sustainable environmental development presented.

1) $$SED_{i,t} = \sigma_0 + \sigma_1 SED_{i,t-\tau} + \sigma_2 GMILEX_{it} + \sigma_3 GAGREX_{it} + \sigma_4 GHEEX_{it} + \sigma_5 GEDUEX_{it} + \eta_i + u_t + \epsilon_{it}$$

2) $$SED_{i,t} = \sigma_0 + \sigma_1\left(SED_{i,t-\tau} - SED_{i,t-2\tau}\right) + \sigma_2(GMILEX_{it} - GMILEX_{it-\tau}) + \sigma_3(GAGREX_{it} - GAGREX_{it-\tau}) + \sigma_4(GHEEX_{it} - GHEEX_{it-\tau}) + \sigma_5(GEDUEX_{it} - GEDUEX_{it-\tau}) + (u_t - u_{t-\tau}) + (\epsilon_{it} - \epsilon_{it-\tau})$$

Where:

The $SED_{i,t}$ denotes sustainable environmental development index of country i in period t, σ_0 is a constant, τ, is the degree of auto-regression that is one as such a lag correctly handle past statistics, GMILEX, GAGREX, GHEEX & GEDUEX stands for government military, agricultural, health, and education expenditure, σ_1, σ_2, σ_3, σ_4 & σ_5 represent the (coefficients) magnitude of the effects of lagged social development, GMILEX,

GAGREX, GHEEX & GEDUEX at time t, on the SED of country i at time t, respectively. $\eta_i$is the country-specific effect, u_t is the time-specific fixed effect, and ϵ_{it} is the disturbance terms.

Table 1: Discriptive Statistics—Sustainable Economic Development (2008--2022)

	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Mean
Countries	SDG 6	SDG 6	SDG 6	SDG 13	SDG 13	SDG 13	SDG 15	SDG 15	SDG 15	Sustainable Environmental Development
Angola	48.59	54.29	52.09	90.40	96.35	93.62	66.18	67.06	66.78	70.83
Benin	47.74	49.41	48.69	97.78	98.35	98.05	65.39	66.87	66.51	71.08
Botswana	60.49	68.14	65.27	85.06	89.43	87.74	74.09	74.42	74.19	75.73
Burkina Faso	44.84	46.02	45.39	98.80	99.15	98.96	83.59	87.94	87.64	77.33
Burundi	52.98	55.23	54.32	99.73	99.78	99.75	72.21	72.94	72.73	75.60
Cabo Verde	58.33	67.39	63.48	97.07	97.77	97.45	70.88	71.64	71.41	77.45
Cameroon	53.41	55.97	54.88	98.06	98.37	98.20	63.54	64.82	64.38	72.48
CAR	40.42	44.70	41.96	99.43	99.70	99.53	89.72	89.93	89.87	77.12
Chad	40.62	42.40	41.58	98.11	99.09	98.77	75.16	78.54	77.48	72.61
Congo (The)	47.45	51.99	50.37	89.96	92.50	91.58	77.54	83.54	80.39	74.11
Cote d'Ivoire	53.35	55.25	54.42	97.73	98.53	97.95	69.57	74.44	73.26	75.21
DRC Congo	42.11	43.18	42.62	99.42	99.61	99.56	69.10	70.64	69.37	70.52
Eswatini	43.42	50.52	47.64	96.62	98.05	97.45	49.98	50.55	50.35	65.15
Ethiopia	53.41	55.97	54.88	98.06	98.37	98.20	63.54	64.82	64.38	72.48
Gabon	58.72	61.37	60.39	83.85	89.92	86.63	82.69	83.19	82.81	76.61
Ghana	50.84	57.68	54.69	96.57	97.61	96.96	67.97	72.89	71.44	74.36
Kenya	45.64	46.96	46.23	98.38	98.83	98.56	58.50	60.80	59.78	68.19
Lesotho	41.41	49.65	46.13	96.22	97.56	97.16	74.23	74.29	74.26	72.51
Liberia	50.13	53.00	51.80	98.28	99.05	98.73	47.63	50.44	49.58	66.70
Madagascar	***40.71***	***44.87***	***42.96***	***99.34***	***99.48***	***99.40***	***42.53***	***49.89***	***47.16***	***63.17***
Malawi	48.57	52.47	50.80	99.40	99.58	99.51	60.36	61.56	61.23	70.51
Mali	***50.91***	***61.71***	***57.01***	***98.97***	***99.24***	***99.07***	***85.06***	***86.76***	***85.33***	***80.47***
Mauritania	47.61	58.16	54.31	96.13	97.52	97.08	51.10	51.29	51.20	67.53
Mauritius	68.64	71.13	70.75	91.24	92.75	91.89	26.17	27.41	26.66	63.10
Mozambique	42.89	54.70	48.94	97.46	98.89	98.32	63.11	67.06	65.63	70.96
Namibia	53.63	56.01	55.03	82.79	91.19	88.07	81.62	89.86	88.20	77.10

Niger (The)	40.67	43.31	42.23	99.43	99.54	99.48	58.02	73.98	64.28	68.67
Nigeria	50.54	59.71	55.69	96.19	97.35	96.85	74.61	79.70	78.22	76.92
Rwanda	53.72	57.75	56.28	99.25	99.46	99.34	66.80	67.96	67.25	74.29
Senegal	57.18	64.81	61.52	97.57	98.35	97.90	66.30	67.40	66.98	75.47
South Africa	61.63	64.12	62.42	77.50	82.70	80.60	56.93	58.15	57.65	66.89
Togo	45.08	50.89	48.52	98.44	98.94	98.76	77.56	82.91	81.15	76.14
Uganda	41.72	47.39	44.59	99.32	99.43	99.37	62.00	67.84	65.79	69.92
Tanzania	41.39	51.66	47.45	98.87	99.21	99.07	58.53	60.77	59.85	68.79
Zambia	48.34	52.93	50.98	97.46	98.47	97.99	68.37	70.62	69.98	72.98
SSA	**48.59**	**54.29**	**52.09**	**90.40**	**96.35**	**93.62**	**66.18**	**67.06**	**66.78**	**70.83**

Source: (SDG Transformation Center-2024)

Data standardization

The SED performance has numerical values for diverse gauges, and a larger achievement in one goal may overwhelm the small value's results in the other(s). In most countries in SSA, a significantly large score is noted in SDG13 (climate action); if standardization is overlooked, the SED score would have been deceptive. Hence, standardizing the performance score is vitally important (Petkovová et al., 2020; Sharm & Bandyopadhyay, 2023). In this context, Petkovová et al. (2020) stated that there are numerous means to standardize data, but the min–max method is the most efficient and largely recognized method for CI buildings.

$$N(X)_{ij} = \left[\frac{x_{ij} - \min(x_{ij})}{\max(X_{ij}) - \min(X_{ij})}\right]$$

4.2 Discriptive Analysis, Government Expenditure

The results in Table 3 show that in SSA, the average largest public expenditure in the period between 2008 and 2022 was health expenditure, followed by education expenditure. Additionally, the table shows that there are significant differences among states in the allocation of public resources in military, agriculture, health and education in SSA.

Table 2: Max-Min Standardized Sustainable Environmental development

Mean	0.539139
Median	0.562119
Maximum	1.00000
Minimum	0.00000
Std. Dev.	0.338060
Skewness	-0.173562
Kurtosis	1.646349

Jarque-Bera	42.71894
Probability	0.000000
Sum	283.0479
Sum Sq. Dev.	59.88500
Observations	**525**

Source: SDG Transformation Center-2024

Table 3: Public Expenditure in Percentage of GDP (2008-2022)

		Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Countries	Observations	GMILEX(%GDP)	GMILEX(%GDP)	GMILEX(%GDP)	GAGREX(%GDP)	GAGREX(%GDP)	GAGREX(%GDP)	GHEEX(%GDP)	GHEEX(%GDP)	GHEEX(%GDP)	GEDUEX(%GDP)	GEDUEX(%GDP)	GEDUEX(%GDP)
Angola	15	1.29	4.71	2.96	0.08	1.12	0.30	1.08	2.60	1.54	2.04	3.87	2.77
Benin	15	0.46	0.92	0.66	0.47	1.73	1.09	0.28	0.87	0.55	2.78	4.40	3.26
Botswana	15	2.15	3.41	2.86	0.74	2.05	1.33	3.41	5.02	4.11	6.38	10.10	8.37
Burkina Faso	15	1.15	3.09	1.62	0.46	1.16	0.80	1.06	2.83	1.86	3.50	5.63	4.59
Burundi	15	2.00	4.00	2.59	0.48	1.69	0.98	1.06	2.83	1.94	4.69	8.00	6.05
Cabo Verde	15	0.49	0.66	0.55	0.57	1.78	1.07	2.45	4.71	3.17	2.87	3.94	3.41
Cameroon	15	0.95	1.29	1.12	0.61	1.11	0.80	0.14	0.64	0.47	2.50	3.10	2.78
CAR	15	1.34	2.83	1.84	0.20	1.84	0.96	0.42	2.64	0.89	1.11	2.64	1.77
Chad	15	2.02	7.96	3.92	0.38	1.65	0.87	0.65	1.22	0.89	1.79	2.89	2.38
Congo (The)	15	1.66	4.94	2.52	0.17	0.86	0.40	0.62	1.90	1.10	2.40	5.69	3.70
Cote d'Ivoire	15	0.89	1.26	1.06	0.32	1.01	0.53	0.32	1.33	0.70	2.87	3.94	3.41
DRC	15	0.54	1.30	0.85	0.07	0.83	0.28	0.25	0.76	0.50	1.28	2.93	2.12
Eswatini	15	1.65	2.37	1.96	0.50	3.02	1.06	2.74	4.46	3.57	5.08	7.07	5.90
Ethiopia	15	0.49	1.52	0.84	0.59	3.22	1.33	0.38	1.12	0.86	3.74	5.57	4.79
Gabon	15	1.14	2.00	1.58	0.05	0.22	0.10	1.06	2.01	1.65	2.21	3.56	2.97
Ghana	15	0.28	0.59	0.37	0.12	0.35	0.20	1.30	2.90	1.97	2.91	8.14	4.72
Kenya	15	1.00	1.62	1.27	0.39	1.02	0.61	0.85	2.22	1.72	4.02	5.11	4.70
Lesotho	15	1.47	3.16	2.04	1.12	2.51	1.71	3.98	6.38	5.31	6.43	12.33	8.21
Liberia	15	0.50	1.27	0.97	0.21	0.90	0.46	0.34	1.69	1.20	1.70	2.66	2.14
Madagascar	15	0.50	0.96	0.62	0.37	1.00	0.60	0.68	2.37	1.48	1.78	3.25	2.66
Malawi	15	0.45	0.95	0.69	1.14	4.82	2.97	0.96	2.50	1.64	2.43	5.85	3.63
Mali	15	1.16	3.44	2.17	1.44	4.06	2.92	0.41	1.39	0.96	3.09	4.36	3.66
Mauritania	15	2.00	3.14	2.35	0.14	1.44	0.84	0.73	1.60	1.13	1.28	3.71	2.34
Mauritius	15	0.14	0.19	0.16	0.44	1.29	0.68	1.39	3.33	2.33	3.05	4.88	4.16
Mozambique	15	0.66	2.02	1.12	0.32	1.44	0.67	1.24	3.50	1.80	5.39	8.21	6.17
Namibia	15	3.00	4.53	3.51	0.62	1.86	1.00	3.46	5.00	4.13	6.40	10.31	8.92
Niger (The)	15	0.74	1.92	1.38	0.33	1.76	0.94	1.04	2.31	1.59	2.58	5.10	3.51
Nigeria	15	0.41	1.01	0.54	0.09	0.44	0.15	0.40	0.66	0.51	0.80	1.75	1.12
Rwanda	15	1.04	1.51	1.25	0.74	1.56	1.12	1.82	4.20	2.39	3.07	5.59	4.01
Senegal	15	1.11	1.74	1.39	1.18	2.79	1.96	1.01	1.72	1.22	4.03	5.72	5.18
South Africa	15	0.74	1.09	0.96	0.32	0.75	0.47	3.38	5.30	4.36	4.37	6.56	5.53
Togo	15	1.53	5.44	2.24	0.37	1.64	1.03	0.61	1.63	1.03	2.42	4.23	3.55
Uganda	15	0.89	2.68	1.64	0.45	0.89	0.59	0.57	1.11	0.88	1.73	2.64	2.18
Tanzania	15	0.70	1.09	0.98	0.12	0.91	0.40	0.83	2.26	1.35	3.12	4.64	3.94
Zambia	15	0.98	2.08	1.43	1.14	2.90	1.64	1.31	3.60	2.05	1.10	4.74	3.57
SSA	**525**	**1.07**	**2.36**	**1.54**	**0.48**	**1.65**	**0.94**	**1.21**	**2.59**	**1.80**	**3.06**	**5.23**	**4.06**

Sources: World Bank, IMF and MOF (2024)

Table 4: Endogeneity test

Covariance Analysis: Ordinary, Sample: 2009 2022: Included observations: 490 Balanced sample						
	Correlation (t-Statistic) Probability					
	Error(ϵ_{it})	**L._SED**	**GMILEX**	**GHEEX**	**GEDUEX**	**GAGREX**
Error(ϵ_{it})	1.000000					
L.SED	0.579213	1.000000				
	15.12292	-----				
	0.0000***	-----				
GMILEX	-0.046963	-0.061155	1.000000			
	-1.000644	-1.304053	-----			
	0.3175	0.1929	-----			
GHEEX	0.039698	0.142880	0.182169	1.000000		
	0.845591	3.072557	3.943226	-----		
	0.3982	0.0023	0.0001	-----		
GEDUEX	-0.003760	0.067726	0.315166	0.720269	1.000000	
	-0.080033	1.444775	7.068137	22.09917	-----	
	0.9362	0.1492	0.0000	0.0000	-----	
GAGREX	-0.012512	-0.033472	0.121876	0.101466	0.192400	1.000000
	-0.266319	-0.712820	2.613459	2.170786	4.172976	-----
	0.7901	0.4763	0.0093	0.0305	0.0000	-----

Sources: Authors' own computation

Table 5: Heteroscedasticity

Panel Cross-section Heteroskedasticity LR Test Null hypothesis: Residuals are homoscedastic			
	Value	df	Probability
Likelihood ratio	323.3613	35	0.0000
LR test summary:			
	Value	df	
Restricted LogL	131.7757	484	
Unrestricted LogL	293.4563	484	

Sources: Authors' own computation

Table 6: Stationarity test

Newey–West automatic bandwidth selection and Bartlett kernel: Total (balanced) observations: 455 Cross-sections included: 35: Method: Levin, Lin & Chu t*		
Variables	Statistic	Prob.**
SED	-2.59888	0.0047
GMILEX.	-5.463191	0.0000
GAGREX	-5.472894	0.0000
GHEEX.	-2.691530	0.0036
GEDUEX.	-5.721083	0.0000

Source: Authors' computation

Table 7: Test for Cross-Sectional Dependence

Residual Cross-Section Dependence Test Periods included: 15, Cross-sections included: 35: Total panel observations: 525			
Test	Statistic	d.f.	Prob.
Breusch–Pagan LM	2288.891	595	0.0000
Pesaran scaled LM	49.10343		0.0000
Bias-corrected scaled LM	47.75728		0.0000
Pesaran CD	0.502976		0.6150

Source: (Authors' computation by-EViews 10)

Table 8: Multicollinearity test

Model		Collinearity Statistics	
		Tolerance	VIF
1	SED_1	.968	1.033
	MIL	.445	2.248
	AGR	.475	2.105
	HEALTH	.939	1.065
	EDU	.916	1.091
a. Dependent Variable: SED			

Source: (Authors' computation

Model selection

$SEDD_{it} = \Phi * SED_{it-1} + \beta X'_{it} + u_{it} + \epsilon_{1it}$ where i= 1, 2….. N (35), T= 1, 2, T (15) in deciding whether to use difference or system GMM, Bond (2001) suggested that the pooled OLS value of lagged SED(Φ) must be considered as the upper bound estimate and that the fixed effect figure of Φ should be considered as the lower bound estimate. If the value of Φ in difference GMM is close to or less than the value obtained by fixed effect estimate, difference GMM yields downward biased and inefficient estimates. The coefficient of the lagged value of the dependent variable in Table 9 (Φ=0.601781 obtained from the difference GMM<Φ=0.744737 obtained from the fixed effect estimate) suggests that the system GMM is the preferred estimate over the difference GMM.

Table 9: Model comparison: OLS, fixed and difference GMM estimates

Regressor Variables	OLS-Estimate Coefficient (Std. Error) Prob.	Fixed Effect-Estimate Coefficient (Std. Error) Prob.	Difference GMM-Estimate Coefficient (Std. Error) Prob.
L1. SSD (ϕ)	0.783716	0.744737	0.601781
	(0.030296)	(0.037514)	(0.015956)
	0.0000***	0.0000***	0.0000***
GMILEX.	-0.000644	0.008155	0.087931
	(0.005849)	(0.017400)	(0.004382)
	0.9124	0.6395	0.0000***
GAGREX.	0.008698	-0.002988	0.013725
	(0.006884)	(0.021667)	(0.004535)
	0.2070	0.8904	0.0000***
GHEEX.	0.011246	0.045909	0.128610
	(0.006075)	(0.022583)	(0.005208)
	0.0648*	0.0427**	0.0000***
GEDUEX.	0.000685	-0.020110	0.013725
	(0.005541)	(0.009759)	(0.004535)
	0.9017	0.0399**	0.0026***
R-squared	0.672524	0.689600	******
Adjusted R-squared	0.669141	0.662699	******
F-statistic	198.7941	25.63441	******
Prob(F-statistic)	0.0000***	0.0000***	******
		Hausman Test Chi-Sq. Statistic	12.115646
		(Chi-Sq. d.f)	(5).
		Prob.	0.0332****

Sources: Authors' own computation (EViews 10)

Arellano–bond serial correlation test result in Table 10 shows that endogeneity problem removed in Model-4 where the fifth lag of outcome variable used as explanatory. Moreover, the sign and significancy of the coefficients of all explanatory variables in five-alterative models are the same signifies that the stability of results under varied instrument variables.

Table 10: Model stability test and Valid Instrument Identification (Arellano-Bond Dynamic Panel Estimations (Two-Step System GMM))

	Model-1	Model-2	Model-3	Model-4	Model-5
L1. SED.	0.626242	0.531070	0.458769	0.399333	0.471621
	(0.022692)	(0.011881)	(0.021550)	(0.004824)	(0.011102)
	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
GMILEX.	0.088986	0.127762	0.154897	0.229190	0.165768
	(0.013205)	(0.008014)	(0.007821)	(0.005685)	(0.008094)
	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
GAGREX.	0.033544	0.137606	0.158384	0.210494	0.196371
	(0.012490)	(0.003694)	(0.002537)	(0.004482)	(0.025885)
	0.0075***	0.0000***	0.0000***	0.0000***	0.0000***
GHEEX.	0.104460	0.142293	0.193826	0.208285	0.133893
	(0.059992)	(0.013573)	(0.011838)	(0.010780)	(0.018716)
	0.0823	0.0000***	0.0000***	0.0000***	0.0000***
GEDUEX.	0.009009	0.011269	-0.026216	0.001026	0.141417
	(0.019435)	(0.007271)	(0.005741)	(0.005303)	(0.009817)
	0.6432	0.1219	0.0000***	0.8468	0.0000***
Sample (adjusted):	13	13	13	13	13
Cross sections	35	35	35	35	35
Observations	455	455	455	455	455
Instrument Overidentification- Hansen J Test					
Model	Model-1	Model-2	Model-3	Model-4	Model-5
Instrument variable	L2_SED	L3_SED	L4_SED	L5_SED	L6_SED
Mean dependent var	-0.133171	-0.133171	-0.133171	-0.133171	-0.133171
S.E. of regression	0.202744	0.229999	0.246223	0.285904	0.286523
J-statistic	28.69944	34.43131	30.91463	33.46597	32.47295
Prob(J-statistic)	0.533424	0.263919	0.419613	0.302682	0.345864
Instrument Relevance- F Test					
Coefficient	0.785715	0.619834	0.415687	0.274769	0.121265
R-squared	0.655878	0.409791	0.183804	0.079739	0.013730
Adjusted R-squared	0.655118	0.408379	0.181673	0.077095	0.010578
F-statistic	863.3925	290.2232	86.25000	30.15369	4.357158
Prob(F-statistic)	0.000000***	0.000000***	0.000000***	0.000000***	0.037662**
Arellano–Bond Serial Correlation Test					
AR (1) - m-Statistic	-3.697039		-2.475873	-3.595137	-9.641252
(SE (rho))	(3.245242)	NA	(4.006162)	(2.566370)	(1.078139)
Prob.	0.0002		0.0133	0.0003	0.0000
AR (2) - m-Statistic	2.285936	0.000870	2.016884	1.571282	1.058409
(SE (rho))	(1.341813)	(3216.685)	(1.130005)	(1.298140)	(1.914150)
Prob.	0.0223	0.9993	0.0437	0.1161	0.2899

Source: (Authors' computation by-EViews 10)

Note: Dependent variable=SED, * & **, denote statistically significant variables at the 1% and 5% levels of significance, respectively.**

Table 11 supports the robustness(stability) of models tested in above table 10. The Robust Least Squares estimation reveals that the coefficients and sig of all

explanatory variable remain the same as the valid models in difference and Two-step system GMM.

Table11: Robust Least Squares estimation

Dependent Variable: SED
Method: Robust Least Squares: Sample (adjusted): 2009 2022
Included observations: 490 after adjustments: Huber Type I Standard Errors & Covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
L1. SED	0.964869	8.11E-05	11898.37	0.0000
GMILEX.	0.004773	3.06E-05	155.9886	0.0000
GAGREX.	0.017255	4.16E-05	414.4205	0.0000
GHEEX.	0.000259	3.60E-05	7.204554	0.0000
GEDUEX.	0.000018	0.000032	0.553846	0.0534

	Robust Statistics		
R-squared	0.732887	Adjusted R-squared	0.730684
Rw-squared	0.928881	Adjust Rw-squared	0.928881
Akaike info criterion	866.5818	Schwarz criterion	897.5682
Deviance	5.139003	Scale	0.077007
Rn-squared statistic	4.33E+08	Prob(Rn-squared stat.)	0.000000

Source: (Authors' computation by-EViews 10)

Table 12: Optimal Model - Arellano-Bond Dynamic Panel Estimations

	(Difference GMM)	(Two-Step System GMM)
	SED (Outcome Variable)	SED (Outcome Variable)
L1. SED	0.395228	0.399333
	(0.010622)	(0.004824)
	0.0000***	0.0000***
GMILEX.	0.228025	0.229190
	(0.006752)	(0.005685)
	0.0000***	0.0000***
GAGREX.	0.213451	0.210494
	(0.005523)	(0.004482)
	0.0000***	0.0000***
GHEEX.	0.205980	0.208285
	(0.015249)	(0.010780)
	0.0000***	0.0000***
GEDUEX.	0.005536	0.001026
	(0.005279)	(.005303)
	0.2948	0.8468
Sample (adjusted): 2010 2022(Min.obs.)	13	13
Cross section (Number of countries) included	35	35
Observations	455	455

Source: Authors' computation: Note: * & **, denote statistically significant variables at the 1% and 5% levels, respectively.**

5. Results and Discussion

Table 11 presents the results from the different GMM and two-step system GMM methods. We focused on the coefficients obtained from two-step system GMM, as it is more efficient than the difference GMM is, as stated in the model comparison results of Table 9, although the sign and significance of the coefficients of the explanatory variables are the same under both difference GMM and two-step system GMM. Econometricians state that the regression results from optimal GMM estimators are invariant to the transformation method (i.e., orthogonal transformation in system GMM differencing in difference GMM) (Blundell, & Bond,1998; 2000).In this study, the coefficients of all explanatory variables are consistent in both the difference GMM and two-step system GMM). The results indicate that the coefficient of military expenditure is positive, indicating that military expenditure positively and significantly affects sustainable environmental development in SSA. In sub-Saharan Africa government expenditure in % of GDP on average accounts 1.54% is larger than spending in agriculture which critical need in SSA. The results revealed that a 1% increase in military expenditure led to a [0.229190 units] increase in the minmax standardized value of the SED outcome in the study area. This positive impact of military expenditure might have varied across a country in the study area due to differences in governance, infrastructure, and policy implementation among a country.

Sustainable development theory claims that when government military expenditure is not aligned with SDGs goals, it damages SED. The theory argues that the plants that are used to produce guns, ship them, and extraction of minerals for their manufacture all cause massive harm to energy and natural resources and are key suppliers of pollution and environmental worsening (WCED., 1987). Fortunately, in Africa, there are no massive weapon factories that can trigger environmental pollution or natural resource destruction. In Africa, there are no massive weapon factories that can trigger environmental pollution or natural resource destruction. In addition, the military sector in many countries in Sub-Saharan Africa links military activities with ecological development. For instances, growing investment in South Africa in solar energy and electric vehicles for military operations to reduce its CO_2 emissions (Defense

Web.,2017), extensive investments by Uganda in ecofriendly military training infrastructures since 2017 (Uganda Vision 2040., 2018), defense force deployment in Kenya and Tanzania to defend national parks and woodlands from illegitimate hunting and gathering activities, strong participation and rapid response of the military to natural disasters such as heavy erosion, and wildfires in Ethiopia (UNEP & UNHCR. 2017).

The result confirm that sustainable development theory does not hold true in SSA, where as the result is consitent with ecological modernization theory (Mol &Spaargaren, 2000), stating that government expenditures in the military can support environmental development and improve SED is valid. This finding contradicts the findings of (Isiksal, 2021;Tarczyński et al., 2023),who stated that government expenditures in the military increase Co_2 emissions, thereby negatively affecting environmental development. Additionally,Habibullah et al. (2023)noted that an increase in defense spending deepens the depletion of biodiversity, and in Next eleven (N-11) countries, militarization worsened environmental degradation(Zhu et al., 2023).This is most likely due to those studies conducted in developed states where weapon manufacturering are considered equal to or more important than other factories and studies that consider a single goal or target of SED by overlooking goals such as living on land, engaging in climate action, and cleaning water and sanitating. Nevertheless, the findings are consistent with those of a previous study in which government expenditures on the military have a crowding-in effect on green capital (Das & Hussain., 2023); the study by Saba. (2023) determied that military expenditure reduces CO_2 emmisions in long-run. Additionally, Solarin et al. (2018) argued that technological investment in the military reduces the threat of environmental development. In addition researcher noted that investment inmilitary research and development can lead to improvements in environmental technologies and advance environmental development (Radelet& Sachs,1998), and Smith (2016) argued that when investment strategies incorporate environmental development, valuable ecological outcomes can result.

In addition, Sustainable development theory argues that increased public expenditure on agriculture promotes sustainable farming practices, a farming activity aimed at meeting the nutrition needs of the current

generation deprived of compromising the capacity of coming generations to satisfy their own needs unlike conventional farming system which less efficient in land management, low access of modern agricultural technologies and results soil depletion. sustainable farming practices links environmental conservation, economic efficiency, and social justice. In sustainable farming practices, water conservation, use of carbon-based inputs(low carbon emitting), and soil management practices and enhanced farmers' awareness of overall natural resource management, brings environmental development (WCED., 1987; FAO, 2016; OECD, 2020). The coefficients from both difference and system GMM revealed that the effect of agricultural expenditure on SED is positive and significant at the 1% level. A 1% increase in agricultural expenditure leads to a [0.210494units] increase in the standardized value of SED in SSA. Thus, the study failed to reject sustainable development theory. However, the magnitude of effects of agricultural expenditure on sustainable might be different from state to state due to differences in agricultural policies and infrastructures.

Moreover, the study results are inconsistent with the findings of earlier studies. For example, Kelsey and Rudd (2021) noted in their study that government expenditures on the production of certain crops, corn, rice and wheat, can lead to biodiversity forfeiture and degradation of the environment. Zhao et al. (2022) also reported that the intensification of public spending on water-intensive crops has increased water contamination and reduced resource use. Public investment in traditional farming practices contributes to environmental quality deterioration (Ghosh & Ranjan, 2023), whereas the findings are consistent with the findings of Gurr et al. (2016) in Brazil, who concluded that public agricultural spending reduces land degradation and increases water quality. Moreover, research by the FAO (2013) revealed that in Bangladesh, public funds help farmers adjust to variable climate conditions, which can lessen the risk of ecological degradation.

Additionally, the results in Table 12 show that health expenditure has a positive and significant effect on SED at the 1% level of significance. This is true for both the difference and system GMM. The coefficient from the system GMM shows that a 1% increase in health expenditure leads to a [0.208285 units] increase in the minmax standardized value of the SED

outcome in SSA. Hence, the study confirmed that sustainable development theory upholds in points of view of this expenditure. The theory posits that the government should invest in housing, health, and food security to improve natural resource quality. These findings are in line with those of previous studies. They reported that government expenditure on health is important determinant of achieving sustainable development goals (Meiling et al. 2022)that healthier people are usually more capable of contributing to environmental initiatives, leading to improved environmental resilience (WHO, 2020), and environmentally unified government expenditures on health increase ecological development(Khan & Kumar, 2021). On the other hand,Ganada (2021) reported thatdomestic general public health spending intensifies carbon emissions in BRICS countries. However, this study used a modified ordinary least square model, whose static model cannot consider the effects of lagged development and endogeneity problems because lagged dependent variables are included as regressor variables.

Finally, the study tests whether government education expenditures affect SED in SSA. In difference and system GMM, education spending has a positive but insignificant effect on SED in SSA, though Public expenditure in education in SSA on average accounts more than 4 percent of GDP which is determined to have the largest of all expenditures considered in this study. This indicates that spending in education in the study area failed to significantly considered environmental education viz., effect of human actions, and the role of caring and sustaining the natural capitals and fostering the consciousness and understanding of ecological matters. Nevertheless, sustainable development theory, which argues that government investment in education improves the awareness and skills of people, enables them to participate in sustainable environmental development activities such that the benefits of environmental development fail to be rejected based on the positive coefficient of the study result. Earlier researchers have argued that trained and equipped people are more likely to implement eco-friendly actions, such as recycling, saving energy, and supporting natural resource protection efforts (Orr, 2004; Sterling, 2004; Tilbury, 2011). A lower educational level significantly intensifies CO2 emissions and vice versa (Ozbay et al, 2022), and environmental education can advance ecological importance via green consumption and

reduce pollution (Wu et al. 2023). Spending on education can produce long-term benefits for ecological sustainability (Bowers, 2020). Nevertheless, Gough and Scott (2007), in their study, argued that schools need energy for light, laboratories (heating and freezing), and electronic devices. Although renewable energy sources can deteriorate environmental quality, the most important problem in these studies was their failure to consider a broad range of sustainable environmental development proxies. To sum up, public spending in military, agriculture, health, and education in SSA can improve sustainable environmental development when the expenditures are directed towards improving the targets of SDG6 such as drinking water, and sanitation services, waste water treatment, water management services, reducing carbo-dioxide emissions (using renewable energy source), and effective carbon pricing, caring terrestrial and freshwater sites, and reforestation

5. Conclusion and Policy Recommendations

In this research, dynamic panel estimates for Sub-Saharan African countries for the time period of 2008--2022 revealed that government military expenditure has a positive and significant effect on SED, suggesting a possible intersection between state security and environmental development sustainability. To improve environmentally sustainable development in sub-Saharan African countries, policy makers have suggested intensifying military expenditures (expenditures in defense technologies) those improves environmental development sustainability, such as the use of green technologies those conserve natural resources and helpful to manage them. Moreover, investment on solar energy and electric vehicles for military operations, increasing training and participation of military force in environmental protections. The empirical results of this study show that high agricultural expenditure may contribute to ecological quality improvement through sustainable (eco-friendly farming) or organic farming practices, which can lead to high quality of life on land, good climate conditions and clean water and sanitation. Public investment in agriculture needs to target sustainable farming practices, promoting organic agricultural practices that lessen waste, pollution, and the use of energy-intensive technologies and invest in training programs for farmers to encourage eco-friendly systems. Public expenditures on health increase public health,

which can lead to more fruitful inhabitants and a reduced burden on natural resources through enhanced public health practices. Governments in SSA have to increase their investment in healthcare, which consists of environmental health, considering issues such as environmental pollution and the impacts of climate shock on the health of people. Additionally, programs that increase public awareness of the relationship between health and ecological quality should be incentivized. Moreover, in this study government expenditures are measured by percentage of GDP. To increase these expenditures the regimes in the region are required to increase the share of tax revenues to GDP.

6. Research implications

This study was carried out to examine the impact of public expenditures on sustainable environmental development to fill the existing knowledge vacuum for policy makers and practitioners in scarce public resource allocation. Military expenditures, agricultural expenditures, and health expenditures significantly contribute to SED. This confirms that sustainable development theory is valid for government agricultural and health expenditures, but the theory is refuted in the case of public military spending. However, ecological modernization is valid for public military spending. Policymakers should redirect spending education to those significantly contributing to SED. In addition, policy makers must not look militarized as a curse for SEDs; rather, they must pay attention to the types and contributions of the military equipment to be acquired.

7. Limitations and Suggestions for Future Research.

In this study we have used three out of four sustainable environmental development goals. Specifically, sustainable environmental development index computed might have been inflated due to SDG14 is not considered because of lack of data. Moreover, this study examined only short-run effect of government expenditure on SED in SSA. Therefore, we suggest that future research should be carried at global level, consider SDG14, and employ long-run effect estimation techniques.

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- that briefly introduces the problem, research gaps and the study area;

- that outlines the methodology, mainly the study design, approaches, sampling strategies, materials used and methods of data collection and analysis;
- containing the key findings of the study, their implications and conclusions or key recommendations.

3. Introduction

In this section, the author(s) should:

- give background to the study problem and the rationales;
- present statements of the problem, setting the contexts, the nature and extent of the problem studied;
- indicate the study area and objectives of the research;
- introduce the research questions or hypotheses;
- present adequate review of the literature (both conceptual —including theoretical and conceptual frameworks— and empirical) related to the research;
- do all these in no more than five pages.

4. Materials and Methods

In here, authors are required to present clear account of:

4.1. the philosophical underpinnings, study design, approaches, sampling strategies, and methods of data collection and analysis. In so doing,

- ☞ standard methods need only be mentioned, or may be described by reference to the literature as long as it is readily available.
- ☞ modifications of standard techniques should be described.
- ☞ if the method is new, it should be described in detail.

4.2. design of the experiment, including the number of replications (if the article results from experimental or quasi-experimental research);

4.3. materials used, including:

- ☞ chemicals, laboratory equipment with the necessary technical specifications; standard units of measurement;
- ☞ any plants or animals involved, with exact descriptions of genus, species, strain, cultivar, line, etc.);

4.4. justifications as to why the materials and methods used were chosen over others.

5. Results and Discussion

Depending on the craft and choice of authors, as well as on what the subject matter warrants, results and discussion can be either intertwined together or presented under separate sections. In any case,

- present only results that add new insights to existing knowledge;
- only results based on data and information scientifically-drawn from sources, but free from authors' personal dispositions and biases.
- results should be simply and clearly stated;
- reduce large masses of data to means, along with the standard error or standard deviation;
- include only tables, figures and graphs that are necessary, clear and worthy reproducing;
- repeat in the text only the most important findings shown in tables and graphs;
- refer in the text each table and figure by its number;
- include negative data—what was not found— if they affect the interpretation of results;
- give only data that relate to the subject of the paper (in other terms, include concomitant/related findings only if they are important);
- provide adequate answers to all the research questions or pursue all the hypotheses/assumptions made at start of the study.

6. Interpretation of the Results

This section, which should preferably be embedded with the 'Discussion' section, should:

- not repeat what has already been said in the review of literature;
- show significance of the results;
- relate the results to the initially-stated objectives and research questions or hypotheses that were set out in the introduction;
- show how the results and their interpretations relate to (agree or disagree with) previous findings and their interpretations.

7. Conclusion and Implications/or Recommendation

This is the section where,

- the author(s) draw, based on the findings and discussions of their implications, logical conclusions about each research question or hypothesis;
- nothing (methods, observations or results) should come as a surprise (should not be mentioned for the first time);
- authors should avoid unnecessary detail or repetition from preceding sections;
- show implications for theory, policy, practice, and/or further research to follow up the results.

8. Citation and Referencing

8.1. All materials, referred to or quoted must be acknowledged properly. Plagiarism is a serious academic dishonesty, which is unethical and illegal.

8.2. EJDR uses the *author-date* system of citations in all of its publications. Thus, authors have toensure that author-date citations in the text agree exactly with corresponding entries in the reference list and that all publication details are accurate.

8.3. Citation and referencing should be complete according to this Style Guide, which is adapted with modifications from the Chicago Manual of Style 16th Edition.

The author-date citation in a running text or at the end of a block quotation consists of the author's/editor's last name, and the year of publication. Examples:

- Author, year, page no.: (Johnson 1987: 22–25).
- Two sources, with one author having two works: (Sen 1999; Jenden 1978a&b).
- More than three authors/editors: (Kassoguè*et al.* 1996).
- Organisation, year, volume, page no.: (World Bank 1988, 2:47).

8.4. Direct quotations should be as short as possible and all details should be reproduced exactly (spelling, punctuation and paragraphing).

☞ Short quotes should be placed in quotation marks.

- ☞ Long quotations should appear indented and centered in the text without quotation marks.

8.5. References in the text should read as follows:

* Brown (1975: 63) has argued that the ...

OR

* One economist (Brown 1975: 63) has argued that...

Use "*et al.*" when citing work by more than two authors. Example: A new treaty (Goody *et al.* 1976) suggests...

The letters a, b, c, and so on should be used to distinguish citations of different works by the same author in the same year. Example: Brown (1985a, 1985c) insist that...

8.6. Essential additional notes should be indicated by consecutive superscript numbers in the text and collected on a separate page at the end of the text, titled *End Notes* and placed before the 'References'.

Numbered notes should be used to denote clarifications about the references used, to include points left out in the text, to add some items which readers may want to know. If the citations or references in the text are too long, or consist of more than three names, it may be advisable to put them in the ***Notes*** at the end.

8.7. All references cited in the text and other supporting material should be listed alphabetically by author in a section titled References. Ethiopian authors should be listed alphabetically by first name first. Shiferaw Bekele, for example, should be listed under S and not under B. The same holds for Chinese names. Write out Ethiopian names in full in the Reference list (i.e., first and second names) as they are given in the publications cited. Do not abbreviate, for instance, as Shiferaw B. In the text, references may use first names only, or full names. Avoid, as much as possible, using honorific titles, such as Ato, Wzro, Dr., etc., in citations or references.

The following are examples of presenting bibliographical details of different entries

- ☞ ***Articles in Journals***

AlemayeguLirenso. 1988. Food Aid and Agricultural Production in Ethiopia. *Ethiopian Journal of Development Research,* 10 (1): 59–90. (The last parts of the Journal can also be given as *Ethiopian Journal of Development Research,* Vol. 10, No 1, pp. 59–90.)

Cowley, R. 1967. The Standardization of Amharic Spelling. *Journal of Ethiopian Studies,* V. 2: 1–8.

Note: The volume and issue numbers should be entered as they are given in the journals cited, i.e., if the numbers are in Roman or Arabic numerals, they should not be changed.

☞ ***Books***

Bahru Zewude. 1991. *A History of ModernEthiopia, 1955–1974*. London: James Curry.

Clapham, C. 1988. *Transformation and Continuity in Revolutionary Ethiopia*. Cambridge: Cambridge University Press.

Donham, D. and Wendy James (Eds.). 1096. *The Southern Marches of Imperial Ethiopia*. Cambridge: Cambridge University Press.

Listing of several works by the same author should be by year of publication, the earlier work preceding the recent. example:

Levine, Donald. 1965. *Wax and Gold: Tradition and Innovation in Ethiopian Culture*. Chicago: University of Chicago Press.

_____. 1974. *Greater Ethiopia: The Evolution of Multiethnic Society*. Chicago: University of Chicago Press.

☞ ***Book chapters and other contributions in books***

Wood, A.P. 1982. Spontaneous Agricultural Resettlement in Ethiopia, 1950–1974. ***In***: J. Clarks and L. Konsinski (Eds.), *Redistribution of Population in Africa,* pp. 1150–82. London: Heinemann.

☞ ***Contributions in proceedings***

Taddesse Tamirat. 1984. Feudalism in Heaven and on Earth: Ideology and Political Structure in Mediaeval Ethiopia. ***In:****Proceedings of the Seventh International Conference of Ethiopian Studies, University of Lund 26-29 April 1982*, pp. 195–200, Edited by S. Rubenson. Addis Ababa: Institute of Ethiopian Studies.

☞ ***Conference papers***

Hyden, H. 1990. 'Ideology and the Social Sciences: The African Experience'. Paper presented at the OSSREA Social Science Conference, 8–10 May, Kampala, Uganda.

☞ ***Unpublished works***

Messing, S. 1957. 'The Highland-Plateau Amhara of Ethiopia'. Ph.D. dissertation, University of Pennsylvania.

Alula Abate, *et al.* [these should be listed]. 1986. Evaluation of the Impact of UNICEF-Assisted Water Supply Projects in Bale, Harerge, Shewa and Wello- Ethiopia. Programme Cycle 1980–1983. *Research Report No. 30*, Institute of Development Research, Addis Ababa University, Addis Ababa.

☞ ***Official publications***

Central Statistical Office. 1975. *Results of the National Sample Survey Second Round, Vol. V. Land Area and Utilization*. Addis Ababa: CSA.

World Bank. 1973. 'Agricultural Sector Survey, Vol. I, The General Report. Report no. PA-143a.' Washington: World Bank.

_____. 1989. *Sub-Saharan Africa: From Crisis to Sustainable Growth*. Washington: World Bank.

☞ ***Online sources***

Further to the details in the above categories, include the date of access and the URL of the site whereat the material was accessed.

9. Format

A4 paper size with 2.5cm margins shall be the standard page size.

9.1. Title

Titles should be set in title case, NOT in all caps and should not contain acronyms and abbreviations.

9.2. Endnotes

Authors are advised to use endnotes instead of footnotes.

Endnotes should be numbered consecutively throughout each chapter or article, and placed at the end of a work, in a section titled "Notes", after any appendix and before the reference list.

9.3. Acknowledgements

These should be placed at the end of the text next to the appendix but before the endnotes.

9.4. Headings

Major chapter headings must be in Title Case and centered on the page. Sub-headings must also be in Title Case but aligned with the left margins. A manuscript with subsections should be presented as follows:

10.	1.	2.	3.
1.1	2.1	3.1	
1.2	2.2	3.2	

However, authors are advised to avoid using more than three levels of subheadings unless the complexity of the argument warrants it. Preceded by the decimal notations indicated above.

- 1st level titles should be set in Times New Roman 14pts, bold;
- 2nd level titles should be set in Times New Roman 12pts, bold;
- 3rd level titles should be set in Times New Roman 12pts, bold-italics, run-on with text.

10.1. Text

Text should be set in Times New Roman, 12pt font size, double-spaced. Block quotes should be indented from both sides and set in 11pt font.

10.2. Tables and Figures

- Tables should be used only where the data requires at least 2 rows/columns by 3 rows/columns. Shorter details shall be presented in text form.
- All tables and figures should be consecutively numbered and referred at the right place in the text.

- Titles of tables and figures should short and not in form.
- Each column and row of a table should have a proper title.
- All footnotes to, and sources of tables and figures, should be placed below them.
- Captions to figures should be placed immediately below the figures, followed by source information and Notes (if any) on some variables in the tables/figures.
- Keys to the different components of figures or graphs shall be placed at upper right corner within the boundary of the figure.
- Tables and figures should be used to present details and thus they should not be duplicated in text form. Unnecessary and lengthy tables and figures should be avoided, or, if important, should be annexed.

10.3. Abbreviations

Avoid use of dots in all familiar abbreviations, such as CSA, EEC, FAO, UNESCO, USA. However, dots should be placed at the end of the followings: e.g., etc., *et al.*, and other similar entries.

10.4. Language

- English is the medium of the Journal. Use one form of spelling, preferably the UK English (English English), throughout the article. Do not mix or switch between the two forms.
- All authors must avoid gender-biased and racist language.
- Use of discriminatory, inflammatory, and unethical expressions (derogatory, inciting, defamatory, etc. language) is unacceptable.

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