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TACKLING CLIMATE CHANGE IMPACTS IN DEVELOPING COUNTRIES: THE CASE OF CLIMATE ADAPTATION POLICY PRACTICES IN ETHIOPIA
A DYNAMIC PERFORMANCE GOVERNANCE APPROACH

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Declaration

I, Abiyot Dagne, hereby affirm that I am the exclusive author of this doctoral dissertation.

This thesis represents an original piece of work that it submitted to the University of Palermo in 2025.

Dedication

This PhD thesis is dedicated to my entire family and extended relatives. A huge thank you all for your endless love and unwavering support during my ups and downs in the past years. You all supported me and stood by me during my difficult times, which I would rather forget. Your contributions have fortified my resolve, enhanced my rationality, and, most significantly, your sacrifices have instilled in me a profound sense of responsibility towards my decisions, my family, and society as a whole. I shall persist in my efforts to enhance your happiness.

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ABSTRACT

Although Least Developed Countries (LDCs) have tiny contributions to GHG emissions, countries like Ethiopia remain acutely vulnerable to climate-induced shocks. Ethiopia, in response, introduced the Climate Resilient Green Economy (CRGE) Strategy in 2011, followed by successive implementation frameworks to strengthen adaptation and resilience capabilities. However, the pace and magnitude of adaptation efforts have remained insufficient to offset escalating climate and ecological risks, particularly in impoverished localities where impacts are disproportionately severe. Moreover, the persistence of a siloed approach and neglect of local realities continue to impede progress and undermine opportunities for generating co-benefits.

This study applies the DPG framework with mixed analysis embedded in the DPG-based feedback learning-oriented approach to evaluate the effectiveness of adaptation measures and governance mechanisms in Ethiopia. DPG enables systemic analysis of the underlying problem by elucidating the feedback loops and interdependencies that shape performance outcomes. It also promotes collaborative platforms as vehicles for shared learning, decision-making, and policy coherence among stakeholders across boundaries.

The study reveals that households adopting multiple adaptation practices experienced moderate increases in agricultural yields and income diversification. Yet, these improvements were offset by recurrent droughts and rainfall variability, exposing the fragility of local adaptive capacity. However, households integrating diverse adaptation practices experienced improved food security and resilience compared to those applying isolated measures. The findings show trade-offs in labor dynamics, indicating that adaptation requires skilled labor, which may displace unskilled labor and exacerbate inequality, underscoring the need for targeted intervention for the unskilled through skill development. The study identifies collaborative governance platforms as essential vehicles for overcoming systemic barriers to policy framing, investment, capacity-building, and monitoring and learning.

The findings suggest the need for developing outcome-based performance frameworks for local governance, integrating adaptation policies into local plans, and aligning initiatives with SDGs and Paris Agreement. Furthermore, findings emphasize the importance of broader community engagement in the planning, monitoring, and evaluation cycles, alongside efforts to ensure scalability, sustainability, and ownership. Overall, the research concludes that when properly framed within systems-based governance model, adaptation can deliver enduring development outcomes in climate-vulnerable regions, thereby advancing Ethiopia's transition toward a resilient and sustainable future.

Keywords: Adaptive Capacity; Ethiopia; Dynamic Performance Governance; Active Citizenship; Climate Change; Collaborative Platforms; System Dynamics

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LIST OF ACRONYMS

AAU	Addis Ababa University
ADF	Adaptation Fund
CBDRM	Community-Based Disaster Risk Management
CCA	Climate Change Adaptation
CBO	Community-Based Organization
CDH	Climate Data Hub
CGIAR	Consultative Group on International Agricultural Research
CLD	Causal Loop Diagram
CRGE	Climate-Resilient Green Economy
CRGI	Climate-Resilient Green Initiative
CSA	Climate-Smart Agriculture
DPG	Dynamic Performance Governance
EDRMC	Ethiopian Disaster Risk Management Commission
EPA	Environmental Protection Authority
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoE	Government of Ethiopia
GPS	Global Positioning System
IPCC	Intergovernmental Panel on Climate Change
LLA	Locally Led Adaptation
LULUCF	Land Use, Land-Use Change and Forestry
M&E	Monitoring and Evaluation
MOPD	Ministry of Planning and Development
MOF	Ministry of Finance
NGO	Non-Governmental Organization
NDC	Nationally Determined Contribution
RAMP	Resilience and Adaptation Mainstreaming Program
SDG	Sustainable Development Goal
SLM	Sustainable Land Management
SPSS	Statistical Package for the Social Sciences
SWC	Soil and Water Conservation
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute

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CHAPTER ONE
INTRODUCTION

1.1. Research Background and Context

Climate change is imposing escalating mounting risks on developing countries, with Sub-Saharan Africa facing vulnerability due to limited adaptive capacity, heavy reliance on rain-fed agriculture, and weak institutions. Rising temperatures and shifting precipitation patterns are already eroding crop yields, exacerbating heat stress, expanding vector-borne diseases, and reducing biodiversity across Africa (IPCC, 2022a). Climate shocks such as droughts, floods, and storms are undermining economic growth, pushing millions into sever food insecurity and poverty trap, and creating urgent needs for resilient systems and infrastructure (World Bank, 2025). Evidence also suggests that in fragile Sub-Saharan states, a 1 °C temperature rise can reduce per capita growth by about 1.8 percentage points, compounding governance risks and institutional stress (IMF, 2022).Without urgent and tangible actions, these pressures threaten to greater food insecurity lock in inequality, destabilize livelihoods, and derail sustainable development outcomes across countries.

Climate change pauses one of the most pressing challenges to Ethiopia's sustainable development, particularly affecting drought-prone and ecologically vulnerable area. Recurring droughts, land degradation, erratic rainfall, and limited livelihood diversification, and low adaptive capacity and subsistence production practices have rendered rural communities significantly vulnerable. The northern parts of the country, including Dehana woreda (district) in Waghemra zone of Amhara National Regional State, exemplify the intersection of climate shocks, low adaptive capacity, and vulnerability, which collectively undermine resilience and adaptive capacity (World Bank Group, 2024).

Agriculture, which supports approximately 70% of Ethiopia’s population, is especially sensitive to climate variability. These climatic stresses undermine rural livelihoods, disrupt food production, and exacerbate poverty (FDRE, 2021; World Bank, 2023). Across Sub-Saharan Africa, climate change has been shown to reduce agricultural productivity, exacerbate water scarcity, and induce livestock losses, heightening economic stress, displacement, and food insecurity (Lombe et al., 2024)

In response, Ethiopia has developed ambitious climate strategies, such as the Climate Resilient Green Economy (CRGE) framework and its updated Nationally Determined Contributions (NDCs), which identify adaptation interventions across sectors like agriculture, water, health, and forestry (FDRE, 2021). Despite these efforts, the effectiveness of adaptation actions remains uneven and sparse, particularly at the local level. Climate adaptation interventions water resources management, sustainable agriculture practices, improved cookstoves, natural, and livelihood diversification have been introduced, but their long-term effectiveness and integration into local governance structures remain unclear at the local level (Koundouri et al., 2025).

Existing studies largely assess adaptation at the policy or project level, often focusing on routine activity and immediate outputs rather than long-term outcomes. Few including the researcher have explore the dynamic interactions, trade-offs, and co-benefits of aggregate mitigation focused interventions with adaptation co-benefits interventions and indicated the governance mechanisms that may enable sustained effectiveness at national level (Dagne et al., 2025). This creates a critical knowledge gap in understanding how adaptation practices contribute to local community adaptive capacity and resilience beyond immediate project cycles, and what governance frameworks may unlock the local potential to enhance the adaptive capacity and ensure sustainability of the locally led adaptation practices in vulnerable districts like Dehana.

This research, therefore, attempts to address these gaps by employing a Dynamic Performance Governance (DPG) approach to assess the sustained effectiveness of climate change actions in Dehana woreda. By linking local adaptation practices with a broader governance and policy framework, DPG enables the elicitation of feedback dynamics, drivers of change, and performance outcomes over time. Through this feedback loop dynamics approach augmented with statistical findings, the study seeks to generate evidence on how locally led adaptation can be better designed, governed, monitored, and scaled to enhance adaptive capacity and resilience in Ethiopia's most climate-vulnerable area.

1.2. Statement of the Problem

Climate change poses a mounting risk to the global economy, society, and ecosystem, with least developed countries such as Ethiopia facing intensifying vulnerabilities. The economy of

these nations is heavily reliant on land use-based subsistence economic activities, rendering them especially vulnerable due to their limited adaptation capacity. Wade & Jennings (2016), indicate that economic growth may be hindered by the ever-changing climate projecting a potential worst-case scenario of a 1%-5% decline in global economy yearly growth rate with a more severe and disproportionate effect on the least developed economies (Tol, 2020).

Although Least Developing Countries (LDCs) contribution to global greenhouse gas (GHG) emissions is minimal, countries such as Ethiopia are exceedingly susceptible to climate-induced shocks. Ethiopia, like many other developing countries, faces compounding challenges stemming from climate change and its effects. The rising intensity, frequency, and magnitude of droughts, floods, desertification, and water scarcity, along with a concerning increase in pest occurrences, largely impact livelihoods, contribute to biodiversity loss, and affect key sectors including agriculture, energy, education, and health. For instance, from 2022- 2023 only, over 4 million cattle were lost in Ethiopia, resulting in significant internal displacement and the degradation of over 50% of the nation's land due to severe drought (World Bank Group, 2024). According to the World Bank, about 5 million people are subjected to an average drought, whereas 250,000 individuals experience an average flood annually. In addition to the widespread human suffering, such occurrences also affect the economy by increasing the urgent need for humanitarian support, damaging infrastructure and loss of household assets, and disrupting economic activity. A drought with a 1-in-5-year return period is projected to result in economic losses over US$1 billion, soaring to nearly US$3 billion for a 1-in-100-year drought event.

The cumulative impacts of the current drought, the most severe in 40 years, have proved catastrophic for local communities in the already parched pastoral and drought prone regions of Ethiopia, which include two-thirds of the country's landmass. Following six consecutive failed rainy seasons, over 22 million people are estimated to be food insecure, while 11.8 million are reported to have suffered substantial livelihood losses in the drought-impacted regions. Recent survey estimates indicate that the current drought shock decreases consumption by 15 percent. The extended drought has led to an estimated 13 million individuals experiencing to water scarcity, 1.4 million children facing the possibility of school dropout, and the death of 4-7 million livestock (World Bank Group, 2024).

Furthermore, it faces widespread challenges in building climate resilience, particularly at the local level where livelihoods are largely tied to natural resources and seasonal climatic patterns.

The country's adaptive capacity is also limited by a combination of entrenched systemic and structural, environmental, socio-economic, and institutional barriers. Chronic poverty, prevalent livelihood insecurity, and overreliance on rain-fed subsistence agriculture make substantial portions of the population, particularly smallholder farmers and pastoralists, exceedingly susceptible to climate variability and extremes. The vulnerability is further intensified by massive land degradation, deforestation, and loss of biodiversity, which compromise the ecosystems essential for local sustenance, including food, water, and income. Access to essential services, including healthcare, education, clean water, rural infrastructure, and markets, is often restricted, thereby limiting households' capacity to adapt and diversify.

Frequent restructuring and myopic governance framing in the climate aligned policy landscape are of equal importance. Despite advancements in climate policy at the national level, including the Climate Resilient Green Economy (CRGE) Strategy, Updated Nationally Determined Contributions (NDCs) and Long-Term Low Emission Development Strategy (LT-LEDS), the localization of these big strategies into tailored adaptation interventions is largely uneven and sparse. Almost all regional and local governments exhibit deficiencies in technical capacity, financial resources, and the ‘right’ framework, hindering their ability to plan and execute context-specific climate resilience-building interventions. The historical patterns of climate damages, combined with the absence of locally driven climate-proof investment pipelines for remote and climate-vulnerable areas such as Amhara, Afar, Somalia, parts of Oromia, and northern Tigray, have resulted in disproportionate effects and have weakened many local communities' ability to adapt and recover from series of recurring climate induced crises. Unclear land use plans, along with restricted access to localized climate information and early warning systems, undermine anticipatory action and long-term adaptation planning. Recent conflicts and displacement have diminished social capital and institutional functionality, exacerbating pre-existing vulnerabilities in Ethiopia.

Countries have sought solutions to the challenges posed by climate change and its repercussions and are making ambitious commitments to mitigate its adverse impact by designing and implementing climate adaptation policies and strategies. In this context, countries like Ethiopia have taken notable steps by introducing its ambitious Climate Resilient Green Development Strategy in 2011, accompanied by adaptation action, and subsequent CRGE generations to endure climate-related shocks and disasters.These strategies, which some of them predates the Paris Agreement (UNITED NATIONS, 2015), aims to build resilience and reduce Ethiopia’s emissions by 64-69% from a business-as-usual trajectory by 2030. The

country has implemented several key climate initiatives with significant mitigation and adaptation potential.

However, the pace and magnitude of climate adaptation efforts are insufficient to address escalating climate and ecological risks and consequences, particularly in the most impoverished and vulnerable local realities where the climate impact is disproportionately severe (Nunn & Kumar, 2019). In addition, studies point to the neglect of local realities and contextual nuances as major contributors to this slow progress. Moreover, despite the localized impacts of climate change, societies fail to address barriers to climate adaptation and building long-term resilience because of siloed climate approaches that could otherwise deliver tangible co-benefits for society, the economy, and ecosystems. Inadequate resources, weak governance, limited capacity, and systemic inequalities further hinder the attempt by restricting access to the benefits of climate action. Furthermore, local communities struggle to secure resources and to design, implement, and monitor the effectiveness of adaptation policies because of myopic localization: the disconnect between national level climate policies and 'place-based' implementation (Bianchi & Grippi, 2025), which in turn inhibits countries' ability to address climate challenges while promoting inclusive development, and often excludes local realities from economic opportunities in the pathway design, creating a gap between climate actions and economic development outcomes. Furthermore, conventional resources for climate-resilience remain inadequate, intensifying vulnerability to climate change, biodiversity loss, and food insecurity, particularly affecting the poorest and most marginalized local communities. Public budgets face increasing strain, whereas private capital remains under-leveraged due to perceived risks, insufficient enabling environments, and a lack of 'place-based' investment-ready and commercially viable adaptation pipelines.

This highlights the need to identify critical systemic and structural barriers to climate adaption and resilience, particularly in light of increasingly competitive resources, lack of capacity and insufficient progress toward sustainable adaptation (Shammin et al., 2022). In addition, an understanding of the long-term performance measures (success measures), the strategic resources upon which decisions would be made to drive performance, and the underlying dynamics fostering climate-resilient growth pathways remain elusive.

Climate change, being a super-wicked problem (Levin et al., 2012), cuts across different layers of governance and poses dynamic, multi-level, multi-actor, and multi-sectoral challenges (Bianchi, 2021). If not addressed with a systemic approach, it further worsens the current

impacts on the local level posing an existential threat to people and the ecosystem that disproportionately bears the brunt of climate impacts. Climate variability further exacerbates the 'double inequality' dilemma (Barrett, 2013), disproportionately shifting risks and responsibilities onto the most vulnerable populations. This can lead to a tripling of the inequality puzzle when systemic climate adaptation and resilience interventions are not properly designed at both policy and local levels. In addition, critical reflections on the intersections and dynamics of governance management (Rahman et al., 2023) remains elusive in policy design and in gauging the performance of implementation using performance measures within the context of local realities. Furthermore, existing platforms designed for supporting climate actions are myopic and contested due to their unclear purpose, vision, and lack of accountability and transparency in governance; they are largely influenced by donors and shaped by emerging perceptions that climate platforms (CPs) used in general international development circles, lack national, place-based, and context-specific framing.

This research, therefore, aims to fill the knowledge gap by examining the sustained effectiveness of locally led adaptation framing, policy and implementation practices in Ethiopia. It will assess their multifaceted dynamics, explore the underlying drivers of change, suggest promising vehicles tailored to the specific context the interventions, and propose outcome measures that can gauge the long-term success of these policies using the Dynamic Performance Governance approach. (Bianchi, 2021, 2022).

1.3. Research Objective

Assessing the performance and effectiveness of locally led climate adaptation and resilience policy practices and their effect on the development outcomes enables decision makers to unpack main drivers of growth, corroborate the constraints, and build on the existing evidence base for future policy design towards climate resilient development pathways. To this end, the study will have the following key objectives.

1. Assessing the dynamic performance and effectiveness of locally led adaptation and resilient policies and practices and their impact on the development outcomes in Ethiopia. Accordingly, the study will gauge the extent to how locally led climate adaptation policies and associated investment decisions help to improve wellbeing and resilience by eliciting added benefits and avoiding costs.

2. Investigating the underlying drivers of change to foster climate-resilient green growth pathways and locally owned development and wellbeing.
3. Developing systemic outcome measures to gauge the long-term performance of locally led adaptation at the local level.
4. Illustrate how Dynamic Performance Governance leverage active citizenship to catalyze climate change adaptation policies design planning, implementation, monitoring and evaluation, and learning at the local level, and
5. To identify mechanisms that can help countries overcome systemic barriers to climate change adaptation and enhance coordination among stakeholders to support place-based climate interventions.

1.4. Research Questions

This research will focus on four central research questions, which will guide the overall research agenda, that is:

1) To what extent have climate adaptation policies and associated investment decisions contributed to improving the resilience of the local community, considering added benefits and avoided costs?
2) What are the key underlying feedback dynamics and drivers of change that influence the transition toward climate-resilient development pathways, fostering sustainable local development and well-being?
3) What outcome measures can be developed to support evaluating the long-term performance of climate policies, specifically at the local level, and how can these indicators be systematically measured and monitored?
4) How Dynamic Performance Governance could leverage active citizenship to catalyze the systemic design, implementation, monitoring and evaluation of climate change adaptation policies at the local level?
5) What mechanisms can help countries overcome systemic barriers to climate change adaptation and enhance coordination among stakeholders to support place-based climate interventions?

1.5. Significance of Study

This study provides insights into the effectiveness of locally led climate adaptation interventions in drought-prone areas of Ethiopia, specifically Dehana woreda in the Waghemra zone.

Methodologically, employing a Dynamic Performance Governance (DPG) approach with quantified statistical computation provides robust systemic understanding of how adaptation practices interact with governance approaches, policy mechanisms, and socio-economic and environmental systems aided with qualitative elicitation of perception and quantified estimates of performance measures over time. This study also provides learning feedback approach for framing and assessing the locally led adaptation interventions, and policy practices as DPG promotes collaborative ecosystem platforms as venue for facilitating policy and performance dialogue among network stakeholders, serve as learning vehicles that help parties elucidate their thoughts and understand the complex feedback structures behind social "wicked" problems such as climate change (Bianchi, 2021; Bianchi, Nasi, et al., 2021; Bianchi, 2022; Bianchi & Grippi, 2025). Furthermore, this study will offer case stories and how performance measures can be framed and defined linked to available strategic resources, which can be tangible and intangible, and performance drivers that can gauge the dynamics progress of the implementations against the benchmarks or the standards.

The findings are also expected to inform individual households, local communities, policymakers, local governments, and development practitioners about which interventions are most effective and sustainable, thereby maximizing resource allocation and enhancing community adaptive capacity and resilience. Moreover, the study contributes to academic knowledge by integrating feedback dynamics, trade-offs, and long-term performance measures into adaptation research a perspective often underexplored in the Ethiopian context. The evidence generated can also support the scaling-up of successful adaptation interventions to other drought-prone areas, strengthening Ethiopia’s broader climate resilience and sustainable development goals.

1.6. Scope of the Study

The research focusses on assessing the sustained effectiveness of locally led climate adaptation practices in Dehana woreda, Waghimra zone, Amhara National Regional State, northern Ethiopia. It focuses on identified interventions related to agriculture, natural resource

management, livelihoods (diversification), jobs and energy; evaluates their effectiveness; and examines policy framing and performance measures in interplay with local governance structures and the policy framing ecosystem. The study employed a mixed-method approach that combined statistical analysis with a system dynamic aided Dynamic Performance Governance (DPG) Approach to evaluate the effectiveness of locally led adaptation measures and analyze feedback dynamics, trade-offs, and long-term outcomes of the broader adaptation measures at the local level. Geographically, it is limited to Ethiopia, with a special case story for Dehana woreda due to its high vulnerability to drought and relevance as a representative case of the northern Ethiopian highlands. The study analyses the identified adaptation measures from a broad perspective of adaptation interventions, aiming to frame strategic resources, performance drivers, and both intermediate and final outcomes. This approach seeks to extend the framework to include broader and scalable policy measures for cross-comparisons that facilitate learning and overall performance improvement at the local level. However, prior to this study, the researcher had also co-authored and led an economy-wide quantitative analysis focusing on the overall long-term macroeconomic implications of national climate actions and their aggregate effects on development outcomes titled "Navigating climate resilience: co-benefits and costs of a net zero development pathway in Ethiopia."[1]

1.7. Limitation of the Study

Although this study is significant for households, the broader community, and its applicability to other areas of the adaptation phenomenon, it also has shortcomings. For instance, historical records of climate adaptation measures and their outcomes provide limited baseline data availability. The study is also conducted within a context of fragmented governance, where misalignment and overlapping roles and responsibilities among local and regional institutions make it challenging to isolate the effectiveness of each target intervention. In addition, research focuses on selected sectors and interventions, primarily agriculture, natural resource management, and livelihoods, jobs and energy potentially excluding other relevant adaptation

[1] Dagne, A., Corfee-Morlot, J., Bassi, A. M., Elliott, C., Pallaske, G., Guzzetti, M., … Pellerin, M. (2024). Navigating climate-resilience: co-benefits and costs of a net zero development pathway in Ethiopia. *Climate Policy*, *25*(7), 1044–1060. https://doi.org/10.1080/14693062.2024.2438300. https://www.tandfonline.com/doi/full/10.1080/14693062.2024.2438300

strategies such as health, education, or infrastructure-related measures due to a lack of proper documentation and investment-ready adaptation project pipelines in the local area.

Furthermore, the ongoing conflict and security situation in the region during data collection has been a significant challenge, restricting access to some communities and limiting field observations. Moreover, some key informants and members of the focus group discussion (FGD) were afraid to share their perspectives due to fears of potential personal political linkages or harm, which may have introduced biases regarding performance success because of the ongoing conflict in the region.

Finally, while the System Dynamics Aided DPG approach allows systemic analysis, certain socio-environmental interactions and complex feedback may not be fully captured due to model assumptions and simplifications. Although this study employed statistical analysis to complete DPG for socioeconomic diagnosis, it does not employ system-wide local-level quantitative modelling to explore the magnitude of the climate adaptation effectiveness of local adaptive capacity building and resilience, largely due to a lack of baseline data and time series data for socioeconomic characteristics, biophysical, and environmental data. However, the study still suggests that while the study offers valuable insights, its findings should be interpreted within the specific local context of Dehana woreda, with data largely driven from KEI, FGDs, document review and case stories supported by statistical findings.

1.8. Thesis Structure

This research is organized into seven interconnected chapters that together build a coherent understanding of climate adaptation practices in Dehana Woreda, Amhara National Regional State of Ethiopia. The first chapter introduces the study by outlining the background and rationale, defining the research problem, and setting out the objectives and underlying questions that guide the investigation. It also states the study's relevance, scope, and delimitations, offering an overview of the broader policy and institutional context of climate adaptation in Ethiopia.

The second chapter provides a comprehensive review of existing literature and theoretical foundations relevant to the study. It examines key concepts such as wicked and super-wicked problems, the evolution of locally led adaptation approaches, and the role of community resilience in climate governance. The review also explores the Dynamic Performance Governance (DPG) framework and its application in understanding complex systems. By

critically assessing previous studies, this chapter identifies gaps that the current research seeks to address and presents the conceptual framework that informs the analytical process.

The third chapter describes the research methodology adopted for the study. It begins by explaining the research paradigm and design, which combine qualitative and quantitative methods within a pragmatic framework. The chapter elaborates on the DPG framework as an analytical lens, provides a detailed description of the study area, and explains the sampling strategies used to ensure representativeness. It further discusses the data collection instruments and analytical techniques, including both statistical and thematic approaches. Ethical considerations and issues of reliability and validity are also presented to ensure methodological rigor.

The fourth chapter sets the contextual foundation by presenting a detailed profile of Dehana Woreda and the Climate Resilient Green Infrastructure (CRGI) interventions. It outlines the area's socio-economic and environmental characteristics and provides insights into the local governance systems that shape adaptation practices. The chapter also highlights the nature and implementation of CRGI components, the stakeholders involved, and their roles in driving local adaptation actions.

The fifth chapter presents the empirical findings of the study. It integrates quantitative data on household characteristics, income, agricultural productivity, and adoption of adaptation technologies with qualitative insights derived from interviews and case stories. The results are discussed in relation to the research objectives, with emphasis on how community initiatives, local governance mechanisms, and CRGI interventions have influenced adaptive capacity. The chapter also applies system dynamics modeling to illustrate causal relationships among the variables influencing adaptation outcomes.

The sixth chapter provides a synthesis and discussion of the results. It interprets the findings in light of the literature reviewed earlier, linking empirical evidence to the DPG framework and the principles of locally led adaptation. This chapter explores the implications of the findings for governance, social learning, and community resilience. It also identifies key trade-offs, institutional challenges, and opportunities for enhancing adaptive capacity through participatory approaches and networked governance systems.

The final chapter draws conclusions based on the overall findings of the research. It summarizes the major insights gained, directly addresses each research question, and presents a set of policy implications for scaling up adaptation efforts. The chapter concludes with

reflections on practical measures to strengthen locally led adaptation, promote inclusive governance, and enhance sustainable financing. It also highlights areas where further research is needed, such as longitudinal analysis of adaptation outcomes and comparative studies across regions, to deepen understanding of local resilience pathways.

CHAPTER TWO
LITERATURE REVIEW

2.1. Climate Change as Socially (Super) Wicked Problem

2.1.1. Background

Modern policy science and practice are dealing with complex social problems that could not be tackled with traditional methods (Termeer et al., 2019). According to Termer et al. (2019) these problems, which are often characterized by high uncertainty, complicated interdependencies, and conflicting values and trade-offs among stakeholders, have been called-wicked problems. The idea of wicked problems first came up in the field of social planning, but it has since spread to many other areas of research, such as public administration, environmental studies, urban planning, economics, and engineering. The idea has led to useful research, but its many meanings and uses have also caused confusion.

A recent concept concerning "super" wicked problems has surfaced to clarify the unique challenges presented by specific global issues, including climate change (Head & Alford, 2015; Levin et al., 2012; Peters, 2017). This review analyses the existing literature on (super) wicked problems, emphasizing their definitions, characteristics, and fundamental nature. This subsequently connects these concepts to the specific challenges associated with adapting to climate change, especially in developing countries' context.

A recent concept which shed some light on the difficulties posed by socially super wicked issues, such as climate change, has emerged. With a focus on their definitions, traits, and essential nature, this review examines the body of research on (super) wicked problems. This then links these ideas to the difficulties in climate change adaptation, particularly in developing nations in the light of Dynamic Performance Governance (DPG) approach.

2.1.2. Definition of Wicked Problems: From Origins to Modern Perspectives

C. West Churchman used the term "wicked problem" for the first time in public in a 1967 guest editorial in Management Science (Churchman, 1967). According to him (1967), the term "wicked" was used to characterize cunning and even evil-like qualities where suggested remedies might make the symptoms worse. Furthermore, he outlined the moral necessity of systemic understanding of the "untamed aspects" of these problems and denounced the

application of rational remedies that merely "tame" and isolate a subset of the underlying problem.

Rittle and Webber (1973) elaborated on the concept in their seminal 1973 paper, "Dilemmas in a General Theory of Planning." The paper stated ten claims about the nature of wicked problems, contrasting them with "tame" or "scientific" problems which have definitive formulations and verifiable solutions. The nature of the wicked problems, later summarized as the 10 claims of the wicked problems, are a basis to understanding the initial conceptualization of wicked problems (Rittel & Webber, 1973). These claims are:

i) There is no definitive formulation of a wicked problem.

ii) Wicked problems have no stopping rule. There is no inherent endpoint where one can definitively say the problem is solved.

iii) Solutions to wicked problems are not true or false, but good or bad. Unlike mathematical problems with objective answers, solutions to wicked problems are judged based on their consequences and perceived desirability.

iv) There is no immediate or ultimate test for solutions. The effects of interventions unfold over time, and there is no simple way to verify their success.

v) Every attempt at a solution is a "one-shot operation"; solutions have effects that may not be reversible or forgettable. Trying to solve a wicked problem can have significant and lasting consequences.

vi) There is no clear set of possible solutions, and perhaps not even a bounded list of potential options, and the solution space is not enumerable or exhaustively describable.

vii) Every wicked problem is essentially unique. Despite potential similarities, each wicked problem has specific contexts and characteristics.

viii) Every wicked problem may be a symptom of another problem. Wicked problems are interconnected and addressing one may reveal a deeper underlying issue.

ix) There are multiple explanations for a wicked problem. The definition and understanding of the problem depend heavily on the perspectives of the stakeholders involved.

x) The planner (policymaker) has no right to be wrong. Policymakers are liable for the consequences of their actions, as these effects significantly impact the people affected.

Following this, various literature in the field have now often referred to these claims as defining characteristics of a specific type of policy problem. As a result, various efforts have been made to condense the ten characteristics into a smaller set of core dimensions related to wicked problem characteristics. For instance, scholars such as Roberts (2000) have identified two dimensions: **1)** a lack of consensus on problem definition and **2)** a lack of consensus on solutions; Xiang (World Bank Group, 2024) has also proposed five key characteristics: **1)** indeterminacy in problem formulation, **2)** non-definitiveness in solution, **3)** non-solubility, **4)** irreversible consequentiality, **5)** individual uniqueness; and Head and Alford (2015) have distilled wickedness to a combination of complexity, diversity, and uncertainty.

The discourse over the definitions and attributes of wicked problems remains largely influenced by the ten core characteristics, despite emerging insights. Nevertheless, emerging scholars are keen to transcend the traditional dichotomy of wicked versus tame problems. Nowadays, many scholars perceive wickedness as a spectrum, highlighting that issues can exhibit varying degrees of complexity, uncertainty, and trade-offs/synergies across multiple dimensions. This continuous perspective on wickedness facilitates a more sophisticated comprehension compared to a simplistic binary classification.

Furthermore, there is a growing interest in the relational character of problem definitions and the importance of the interactions between problems, actors, and attempts to address them. For example, Noordegraaf et al. (2019) introduce the concept of situated wickedness mainly focusing on how people experience problems and whether they perceive them as wicked issues. In a similar vein, the relationship between normative conflict (heterogeneity of preferences) and factual complexity (factual uncertainty) shows that problems become wicked because actors' factual judgments are linked to their normative judgments (Bannink & Trommel, 2019). On the hand, Turnbull & Hoppe (2019) suggest reframing wickedness not as an inherent problem characteristic, but in terms of the " Problematicity" arising from the political distance between policy actors engaging with the problem. This perspective views the level of problematicity as a function of how the problem is being questioned and debated within the network of policy actors.

In addressing such problems in the public domain, many scholars have increasingly drawn attention to the concept of wicked problems, suggesting the intertwined nature of factual uncertainty and normative conflict. Bianchi (2016a) states how dynamic complex problems in the public policy domain are inherently dynamic and relational. He stated that such problems

cannot be objectively defined in isolation but are shaped by the diverse perspectives, values, and interests of stakeholders. This feedback loop- driven behavioral character of problem definitions reflects the notion that different actors, based on their institutional roles and experiential backgrounds, will perceive the same underlying problem differently, leading to contested understandings of the underlying problems and proposed solutions. He indicated that the difficulty in managing these complexities, as the interaction between factual complexity (incomplete or evolving knowledge) and normative plurality (divergent stakeholder preferences), contributes significantly to the wickedness of public policy challenges. To address these issues, Bianchi underscores for a shift from static, linear approaches to a system dynamic aided dynamics performance management and governance framework that leverages systems thinking and feedback mechanisms (Bianchi, 2016a; Bianchi, Bovaird, et al., 2017; Bianchi, 2021, 2022). This method focuses on dynamics, such as feedback loops, time delays, and non-linear relationships, to promote shared understanding, stakeholder involvement, and adaptive learning in framing policies and their implementations. This way, policymakers can better deal with dynamic complexities and interdependencies and create interventions and strategies that take into account both changing knowledge and stakeholder values (Bianchi, 2016a).

In the end, despite the initial assertions of Rittel and Webbers' offer a fundamental conception, emerging framing of wicked problems and their solutions underscore wickedness as a continuum, distinguish along axes such as conflict, complexity, and uncertainty, and accentuate the critical relevance of stakeholder perspectives and interactions in delineating and experiencing the issue.

2.1.3. Nature and Type of Wicked Problems

Socially wicked problems are characterized by their embeddedness in complex systems and environments (Churchman, 1967). They are issues hard to define and manage due to the high complexity of the environment they affect. These problems involve a high interdependency among causal factors (Bianchi et al., 2017). According to Noto & Bianchi (2015) the contexts in which wicked problems exist are marked by complexity, interconnectedness, pluralism, and uncertainty. Accordingly, a key aspect of the nature of wicked problems is that their interpretation is not straightforward. It relies heavily on the value perspectives adopted by different stakeholders, which can differ substantially, i.e., simply collecting information is not

sufficient to understand and resolve it. The multiplicity of explanations for a wicked problem means that the chosen explanation significantly influences the perceived path to resolution.

Wicked problems often transcend the borders of traditional policy domains and involve a range of actors across different scales (Termeer et al., 2019). They cannot be tackled effectively by any single organization and typically spill over administrative levels and responsibilities (Bianchi et al., 2017; Noto & Bianchi, 2015). This multi-level, multi-layer and multi-actor, and multi-sectoral nature adds significantly to their dynamicity and complexity. Because of these intricate interdependencies, any attempts to address a symptom or one facet of a wicked problem may uncover or generate additional issues, often resulting in unintended consequences.

A range of examples for wicked problems mentioned in the sources span various domains:

- Environmental Issues: Climate change, biodiversity loss, natural disasters/hazards, pollution, among others (Bianchi, 2016a; Sterman, 2009; Termeer et al., 2019; Vignieri, 2023);
- Social (including Education and Health) Issues: Migration, ageing populations, healthcare, COVID-19 pandemic, homelessness, Social (Ex) inclusion (Bovaird & and Loeffler, 2007; Termeer et al., 2019; Grippi, 2023a; Bianchi, 2015);
- Urban and Planning Problems: Urban transportation, issues in urban planning and regional urban planning (Noto & Bianchi, 2015; Termeer et al., 2019);
- Security: Terrorism, digital warfare, international drug trafficking, nuclear weapons (Termeer et al., 2019);
- Governance and Public Policy: Problems in public administration, policy design, decision-making, policy delivery, and management (Bianchi, 2021; Noto & Bianchi, 2015).
- Economic Issues: Economic problems (A. Bassi, 2015; Bianchi, 2015; Termeer et al., 2019).

The sources indicate that wicked problems are often studied in fields related to public administration, policy, planning, and management, with a focus on environmental and urban problems. However, the concept has been applied to diverse fields, reflecting the pervasive nature of complex, ill-defined problems across modern society.

Wicked problems are resistant to resolution, meaning there is no single, definitive solution. The goal is often not to address the problem in a final sense, but rather to manage, navigate, or improve it. There is no unique solution to wicked problems, as they are resistant to resolution. Often, the objective is to manage, navigate, or improve the issue rather than to "solve" it completely, as there is never a definitive solution to the issue.

2.1.4. Characteristics of Socially Super Wicked Problems

Building upon the concept of wicked problems, Levin et al. (2012) introduced the distinction of "super wicked problems" in a 2007 conference paper, further elaborated in a 2012 journal article. They argue that certain global environmental problems, such as human-induced climate change, constitute a new class of challenges that are even more difficult than regular wicked problems.

According to Levin et al. (2012), super wicked problems are characterized by four additional, defining features that relate specifically to the agent trying to solve the problem, rather than just the underlying problem itself:

1. Time is running out: There is a significant and urgent deadline for finding a solution. The window for effective action is closing. For climate change, this means the need to peak global greenhouse gas emissions soon to limit warming.
2. Those seeking to solve the problem are also causing it: The actors responsible for creating or exacerbating the problem are simultaneously the ones tasked with finding a solution. This creates inherent conflicts of interest and challenges for effective action.
3. There is no central authority dedicated to finding a solution: Super wicked problems typically lack a strong, centralized governance structure with the power to impose solutions or ensure coordination. This fragmentation and diffuse authority complicate efforts to address the problem at the necessary scale. For climate change, this is seen in the challenges of achieving global agreements and coordinating responses across multiple levels and sectors.
4. Policies irrationally impede future progress: Policy responses often fail to align with the scale and urgency of the problem, frequently discounting future impacts or inadvertently creating barriers to more effective future action. This irrationality stems partly from the difficulty of valuing long-term benefits against immediate costs and the tendency to prioritize short-term interests.

In this paper, the authors argue that these four features combine to create a "policy-making tragedy" where traditional analytical techniques, often based on assumptions of linearity and rational discounting, are ill-equipped to address the problem. Super wicked problems necessitate new epistemological and theoretical orientations for policy and planning.

2.1.5. Approaches for Tackling Wicked and Super Wicked Problems

Given the inherent difficulties and resistance to resolution, traditional policy approaches, particularly those based on rational-linear models or solely relying on bureaucratic and professional means, are often found to fail when applied to wicked problems. The sources discuss various perspectives and strategies for attempting to tackle or manage these complex challenges.

One key insight is that imperfect solutions, partial solutions, or "small wins" are often the only achievable outcomes in practice. This perspective contrasts sharply with Churchman's original moral argument that attempting to tame only a part of a wicked problem is "morally wrong" unless accompanied by honesty about not addressing the whole. Contemporary views propose that feasible partial solutions should account for the wickedness of the problem, rather than ignoring it through rationalized abstraction. Examples include intelligently imperfect solutions, small wins that accumulate into transformative change, or doable policy proposals achieved through problem structuring.

Proposed alternative policy and governance approaches for dealing with wicked problems include inclusive processes involving multiple stakeholders, conflict resolution, adaptive and responsive policies, and boundary spanning across different scales and domains. Various governance models have been suggested, such as network governance, collaborative governance, adaptive governance, and interactive governance. However, the sources caution against assuming that any single approach is sufficient to comprehensively tackle or "solve" wicked problems. Critically, Noordegraaf et al. (2019) argue that applying concepts like networks, trust, and learning to wicked problems can be naive, as wickedness often involves "emotion, secrecy, divisions, competition, resistance and distrust," which can inhibit learning and trust.

Instead of seeking perfect, singular solutions, approaches based on "polyrationality," such as "clumsy solutions" and "messy institutions," are proposed. Bannink and Trommel (2019) suggest four "intelligent modes of non-perfect responses":

- Living with problems: Moderating interventionist ambitions and accepting limits.
- Decomposition and improvisation: Learning from small-scale experiments and making incremental improvements.
- Sociological imagination: Rethinking policy problems in social terms.
- Frame reflection: Reframing conflicting beliefs to make issues less intractable.

These approaches are underpinned by contrasting ideas: modest acceptance of limitations and radical questioning of assumptions. Termeer and Dewulf (2019) propose a "small wins framework" as an intervention perspective. This involves identifying and nurturing concrete, small-scale, positive changes that can accumulate and energize stakeholders, embracing complexity rather than attempting to tame it. Problem structuring is also highlighted as a key activity to make problems amenable for action, often involving balancing opening-up and closing-down sub-questions and engaging in frame reflection among policy actors.

For super wicked problems, traditional policy analysis techniques, such as cost-benefit analysis which often discounts the future, are considered inadequate. The unique features of super wicked problems necessitate different analytical tools. Levin et al. (2012) advocate for an "applied forward reasoning" approach, which explicitly links causal analysis to prescriptive solutions and aims to identify interventions that can trigger policy pathways towards preferred outcomes. They draw on the concept of "path dependency," suggesting that policies should aim to create "stickiness" that makes reversal difficult and encourages progressive incremental change. This involves understanding how interventions can reinforce positive feedback loops and overcome negative ones. Key diagnostic questions for policy makers addressing super wicked problems include what can be done to create irreversibility, to create supporting constituencies, and to transform the existing policy space.

In dealing with wicked and super wicked problems, various forms of collaboration are often emphasized. Nancy Roberts identified collaborative strategies as one way to cope with wicked problems, involving engaging all stakeholders to find mutually acceptable solutions. This approach fosters information sharing but can be challenged by controversial ideas. Problem structuring methods (PSMs) are also collaborative tools used in operations research to address complexity, uncertainty, and conflict by helping groups build consensus or facilitate negotiations. For super wicked problems, the lack of central authority and the need for collective action underscore the importance of coalition building and engaging a wide range of

actors, including firms, NGOs, government officials, and individuals. However, the challenge remains to promote stakeholder learning that moves beyond simply seeking consensus, particularly when strategic self-interests may narrow problem definitions, and instead draw on robust knowledge, such as scientific evidence.

Dynamic Performance Management (DPM) is another approach explored for addressing wicked issues, particularly in public administration (Bianchi, 2016a). DPM aims to provide a more integrated, time-related understanding by balancing contrasting objectives (e.g., service quality of life, governance principles) using system dynamics methodology. This approach accepts the important roles of emergent strategy and learning mechanisms, rather than relying on rigid strategic planning and control.

While the concept of wicked problems has been generative, inspiring research across many fields, it has had limited direct impact on classic policy theories, many of which predate the concept. Some argue for mainstreaming the analysis of wicked problems within public policy, integrating it with existing concepts like problem framing and policy design. Others propose that existing policy science vocabulary is already sufficient. Nevertheless, the concept serves as a warning sign, prompting reflection on the nature of the problems faced when standard approaches fail and encouraging critical assessment of the assumptions underlying policy and governance theories.

For practitioners, the concept of wicked problems can be both challenging and illuminating. Framing problems as wicked can paradoxically lead to paralysis or a retreat from action due to the overwhelming scale and complexity. Alternatively, it can lead to an overestimation of what policy can achieve, tempting policymakers to make unrealistic promises. Churchman argued against this overestimation, viewing it as morally wrong for deceiving citizens and undermining deeper understanding. Despite these risks, recognizing problems as wicked encourages modesty, acceptance of partial solutions, and highlights the need to find ways to overcome paralysis. It serves as an antidote against oversimplification and unrealistic assumptions. Possible ways forward for the concept include rejecting it and relying on other concepts, using it as a knowledge base to understand policy failure, or developing its underlying dimensions (conflict, complexity, uncertainty) into more precise analytical tools linked with contemporary policy science.

2.1.6. Climate Change as Super Wicked Problems

Climate change is widely recognized as a classic example of a wicked problem. Its complexity, multiple interconnected causes and effects, long time horizons, scientific uncertainties, and the involvement of diverse stakeholders with conflicting interests make it resistant to straightforward solutions. Climate Change as a (super) wicked problem, is a dynamic complex societal policy problem featured by high risk and uncertainty and a high interdependency among variables affecting them. They cannot easily be clustered within the boundaries of a single organization or referred to specific administrative levels or ministerial areas (Bianchi, 2016a, p. 61).

Beyond being merely wicked, climate change is frequently cited as the prototypical example of a **super wicked problem**. It embodies all four defining characteristics of this class of problem:

- **Time is running out:** The scientific consensus underscores the urgency of immediate and significant action to mitigate climate change. The Intergovernmental Panel on Climate Change (IPCC) 's Sixth Assessment Report (AR6) highlights that global greenhouse gas emissions must peak before 2025 and be reduced by 43% by 2030 to limit warming to 1.5°C (IPCC, 2023, p. 21). Any delays in mitigation efforts not only escalate the difficulty and cost of adaptation but also amplify the risks of severe climate impacts, including extreme weather events and biodiversity loss.
- **Those causing the problem are also seeking a solution:** Anthropogenic activities, particularly the emission of greenhouse gases from fossil fuel combustion, deforestation, and industrial processes, are the primary drivers of observed global warming. The IPCC's Working Group I report confirms that it is unequivocal that human influence has warmed the atmosphere, ocean, and land (IPCC, 2021, p. 5). This dual role of societies as both contributors to and solutions of climate change poses fundamental puzzles in aligning immediate self-interests with long-term collective needs.

  There is no central authority: Climate change represents a classic global collective action problem. The absence of a central governing authority with the power to enforce emissions reductions or adaptation strategies means that international cooperation is essential. While frameworks like the United Nations Framework Convention on Climate Change (UNFCCC) exist, their effectiveness relies on the voluntary

cooperation of sovereign states, each with varying capacities, priorities, and stages of development. Furthermore, effective climate action requires coordination across multiple levels of government and sectors, leading to fragmented and diffuse authority structures (IPCC, 2022b, p. 26).

- **Policies irrationally impede future progress:** Despite clear scientific evidence and the availability of cost-effective mitigation and adaptation options, global policy responses have been inconsistent with the necessary scale and speed of action. The tendency to prioritize short-term economic concerns over long-term environmental sustainability results in insufficient investment in climate initiatives. Additionally, existing infrastructure and entrenched practices contribute to "carbon lock-in," making transitions to low-carbon alternatives more challenging (IPCC, 2022b, p. 26).

Climate adaptation, as a subcomponent of the broader climate change challenge, also inherits and exhibits many wicked and super wicked characteristics. Adaptation involves adjusting to actual or expected future climate and its effects [not in sources - general knowledge]. It is not a singular event but a continuous process requiring changes in behavior, infrastructure, and governance [not in sources - general knowledge]. Adaptation decisions are often embedded in complex local contexts, involve multiple stakeholders with conflicting needs and priorities, and are subject to deep uncertainty about the timing, magnitude, and nature of future climate impacts. Balancing different objectives, such as improving service quality (e.g., water infrastructure resilience), enhancing quality of life outcomes (e.g., reducing health risks), and adhering to governance principles (e.g., equity, participation) in adaptation planning is a wicked challenge. Adaptation, like other wicked problems, has no definitive stopping rule; as climate impacts evolve, adaptation needs will change. Solutions are context-specific and often require learning by doing, but the irreversibility of some infrastructure investments limits trial-and-error.

2.1.7. Climate Adaptation in Developing Countries: Compounded Wickedness

While the provided sources do not specifically discuss climate change adaptation in the context of developing countries like Ethiopia, the characteristics of wicked and super wicked problems described in the sources suggest that these challenges are likely to be significantly amplified in such contexts. Drawing upon the concepts presented in the sources and applying them to the general understanding of development contexts (this is an inference, not directly stated in the sources), several factors contribute to this compounded wickedness:

- **Increased Complexity and Uncertainty:** Developing countries often have complex socio-ecological systems, high dependence on climate-sensitive sectors like rain-fed agriculture, and low standards weaker infrastructure and weak data collection, tracking and monitoring systems in place to make timely corrective measures and interventions. This can lead to even greater scientific and informational uncertainty regarding future climate impacts and their interactions with social, economic, and environmental factors compared to developed nations. The interconnectedness of problems is often more pronounced, with climate impacts exacerbating existing issues like poverty, food insecurity, and health challenges (Bianchi et al., 2017; Noto & Bianchi, 2015; Vignieri, 2023)
- **Amplified Conflict and Pluralism:** Developing countries often exhibit significant internal diversity in terms of livelihoods, vulnerability, practices, and political landscape. Climate Adaptation measures involve navigating the needs and priorities of diverse stakeholders, the most vulnerable groups of societies, including marginalized communities, which can be particularly challenging due to power imbalances and weaker mechanisms for inclusive participation in the design, implementation and monitoring and evaluation cycles as compared to established democracies. Conflicting interests and values regarding competing priorities (e.g., economic growth vs. environmental protection vs. social equity) using a limited basket of resources in financing the needs become more acute under resource constraints.
- **Weaker Central Authority and Governance Capacity:** While super wicked problems globally lack a strong central authority, governance structures in developing countries may face additional challenges, including limited financial resources, technical capacity, institutional coordination, and potential issues with corruption or political instability. This can hinder the ability to formulate, implement, and enforce effective adaptation policies and programs across multiple levels and sectors. Dependence on external aid and expertise for adaptation funding and technical support can further complicate local ownership and the development of endogenous capacity.
- **More Severe Consequences of Policy Failure:** Given the higher vulnerability of populations and economies in many developing countries, the consequences of inadequate or failed adaptation policies are often more severe, potentially leading to

large-scale displacement, humanitarian crises, and economic setbacks. This intensifies the "right to be wrong" aspect of wicked problems (Termeer et al., 2019).

- **Heightened Urgency and Resource Constraints:** Time is running out more rapidly for adaptation in many developing countries where populations are highly exposed and sensitive to current and projected climate impacts. This urgency is compounded by significant resource constraints, which limit the range of feasible adaptation options and the capacity to implement large-scale interventions.
- **Integrating Scientific Knowledge with Local Contexts:** Applying global or even regional climate science to inform local adaptation decisions in diverse developing country contexts requires significant effort to integrate scientific projections with local knowledge, vulnerabilities, and capacities.

Therefore, while the core characteristics of climate change as a super wicked problem are universally applicable, the specific challenges and constraints present in developing countries like Ethiopia are likely to intensify these characteristics, making effective adaptation planning and implementation even more complex and difficult. The strategies proposed for wicked and super wicked problems, such as embracing complexity, seeking partial and flexible solutions, fostering collaboration, building coalitions, and leveraging path dependency, are highly relevant, but their application must be carefully tailored to the specific socio-political and economic realities of the local context. In summary, climate adaptation, as a necessary response to the impacts of climate change, similarly presents a super wicked characteristics due to its context-specificity, uncertainty, multi-stakeholder nature, and the need for continuous learning and adjustment at scale with the evolving country needs and demands derived from the place-based interventions and localization.

To sum up, the ideas of wicked and super wicked problems offer a useful framework for comprehending the intricate issues that practitioners and policymakers are currently facing. The concept of wicked problems, which has its roots in Rittel and Webber's criticism of rational planning, pinpoints socially wicked problems that are difficult to define, interconnected, have conflicting values, and are manifested by policy resistance to changes (solutions) (Sterman, 2009). By highlighting wickedness as a matter of degree along dimensions like conflict, complexity, and uncertainty, as well as acknowledging the dynamic feedback nature of problem definitions tied to stakeholder perspectives, contemporary viewpoints refine this.

The idea of "super wicked problems," which is especially relevant to climate change, adds key layers by focusing on the challenges that societies face when they attempt to solve them, such as urgency, self-causation, lack of central authority, and the irrational discounting of the future.

Therefore, to tackle the socially super wicked problems, it is paramount to go beyond conventional, linear approaches that aim for holistic solutions. The reviews suggest that leveraging ideas like path dependency and applied forward reasoning to develop policy pathways and form supportive coalitions is considered crucial for super wicked problems.

Climate change is one of the good examples of a super wicked problem because it has the key main characteristics of being urgent, self-causation, having fragmented governance, and being unfair to future generations because of temporal discounting. Climate adaptation, on the other hand, is another feature of socially wicked problems because it has to be implemented in a specific context, its uncertainty involves many stakeholders, and requires ongoing learning and adjustment. Generally, traits of wicked and super wicked problems make it likely that climate adaptation will be even harder in developing countries where their adaptive capacity is weaker and at a lower level of development and resilience. The challenge would likely become even more wicked and super wicked if it became more complicated, conflict-ridden, poorly governed, vulnerable, and limited in resources. This would require approaches that are not only new but also dynamics governance framework aided by systems approach catalyzed by active citizenship.

2.2. Climate Impacts, Vulnerabilities, and Resilience Dynamics

For climate-vulnerable developing nations, climate change represents an immediate, existential peril rather than a remote or abstract concern, manifesting with escalating intensity and frequency. Rising sea levels are inundating coastal communities and polluting freshwater supplies, erratic precipitation patterns and extended periods of droughts, and flooding are debilitating rain-fed agriculture and intensifying chronic food insecurity and poverty; and extreme weather phenomena such as cyclones, floods, and heatwaves are ravaging essential infrastructure, assets, and overwhelming fragile economies. These countries, often located in climate-sensitive geographies and heavily reliant on natural resource-based sectors, lack the adaptive capacity, institutional resilience, and limited fiscal space and flexibility to absorb and recover from repeated shocks (IPCC, 2022a; World Bank, 2023). The compounding nature of these risks means that even moderate climatic disturbances can precipitate systemic

breakdowns, displacing communities, disrupting markets, and reversing hard-won development gains.

In 2022 alone, climate-related losses and damage in developing countries reached an estimated US$109 billion, with projections indicating a need for US$200 billion to US$400 billion annually by 2030 to address escalating impacts (UNEP, 2023; V20 & Climate Vulnerable Forum, 2022).These figures reflect more than monetary costs they represent lost lives, eroded infrastructure, declining public health, and jeopardized futures. The magnitude of these losses highlights not only the urgency for scaled-up international finance and technology transfer but also the imperative for inclusive, anticipatory, and transformative adaptation strategies tailored to the realities of the most vulnerable (IPCC, 2022a; OECD, 2023).

Like many other Sub-Saharan Africa (SSA) Countries, Ethiopia faces an unprecedented multitude of challenges from climate change and its impact. It is highly vulnerable to climate impacts, including increasing the intensity, frequency, and magnitude of droughts, floods, desertification, water scarcity, and alarming incidence of pests, severely affecting livelihoods, biodiversity loss and key sectors such as Agriculture, Energy, Education and Health. For example, over 7 million cattle were lost during Ethiopia's drought in 2022-2023, which also caused massive internal displacement and the degradation of over half of the country's land.

2.3. Collaborative Platforms for Climate Change Adaptation and Resilience

A systems perspective is indeed essential when framing public policies for socially wicked problems such as social exclusion, urban traffic congestion, or climate change. This is due to the constrained capacity of traditional, finite, and static policy design frameworks to anticipate stakeholder responses and the enduring feedback effects of interventions, trade-offs, and their unintended consequences. Consequently, a systems thinking and systems dynamics modelling aided collaborative platform can elicit and facilitate a profound understanding of feedback loops, delays, and interdependencies among variables. Through policy networks, public sector organisations are essential for promoting cooperation and establishing consensus among stakeholders in such complex environments (Bianchi, 2010; Emerson et al., 2012).

Collaborative platforms are important tools for improving policy design and promoting long-term community outcomes, especially when it comes to climate resilience (Bianchi, 2022). According to Ansell &Gash (2018), they may promote integration by creating interfaces that integrate diverse and semi-independent activities into an interacting system. They can also serve

as a learning vehicle to create shared meaning and understanding of different perspectives (Osborne, 2010), foster shared view of the structure behind socially “wicked “problems ((Bianchi, 2015), and serve as a boundary object (Ansell & Gash, 2018, p. 23). Collaborative platforms emerged as a key lever for dealing with super wicked problems, such as climate change issues. These platforms bring together various stakeholders and actor which leads to new ideas, sharing of information, and working together. They anchor the learning process as their fundamental component for enhancing robust strategic planning, leading to sustainable community outcomes when transboundary issues cut across different organisations in a local area. (Bianchi, 2022, p. 415).

Collaborative platforms can be designed in a structured arrangements whether institutional, digital or hybrid, that bring together various actors work together to create, carry out, and keep an eye on interventions that are meant to tackle the complex problems. These platforms, of course, need to have the required approach needed to help public, private, and civic stakeholders work together on an ongoing or sequential basis. They are for dealing with "wicked" policy problems, like those related to climate change and sustainable development, that cross sectors, jurisdictions, and time periods (Bianchi, 2022; Bianchi & Grippi, 2025). In the current climate policy landscape, collaborative platforms are framed as country platforms, which facilitate the alignment of public and private, national and international financing on a substantial scale to support country-led initiatives, policies, and reforms aimed at fulfilling climate, nature, and development objectives (Hadley et al., 2022; Robinson & Larsen, 2025). According to Robinson & Larsen (2025), such platforms necessitate institutional capability and strategic coordination among different actors, including policy makers, financiers , private sectors, nongovernmental organisations, and community members and groups ; they also require adaptability to the specific context and careful sequencing of policy reform, investment project pipeline development, and finance streams. The rationale for collaborative platforms is grounded in the necessity for systemic problem-solving. The United Nations’ 2030 Agenda for Sustainable Development, and specifically Sustainable Development Goal 13 (UN, 2015), emphasize the importance of locally led responses to climate change. As climate impacts are experienced at localized scales, collaborative platforms enable context-specific policy planning while integrating diverse knowledge systems and actors across governance levels (Vignieri, 2023; Xavier & Bianchi, 2020).

According to Bianchi & Grippi (Bianchi & Grippi, 2025, p. 2023; Vignieri, 2023), collaborative platforms to tackling climate change, can serve as integrative hubs for local

stakeholders to co-create, adapt, and scale resilience strategies with the context specific emphasis on place based value creation (in this case long term sustainable solutions) that can align directly with adaptation and resilience interventions at the local level. In this regard, the authors suggest that platforms would support modelling of complex, counter-intuitive behaviours, notably in a dynamic and complex environmental, and socio- ecological systems. Therefore, embedding the collaborative platforms to convene structured multi stakeholder dialogues aided with systems approach is essential for bridging stakeholder mental models and policy design as it directly supports adaptive learning in climate change adaptation at local level.

2.3.1. Fostering Climate Resilience through Active Community

Active citizenship, within the framework of Dynamic Performance Governance (DPG), can play a critical role in fostering sustainable community outcomes and building resilience to climate change. It denotes more than legal or juridical belonging; rather, it reflects a shared moral commitment to collective goals, values, and culture within a community (Bianchi, Nasi, et al., 2021). This deep sense of engagement forms the bedrock for civic responsibility and loyalty, essential components in addressing complex, multi-dimensional problems such as climate change.

Active citizenship is indispensable in building climate resilience. Climate change presents a "super wicked problem," defined by limited response time, weak central authority, and fragmented governance across levels and sectors (Levin et al., 2012). As such, conventional policy framings are often inadequate. Active community engagement enables collective sense-making, joint action, and dynamic learning, which are fundamental to adaptive and locally led climate responses. According to Bianchi et al (2021), through DPG-supported collaborative platforms, citizens can better understand climate impacts, elevate community awareness, and nurture trust and leadership across networks.

In practice, active communities have demonstrated their capacity to drive institutional and cultural changes for climate resilience. For example, in the "Life-CalMarSi" project in Sicily, community organizations mobilized support for a regional decree (DPRS n. 339/2019) protecting the endangered Calendula Maritima. According to Vignieri (2023) active community through collaborative platforms facilitated and enhanced co-design of the conservation actions which involved government agencies, landowners, and citizens ranging

from physical protections to environmental education that shifts ecological dynamics from habitat degradation to restoration.

While economic resilience is less explicitly linked to active citizenship, DPG underscores the need to balance financial, competitive, and social outcomes through an "outside-in" governance lens (Bianchi & Rivenbark, 2014a). For example, Puerto Madero's urban regeneration in Buenos Aires shows how policy needs to balance between profit making with meeting societal goals and improving quality of life over time. Active citizenship in this regard can help build consensus and legitimacy, making sure that economic gains are aligned with local values and long-term benefits.

In conclusion, active citizenship, as defined by the DPG framework, is necessary for making climate adaptation directly relevant to local communities and building resilience in those communities. It connects framing policies, localizing policies in the context specific circumstances, putting them into action, drives for systemic changes in institutions and culture, and helps the local community work together to create public value. Active citizenship is a key part of dealing with complex socially wicked problems as it is built into collaborative governance, performance governance, and community learning.

2.3.2. Collaborative Platforms and Climate Adaptation Policy

Policy networks can still work together informally and implicitly, but collaborative platforms give them a formal way to encourage integration by using boundary objects, shared ideas, or tools that connect different stakeholder points of view (Xavier & Bianchi, 2020). These platforms are important for holding people responsible because they keep track of inputs, processes, and results. They are also the basis for the new field of Collaborative Performance Management(Bianchi, 2010; Bianchi & Rivenbark, 2014b). Therefore, to effectively deal with wicked problems, one also need to use a "outside-in" approach facilitated by collaborative platforms, which puts the needs and resources of communities over individual interest and goals (Bianchi, 2022; Xavier & Bianchi, 2020). This point of view stresses that public value can only be created through shared strategic resources like ecosystem quality, public safety, cultural heritage, green spaces, and civic engagement (Bianchi, 2010; Osborne, 2018; Osborne et al., 2016). These resources help both the community and the institutions do better, which means that the goals of society and organisations are the same. This because of the fact that that public value is created not within organizational boundaries but across dynamic, multi-actor systems involving institutions, services, individuals, and shared beliefs (Osborne, 2018;

Osborne et al., 2016). This requires a shift from internal performance value chains to external, citizen-focused value creation processes.

As indicated above, collaborative platforms can play key role for improving outcome oriented and place-based climate action design, implementation, and create public value through locally led adaptation. Therefore, one must consider the full system to establish robust policies and achieve long-term effects though leveraging such platforms to bring stakeholders together and use "boundary objects" to help them understand complex issues, encouraging collaborative governance (Bianchi, 2022; Bianchi & Grippi, 2025; Osborne et al., 2016; Xavier & Bianchi, 2020).They promote "outside-in" policymaking that prioritises local community needs over organisation interest that creates shared strategic resources and improves societal wellbeing. The outside-in view facilitates a dynamic learning process that links design and implementation, increases communication, and fosters partner consensus (Bianchi, 2022; Vignieri, 2023). Platforms allow private sector and civil society members to use a variety of ideas, skills, and energies to solve "wicked" problems, make places more appealing, and improve quality of life and public value.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Introduction

This chapter outlines the research methodology employed in this study to assess and evaluate the effectiveness of adaptation policy practices in Dehana Woreda, Ethiopia. The study aims to assess and evaluate the extent to which adaptation policies are being localized and function in addressing climate change impacts, their role in building resilience, and their contribution to sustainable livelihoods.

Moreover, this section examines the different layers of governance structures, community participation, and decision-making processes in localizing the climate adaptation strategies using a Dynamic Performance Governance (DPG) approach and how DPG can enhance the effectiveness and sustainability of locally led adaptation initiatives on the ground.

Traditional and static methodological frameworks, such as SAM multiply analysis, Computable General Equilibrium (CGE), and partial equilibrium (PE) models are mostly used to assess the impacts of climate-related policy interventions in developing countries (Bassi, 2014). However, these models are partly static and have limitations to accommodate human, economic, and natural elements in a single framework of analysis. Furthermore, there is limited empirical evidence showing more targeted policy-wide climate intervention performance assessment and analysis of the effectiveness of adaptation investment decisions considering the economy, society, and environmental dimensions at the local level, and often misses the temporal dynamics between these aspects. In addition, these tools are not able to provide information that can support: the management of dynamic complexity, measurement of intangibles, detection of delays, understanding of linkages between short- and long-term, and setting proper system boundaries in strategy design or planning processes (Bianchi, 2016b). Moreover, these tools could not help in searching for consistency between the policies designed at the national level and implemented by different local area stakeholders, which may lead to poor performance outcomes at the local level (Bianchi, 2022), particularly in addressing supper wicked societal problems at the local level.

However, dynamics models using the system dynamics modeling approach (Andrea, 2014) and Dynamic Governance framework (Bianchi, 2021, 2022) have the good virtue of eliciting critical strategic resources, performance drivers, and end results which allow assessing the

performance of climate policy interventions and their effects on development outcomes at the specified scope of work (Bassi, 2015a). According to Bianchi (2016), SD modeling process may support framing super wicked problems, assessing the performance of policy implementations, evaluating performance results by eliciting performance drivers, and facilitating to make targeted interventions based on the identified leverage points. Furthermore, these modeling frameworks allow policy practitioners to make extensions and advancements in policy analysis with other tools by accounting for the dynamic complexity embedded in the systems studied, facilitating the investigation and understanding of the relations between natural capital, society, and the economy (Bassi, 2015).

Therefore, to address the objectives mentioned above, this research will employ the System Dynamics-aided Dynamic Performance Governance framework (Bianchi, 2022) to assess the performance of policy interventions and their impact on the development outcomes at the local level in Ethiopia based on qualitative and quantitative surveys and scientific literature reviews. According to Bianchi (2021; 2022), DPG helps to elicit alternative means of improving the performance of climate adaptation policies design and implementation by portraying tradeoffs in time and space (Bianchi et al., 2021). In studying climate change adaptation policies, this research utilizes a combined framework of resilience and systems theory using the DPG framework to detect dysfunctions within adaptation systems at the macro and local levels along with qualitative and quantitative analysis from two field data collection sites in Ethiopia.

The methodology provides a detailed explanation of Dynamic Performance Governance Framework with the detailed research design, study area, data collection methods, sampling techniques, data analysis procedures, and ethical considerations. This framework ensures the study's rigor, reliability, and validity while capturing the complex dynamics of climate adaptation governance, economic diversification, and resilience-building.

3.2. Research Paradigm and Design

Research adheres to scientific procedures and methodologies to investigate phenomena and address issues within a social context where problems arise (Grippi, 2023b). Therefore, this research will follow a mixed pragmatist approach to assess and evaluate the effectiveness of adaptation measures using qualitative and quantitative approaches to examine the problem at hand (Abbadia, 2022). According to Abbadia (2022), this approach may entail interpretivism and positivism approaches to investigate a super wicked problem. Pragmatism accepts that both objective and subjective knowledge are necessary to understand a complex problem such as

climate adaptation in rural Ethiopia. It allows the researcher to combine post-positivist quantitative analyses, used to measure outcomes such as income, crop yields, and adoption rates, with constructivist qualitative inquiries, used to elicit the meanings and experiences of community members and local officials. The pragmatic stance recognizes that phenomena like adaptation at local the level are multi-faceted and cannot be reduced to a single paradigm. It also aligns with the Dynamic Performance Governance (DPG) lens adopted in this research, because DPG emphasizes continuous learning and flexibility for context-specific approaches, and to policy performance measures. Following the pragmatic paradigm, the study employs an explanatory sequential mixed-methods design. In the first phase, quantitative data is collected through a structured household survey and analyzed to identify patterns in socioeconomic characteristics, focusing on climate-resilient green infrastructure (CRGI) projects with broader adaption policy practice lenses and key outcome variables. Statistical tests determine whether changes in livelihoods, food security, and resource management are significant and establish relationships between key outcome variables. In the second phase, qualitative data were collected via focus group discussions (FGDs), key informant interviews (KIIs), and case studies, augmented with extensive document reviews. These methods probe deeper into the mechanisms behind the quantitative patterns; for example, they explore why some households adopt soil and water conservation practices while others do not, or how governance structures influence perceptions of project impact. The qualitative phase thus explains and contextualizes the statistical findings and provides a richer, more holistic understanding of the phenomenon underpinning adaptation. The sequential nature of the design ensures that insights from the quantitative phase inform the sampling and questioning of the qualitative phase, maximizing complementarity between the two components. The mixed methods approach also enhances validity through triangulation and caters to the multi-dimensional nature of underlying problems.

3.3. System Dynamics & Dynamics Performance Governance as a Methodological Framework to Assess the Place-Based Adaptation Measures

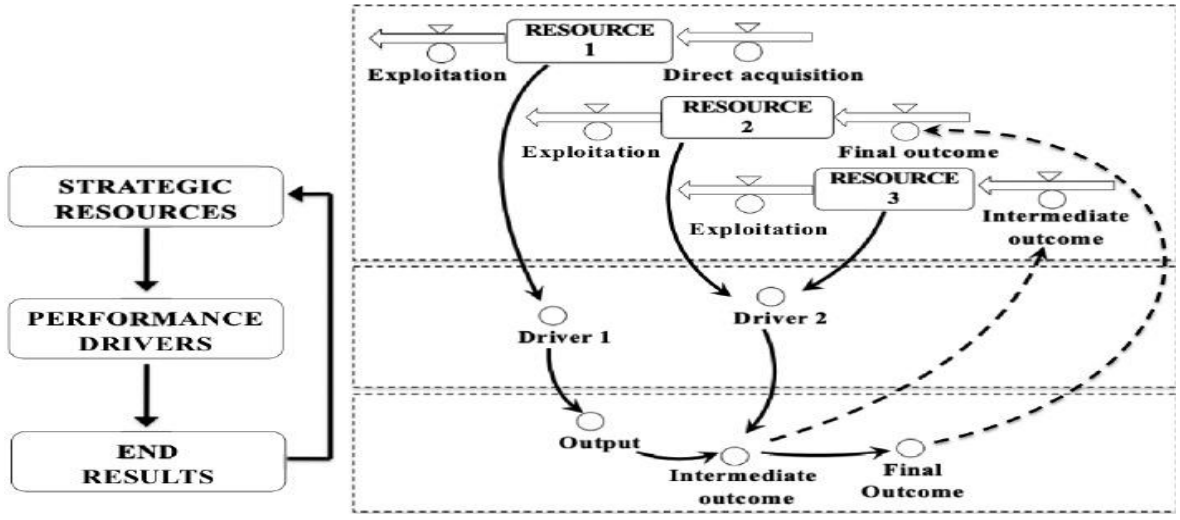
According to (Bianchi, 2021),the concept of performance governance is related to different strands, such as: (a) organizational relationships within and beyond the public sector; (b) participation and citizen engagement in performance feedback; (c) focus on outcomes, public

value, trust in government, and social capital, (d) information sharing, and (e) joint responsibility/accountability.

Therefore, consistency between the policies designed and implemented by different local area stakeholders is needed, particularly when "wicked" social problems are addressed. For this goal, an "outside-in" view of sustainable performance assessment is required (Bianchi, 2016a, 2022; Xavier & Bianchi, 2020). Through this view, policy design is first about a local area, rather than individual organizations. This allows stakeholders to outline collaborative policies that generate shared strategic resources(Bianchi, 2021; Bianchi, Bereciartua, et al., 2021a; Bianchi & Grippi, 2024) at society level, which also strengthens performance at agency level. Such change in mental models is possible if stakeholders are supported by learning facilitators to perceive that by pursuing their individual goals to the detriment of community outcomes may lead to a crisis or diminished performance for their organizations (Xavier & Bianchi, 2020)

Through an "outside-in" view, each agency would focus as a next step of policy making – on how to implement the community policies agreed with the other stakeholders, with the goal to affect the endowment of shared strategic resources in a local area.

Figure 1:*The Instrumental View of Performance*

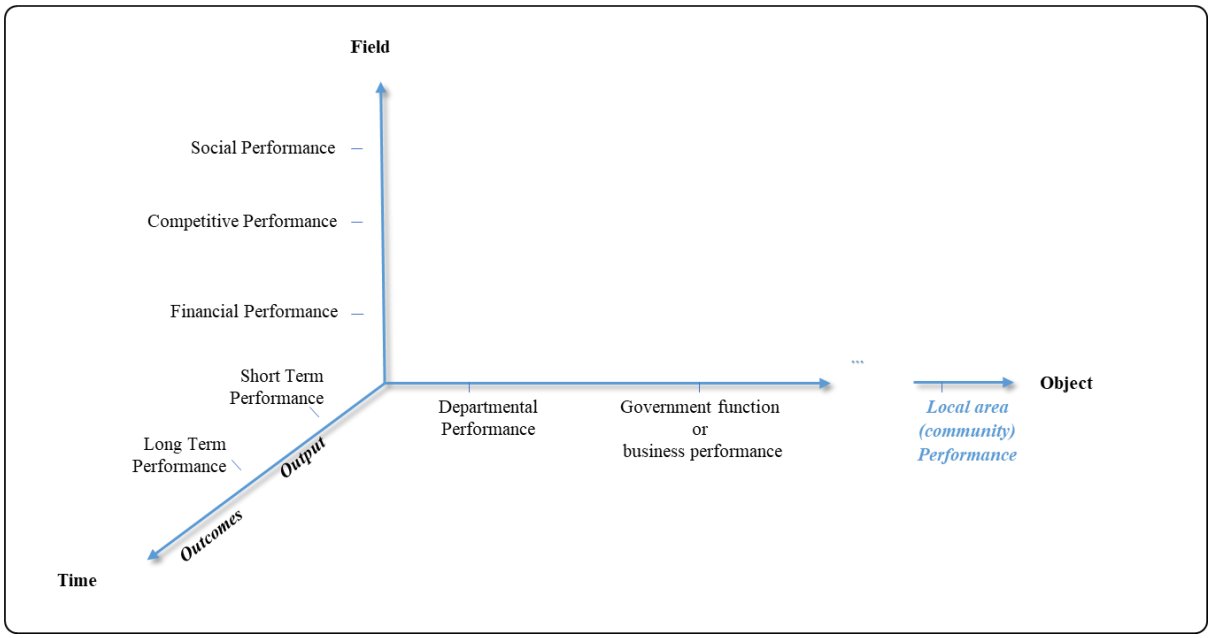


Source: Bianchi (2016, p. 73).

More specifically, by adopting a Dynamic Performance Management and Governance approach, through an "outside-in" view, the designed community development policies provide a basis for implementation at an organizational level. This requires that the policies designed at corporate level by each stakeholder institution pursue organizational outcomes which are

consistent with the targeted community outcomes. It also requires that corporate policies be consistently cascaded at departmental level, and that implementation results are constantly monitored, through performance drivers, and emerging outputs and outcomes. Such control process, if referred to the implementation of policies related to social "wicked" problems, should not be bounded to a feedback mechanism. It should also enable a proactive feedforward logic (Otley, 1999, p. 369), implying that the emerging problems or opportunities from implementation at departmental level may suggest possible changes in the policies designed at both institutional and community level. This is the core of a strategic dialogue (supported by learning facilitators) between stakeholders with different roles in both an organizational and interorganizational setting (Bianchi, 2021, p. 341, 2022; Vignieri, 2023).

Figure 2: A Balanced View of Sustainable Performance Governance Depiction



Source: Adapted from Bianchi (2016, p. 53).

A combined Dynamic Performance Management and Governance approach may enhance the design and implementation of "collaborative platforms" for assessing sustainable performance outcomes, in relation to three interconnected viewpoints: (1) field (financial, competitive, and social), (2) time horizon (short vs. long term), and (3) object (organizations vs. local area) (Bianchi, 2016; Bianchi et al., 2019; Xavier & Bianchi, 2019). Under the first viewpoint, sustainable policies require that the achieved outcomes under the social and competitive (e.g. quality and scope of provided services) dimensions may also ensure financial equilibrium (Coda, 2010). Under the second viewpoint, sustainable performance should balance trade-offs

in the short and long term. Under the third viewpoint, which synthesizes the previous two, sustainable organizational outcomes (at departmental and government function or business unit level) should foster community outcomes, and vice versa.

Based on such perspective, we may now outline the attributes of Dynamic Performance Governance (DPG), as an overarching framework to DPM for implementing an "outside-in" view of policy design when a local area is the object of policy assessment. This approach enhances collaborative governance regimes, that is, "collaborative summits where partners periodically gather to review their joint performance" (Douglas & Ansell, 2019, p. 1).

In this regard, the concept of local area performance needs more analysis. Sustainable performance at the local area level comes from the aptitude of stakeholders in a region to collaborate for developing shared strategic resources. Such resources refer to "common goods" (or "common-pool-resources") (Hardin, 1968; Ostrom, 1990), and other community assets.

An "outside-in" view of DPG frames policy design as a process aimed at fostering sustainable outcomes in a local area. This supports stakeholders in sharing policies that will enable them to interact on the same system, by taking complementary roles in leveraging common goods and other strategic resources, at both community and organizational level. Although shared strategic resources are not individually owned by any of the stakeholder institutions – and therefore are not under their direct control – they are important levers to build and sustain local area performance (Bianchi et al., 2019).

3.3.1. **Systems Dynamics Modeling**

System Dynamics Modeling (SD) is a form of computer simulation modelling approach designed to facilitate a comprehensive approach to tackle super wicked social problem in the policy design and planning cycles in the medium to long term (Forrester, 1994; Meadows, 1980; Sterman, 2009). SD operates by simulating differential equations with "what if" scenarios, explicitly represents stocks and flows, and can integrate optimization and econometrics (A. M. Bassi, 2015). According to Bianchi (2016a) the role of SD is not to make precise estimation predictions of the future, or to optimize performance; rather, it facilitates double loop learning process through eliciting the behavioral dynamics of the problem; and help stakeholders or interested parties identify the key performance drivers of change , and intended outcomes (both desirable and undesirable).

Systems Dynamics modeling can effectively enhance performance management and governance by addressing dynamic complexity (Bianchi, 2016a). This approach aids decision-makers in evaluating current performance levels and diagnosing the underlying patterns that shape the existing state of a context (Bassi, 2015; Bianchi, 2016b). System Dynamics modeling can also provide decision-makers with proper 'lenses' to frame dynamic complexity and to enhance traditional performance management approaches (Bianchi, 2016c, p. 14; Bianchi, Bovaird, et al., 2017; Forrester, 1992). Furthermore, facilitated modeling sessions are a vehicle to raise doubts and to foster a strategic dialogue on the hypotheses upon which past decisions have been made, and to suggest alternatively a given cause-and-effect relationship could be modeled. In this regard, System dynamics aided modeling approaches, as a learning framework, rather than being prescriptive, are descriptive. They help people to better frame the systems in which they operate and to figure out different possible outcomes related to several sets of adopted policies, according to different scenarios (Bianchi, 2016c).

The process of SD modeling can support the performance management cycle through the following phases: (1) mapping (framing the system); (2) planning; (3) implementing decisions/operations; (4) measuring/evaluating results, and undertaking corrective actions (Bianchi, 2016c, p. 39). The main purpose of system dynamics methodology is to understand the causes of undesirable dynamics and design new policies to ameliorate/eliminate them (Barlas, 2007, p. 1113). SD modeling can support policy cycles by fostering double loop learning (Bianchi, 2016c; Morecroft, 1983; Sterman, 2009).

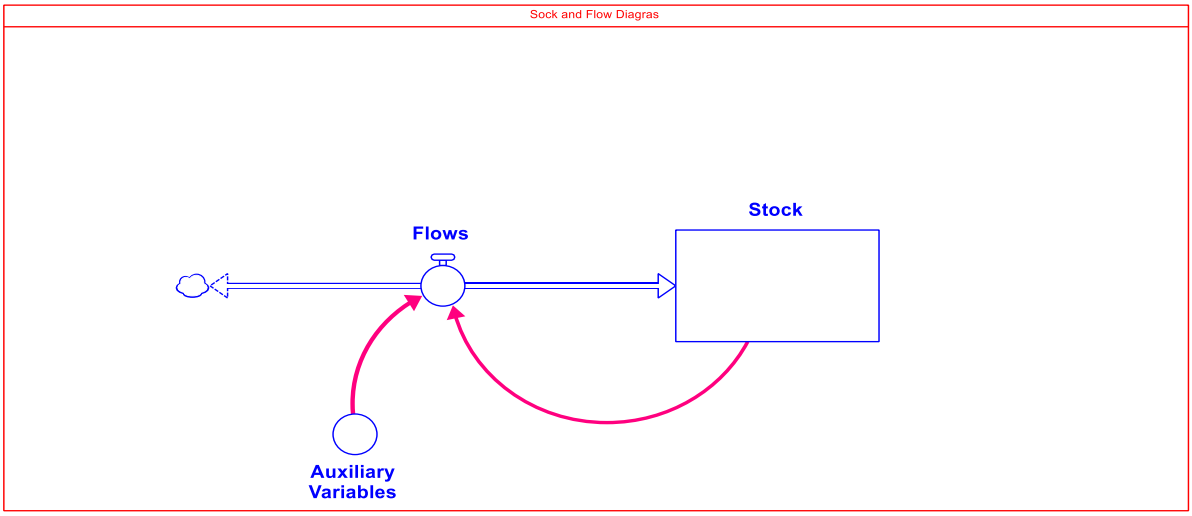
3.3.1.1. Stocks and Flows

Stocks: Stocks are the building blocks of Systems Dynamics Modelling (Ford, 2010, p. 14). They are also called levels or state variables representing accumulations over time. They can also be identified as a snapshot of the system in memory. They are central elements of dynamic systems, and foundations for system Dynamics Modeling as they dictate the system's existence and stability. Their significance is in their capacity to alter solely via flows, establishing them as the principal leverage point for managers to affect system outcomes (Forrester, 1994; Sterman, 2009). They demonstrate persistence and inertia, acting as buffers that mitigate shocks and stabilize fluctuations, therefore averting sudden collapse (Meadows, 2008). In addition, stocks create delays by decoupling and buffering their related flows, which frequently complicates system dynamics and decision-making (Richardson & III, 1997). Typical examples include area of land, Population of a species, Image, Trust, inventory of goods,

capital accumulation, deposit in bank account. Water volume in a reservoir among others. Stocks are central to SD modeling because they generate inertia and time delays in system behavior (Sterman, 2009).

Flow: Flows (or rates) are the processes that change the quantity of stocks over time. They represent the movement of material, energy, or information into or out of stock. For instance, in population dynamics, births serve as inflows and deaths as outflows. In financial systems, investments may increase capital, while depreciation reduces it. Flows connect decision-making and policy levers to system accumulations (Forrester, 1992).

Figure 3: Stock and Flow structure in System Dynamics



Source: Author depiction Using Stella Software 3.8

3.3.2. **Dynamic Performance Management (DPM) Approach**

Dynamic Performance Management (DPM) is a learning-oriented approach that integrates concepts from System Dynamics (SD) into the performance management domain to foster a shift of mind from a static to a dynamic understanding of organizational performance (Bianchi, 2016c; Bianchi et al., 2017). DPM is primarily focused on the agency or organizational level, supporting internal consistency and learning in policy design, implementation, and evaluation within a single entity. It challenges conventional, financially oriented performance measurement systems that often rely on static, retrospective reporting, which can lead to a narrow and fragmented perception of organizational performance (Bianchi & Rivenbark, 2014b).

By embracing the complexity of dynamic systems characterized by nonlinear relationships, time delays, and feedback loops, DPM provides decision-makers with analytical tools to

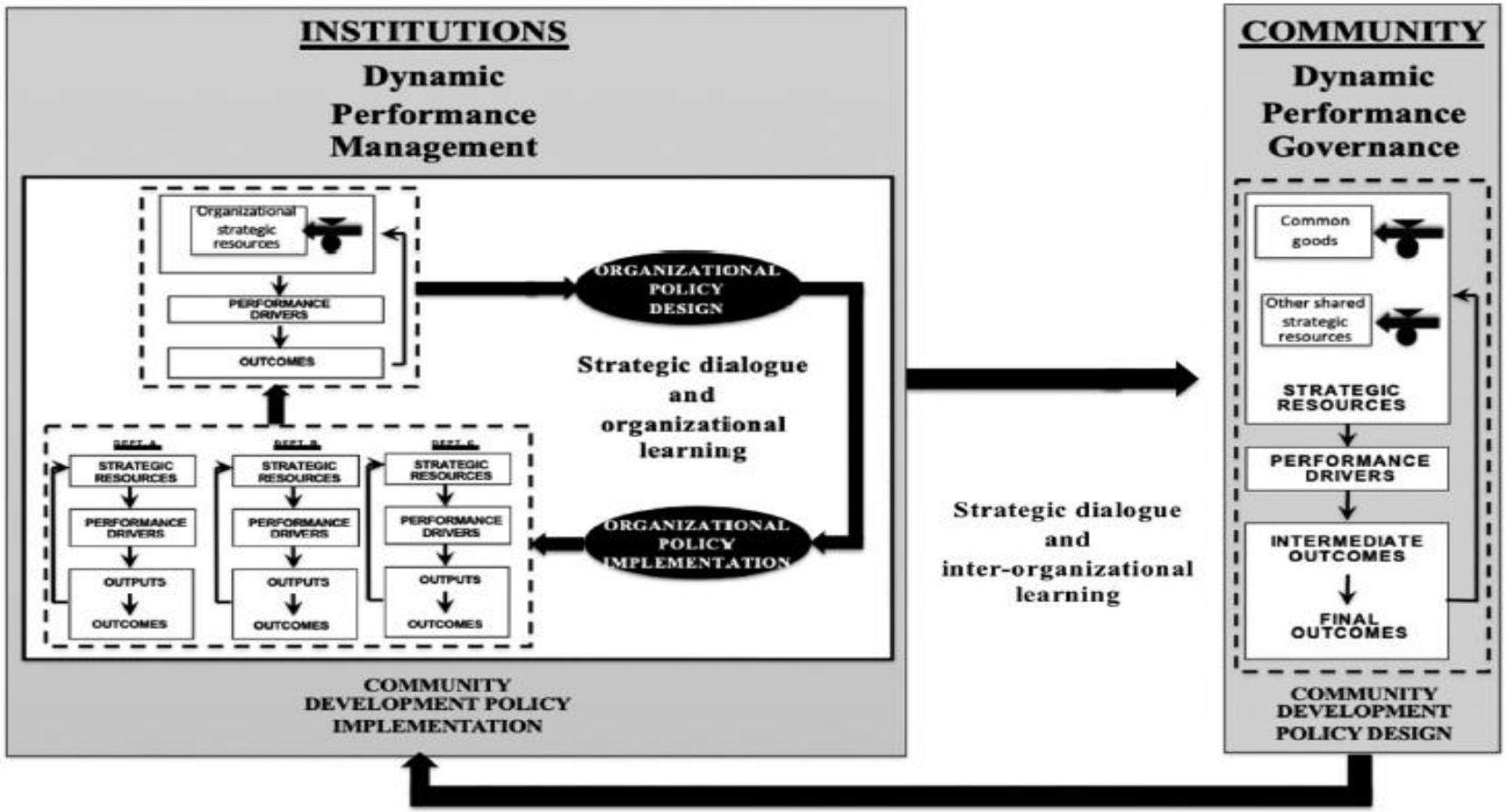
understand the systemic causes of performance issues rather than their symptoms (Bianchi, Nasi, et al., 2021). A key feature of DPM is its ability to frame trade-off analysis across time and space, balancing short-term outputs with long-term outcomes and reconciling effects across different organizational subsystems (Bianchi et al., 2017). DPM structures performance assessment by linking strategic resources (tangible and intangible assets) to performance drivers (critical success factors expressed as ratios) and end results (outputs and outcomes expressed as flows). Through this structure, DPM allows organizations to identify weak signals of future change and to undertake feedforward actions (Bianchi, 2016c).

DPM utilizes three complementary and interconnected viewpoints: the instrumental view, focusing on *how* to affect performance; the objective view, defining *what* the object of performance management is by mapping products and processes; and the subjective view, focusing on *who* is responsible for generating results (Bianchi, 2016c; Bianchi, Bovaird, et al., 2017).

3.3.3. **Dynamic Performance Governance (DPG) Approach**

Dynamic Performance Governance (DPG) is a conceptual and analytical framework that integrates principles from performance management, systems thinking, and collaborative governance (Bianchi, 2022). Traditional approaches to performance management have often concentrated on measuring input, activities, and output within the boundaries of individual organizations, emphasizing efficiency and short-term targets. While this provides valuable information, it tends to oversimplify complex realities by neglecting long-term impacts, interdependencies across sectors, and the social dynamics that determine whether interventions are sustained over time.

Figure 4:Dynamic Performance Management and Governance Framework in supporting policy design and implementation in policy networks: an "outside-in" view



Source: Bianch (2021, p. 342)

While DMP promotes consistency and learning within individual organizations, Dynamic Performance Governance (DPG) extends and complements DPM by adopting an "outside-in" perspective of policy design and performance assessment (Bianchi, 2021). DPG extends the analytical focus from the individual organization to the community or territorial level, emphasizing interorganizational performance and the pursuit of sustainable community outcomes. This approach recognizes the importance of leveraging shared strategic resources such as environmental quality, human capital, and social well-being which are common goods not directly tradable in markets but essential to collective prosperity (Bianchi & Rivenbark, 2014b).

3.3.4. Applying Dynamic Performance Governance to Assess the Performance of Climate Adaptation at the Local Level

The DPG framework informs the research in three interconnected ways. First, it guides the selection of indicators. The household survey instrument includes variables that capture not only material outcomes such as income, crop yields, and access to water, but also governance processes such as participation in meetings, trust in local leaders, clarity of roles, and frequency of information sharing. These variables align with the DPG pillars of learning, coordination, resource support, incentives, and adaptation.

Second, DPG shapes the qualitative inquiry by prompting interview questions that go beyond technical practices to examine governance dynamics. Questions focus on how decisions are made, who sets priorities, how feedback is gathered and used, and whether mechanisms exist to adjust interventions when problems arise. This ensures that governance processes are analysed as active drivers of performance rather than as background conditions.

Third, DPG provides an interpretive lens during data analysis. Both statistical and thematic findings are organised into feedback loops and causal relationships, which make it possible to identify reinforcing or balancing dynamics. For example, increased capacity through training can encourage adoption of improved practices, leading to higher yields and greater income, which in turn fosters further participation and creates a virtuous cycle. Conversely, delays in resource delivery can weaken trust, reduce participation, and undermine outcomes, creating a vicious cycle.

By informing indicator selection, guiding qualitative inquiry, and shaping interpretation, the DPG framework strengthens the integration of quantitative and qualitative components within

the mixed-methods design, ensuring that governance dynamics and performance outcomes are analyzed in a coherent and complementary manner.

3.4. Study Area Description

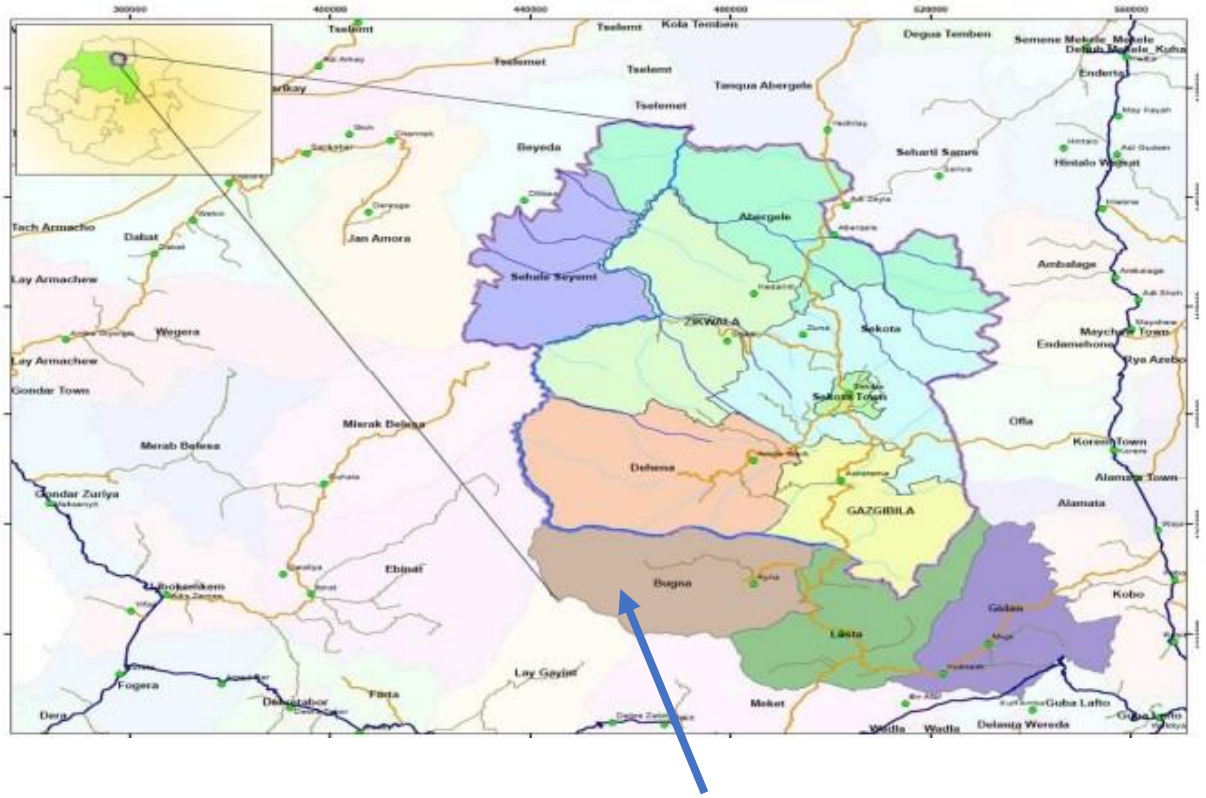
The study focuses on Dehana Woreda, Waghimra Zone, Amhara Regional State, Ethiopia. This area has been severely affected by climate change, with recurrent droughts, land degradation, and biodiversity loss exacerbating environmental and socio-economic vulnerabilities. Climate variability has significantly impacted agricultural productivity, water availability, and local livelihoods, increasing the need for effective adaptation measures.

The research assesses the performance effectiveness and governance of adaptation measures taken to avert the impact of climate change in this local area. The study particularly assesses measures such as watershed and natural resource management, climate-resilient agriculture, renewable energy enterprises, and sustainable asset value chain co-creation. These interventions were designed to strengthen the local community resilience by improving water retention, promoting diversified livelihood strategies, transitioning away from biomass use through clean cooking and improved and efficient use of cook stoves, and fostering community engagement in sustainable practices.

The study targets Shimamdan and Wizaba kebeles in Dehana Woreda. The two kebeles are purposely selected for this study based on their high climate vulnerability and local community participation in adaptation initiatives. The two kebeles provide a basis to assess the participation, governance effectiveness, dynamicity, and sustainability of climate adaptation measures at the local level. The selection was informed by prior assessments and discussions with local authorities and implementing agencies.

Figure 5: *Location of Dehana Woreda*

The study's conclusions are relevant not only for Ethiopia's Dehana district but also for other sub-Saharan developing nations that struggle with similar challenges, ranging from weak adaptive capacity and myopic policy and governance design to implementation as well as monitoring and evaluation capacity, and can be framed as the contextual exploration for adaptation and resilience in the policy domain.



3.5. Sampling Strategy and Sample Size

A combination of stratified random sampling and purposive sampling was used to ensure a representative and diverse sample. Household surveys used stratified random sampling to ensure proportional representation of adaptation measures to support beneficiaries. The sample frame consisted of 2195 households in Dahana Woreda, with 500 Watershed and natural resource management activities, 200 Sustainable, diversified and climate-resilient agriculture such as irrigation, drought-resistant crops, and bee keeping activities, 1450 Sustainable energy sources and products and 45 Agro-business & other. The use of proportional stratified sampling was intended to ensure that the sample accurately reflects the population, based on the stratification criteria (Zikmund et al., 2009).

In order to determine the representative simple size, the study uses the following formula. The sampling size selection process involves five key steps: determining goals; establishing the

desired precision of results; determining the confidence level; estimating the degree of variability; and estimating the response rate (Watson, 2001). By considering these factors, the research aimed to achieve a sample size that would provide reliable and accurate results for the study.

$$n = \frac{z^2 + P(1-P)}{d^2 + z^2 \frac{P(1-P)}{N}}$$

Where,

n = sample size required

N = number of populations

P = estimated variance in the population = 50% (commonly used)

d = margin of error = 5% (assuming 95% error free precision)

Z = confidence level = 1.96 (assuming 95% confidence)

R = estimated response rate=95%

Thus, a total of 284 households were selected and questionnaires were distributed to the respondents proportionally according to their sector (strata) as shown below.

Table 1: Population and sample size of the respondents

Activities	Target Population	Sample
1. Watershed and natural resource management activities	500	81
2. Sustainable, diversified and climate-resilient agriculture such as irrigation, drought-resistant crops, and bee keeping etc	200	65
3. Sustainable energy sources and products (e.g. cook stoves and solar lamps).	1450	108
4. Agro-business and other	45	31
Total	2195	284

Source: Author calculation based on the sampling technique

I used a purposive sampling technique for the focus group discussions (FGD) and key informant interviews (KI) to select key stakeholders to augment the systemic analysis of the study with broader knowledge and experience in adaptation measures in the local area. The selection of FGD participants ensured inclusivity across gender, age, and socio-economic

groups, capturing diverse perspectives on adaptation measures applicability and effectiveness their implementations.

Case studies involved participants chosen based on their engagement in locally led adaptation efforts and climate resilience programs. These individuals were selected based on their direct experiences with adaptation initiatives design, implementation, monitoring and evaluation, as well as their ability to provide in-depth reflections on the performance governance framework.

3.6. Data Collection Methods

A multi-method data collection strategy is employed to gather both primary and secondary data, ensuring a holistic assessment and evaluation of adaptation measures effectiveness and governance.

Primary data is collected through household surveys, focus group discussions, key informant interviews, case studies, and field observations. Structured questionnaires were administered to a sample of 284 households. The household survey captures both quantitative data on key socio-economic indicators and qualitative insights into how adaptation interventions have shaped community well-being.

About twelve focus group discussions were conducted with women, youth, and community leaders to explore perceptions of adaptation policy effectiveness, governance structures, barriers to implementation, and sustainability challenges. These discussions provided deeper insight into social dynamics, decision-making processes, and local knowledge integration.

Interviews with local government officials, project coordinators, and community leaders assessed the decision-making process, governance mechanisms, and implementation of adaptation measures. The key informant interviews further provided an opportunity to understand institutional perspectives on adaptation planning and coordination.

Thirteen case studies documented the individual and community experiences with adaptation interventions, highlighting successes, challenges, and opportunities for scaling up. Case studies illustrated real-life applications of adaptation practices and their socio-economic benefits.

Field observations were conducted to validate survey and interview findings by assessing watershed conservation areas, sustainable energy initiatives, and value-chain production activities. Observations allowed the researcher to directly examine project implementation and contextual factors influencing adaptation success.

Secondary data were collected from document reviews and policy analysis. Key project reports, policy documents, and national climate resilience strategies were analyzed to understand the alignment of local adaptation efforts with national policies. Regional and national climate adaptation policies were examined to assess institutional gaps and opportunities for improved governance in local adaptation initiatives.

3.7. Data Analysis Techniques

A sequential explanatory mixed-methods approach guided the data analysis process. Quantitative data analysis was conducted using statistical methods, including descriptive statistics, to identify patterns in household survey data. The quantitative analysis helped establish baseline conditions and measurable impacts of adaptation policies.

Qualitative data analysis was conducted, focusing on governance effectiveness, community participation, and barriers to adaptation adoption. The qualitative component provided nuanced insights into stakeholder perspectives and policy implementation challenges.

Finally, a systemic analysis combining qualitative and quantitative methods was conducted using DPG framework and feedback loop dynamics to understand the underlying problem dynamics and the long-term effects of adaptation measures on local adaptive capacity and resilience through the Dynamics Performance Governance approach.

3.8. Ethical Considerations

Ethical principles are strictly adhered to, including informed consent, confidentiality, and based on voluntary participation of individuals and groups during the data collection process. Ethical clearance was obtained from relevant institutional review boards and local authorities. The research followed a ‘Do Not Harm Approach’, ensuring no undue risks for participants. Special attention was given to the inclusion of marginalized groups such as youth, women, and highly vulnerable households. The study maintains transparency in its objectives and findings by engaging local stakeholders in feedback sessions.

CHAPTER FOUR
CONTEXTUAL OVERVIEW OF DEHANA WOREDA AND THE CLIMATE ADAPTATION INTERVENTIONS

4.1. Socioeconomic and Environmental Context

4.1.1. Geography and Climate

Dehana Woreda is a highland district in the Wag-Himra Zone of Amhara National Regional State of northern Ethiopia. It spans about 1,643 km² of rugged terrain, with elevations ranging from deep valley gorges to high mountain plateaus above 3,000 meters. The woreda's remote geography contributes to its isolation, as the nearest major towns are many hours away over difficult roads. The climate is characterized by a subtropical highland pattern with one main rainy season (June–September) and a shorter spring rain; however, rainfall is highly erratic and unreliable. Recurrent droughts are common – the area has suffered prolonged rain failures and delayed and erratic rains in recent decades, resulting in frequent crop failures, and thereby substantial reduction in yield. Local elders recount that severe droughts and water scarcity have intensified over the past 50 years, a trend attributable to climate change (Helvetas, n.d.). Even in normal years, total annual precipitation is quite low and unevenly distributed, which severely affects agricultural activities and limits crop yields. Meanwhile, temperatures vary with altitude; highland areas are mild, whereas low valleys experience hotter, semi-arid conditions. This climatic volatility leaves Dehana extremely vulnerable to climate shocks, especially to frequent and severe drought. When rains falter, harvests decline and pasture withers, undermining food security for the predominantly agrarian communities.

4.1.2. Environmental Challenges

The woreda's environment is markedly degraded after centuries of settlement and cultivation. Steep hillsides have been deforested for fuel and farmland, and soil is eroded by runoff. Wag-Himra Zone (of which Dehana is part) lies in Ethiopia's drought-prone belt where land degradation and erratic rainfall form a vicious cycle of ecological fragility and poverty (*WTAC*, 2022). Topsoil loss and gullying are widespread; many farmers cultivate marginal sloping lands with low productivity. Vegetative cover is sparse in much of Dehana, and biodiversity has declined as natural forests gave way to cropland. The Tekezé River forms the woreda's western boundary, but its deep gorge is largely inaccessible for irrigation, and few permanent streams exist on the plateau where water shortages are chronic. Scarcity of water and arable land drives

unsustainable farming practices: farmers encroach on hillsides and overgraze communal areas, further exacerbating erosion. Moreover, recurrent droughts and high temperatures accelerate vegetation loss, leaving the land less able to retain moisture. This environmental degradation directly threatens livelihoods. According to Wag Development Association (WDA) (2022), by the mid-2000s, an estimated 70% of households in Wag-Himra had experienced climate-related shocks (droughts, crop failure, or livestock deaths) as major blows to their income. Such shocks are frequent in Dehana, undermining development gains and trapping many families in subsistence survival mode.

4.1.3. Population and Livelihoods

Dehana Woreda had a population of roughly 110,000 in the 2007 census (growing to an estimated 120,000 by 2012), of whom over 96% reside in rural areas(Central Statistical Agency, 2008). The population is predominated by Amhara and Agew agro-pastoralists. According to the census, the average household has about 4 to 5 members, and population density (around 67 people per km²) is higher than the zone's average, putting pressure on limited arable land. Livelihoods are based mainly on rain-fed subsistence agriculture where local agrarians cultivate staple cereals (sorghum, teff, barley) and pulses on small plots, primarily for household consumption. However, the yield is often insufficient, and the community is chronically food insecure. The woreda, during relatively better climatic seasons, households still rely on food aid and depend on the Productive Safety Net Programme (PSNP) support to meet their basic needs. Livestock rearing (cattle, goats, sheep) is predominantly essential household asset in the area, and serving as a form of savings and livelihoods. In drought season, sales of livestock are a common coping mechanism, which erodes household assets over time. Off-farm income opportunities are very sparse: a few households participate in petty trade in the small towns (like Amde Werq, the administrative capital of the district) or migrate seasonally in search of labor. Overall, unemployment and underemployment are high, especially among youth in rural villages.

Despite these challenges, Dehana possesses some natural resource-based livelihood potential. Notably, the woreda is known for its honey production potential: it has a long tradition of beekeeping and accounts for about 10% of regional honey output (Phogella & Anbaw, 2024). Many households maintain traditional beehives in nearby forests, and honey has become a major cash crop locally. According to this study, honey and beeswax provide sources of income

for farmers and youth, next to crops and livestock in economic importance. In recent years, youth cooperatives started involving in honey processing and trade, signaling to livelihood diversification beyond staple farming as a coping mechanism for adverse impacts of climate income and asset losses due to crop failure and drought impacts. However, realizing the full value of this honey value-chain is constrained by poor market linkages and lack of processing facilities. Other emerging livelihoods include small-scale irrigation in valley bottoms (for vegetables or fruits) and handicrafts, but these remain marginal due to water scarcity because of drought and limited market access. Overall, the economy of Dehana is narrow and highly climate-sensitive, with few alternative income sources. This makes the community extremely vulnerable to climatic swings: a failed rainy season directly translates to lost income, and assets, thereby exacerbating food insecurity situations and further weakens the local adaptive capacity.

4.1.4. Infrastructure and Services

Structural limitations in the local economy are compounded by the severe lack of basic infrastructure and public services. Dehana's rural communities are physically isolated from access to road networks, the existing ones are mostly unpaved and often difficult to use during rainy seasons, inhibiting information and market access, including emergency aid delivery for the most vulnerable. Only a few villages are reachable by vehicle; many people travel on foot for hours to the nearest road. Access to clean water and sanitation is very low: as of 2007, about 66% of households relied on unsafe water sources, and two-thirds had no latrine facilities (*WTAC*, 2022). Health and education services are also rudimentary. There is only one small district hospital for the entire Wag-Himra Zone, meaning Dehana's 100k+ population shares a hospital located far away (Sekota town) that serves nearly 200,000 people (*WTAC*, 2022). Clinics within Dehana are under-staffed and lack medicine. Schools are few and often far from villages; while primary school enrollment has improved, dropout rates are high as children are needed for farm work or cannot travel long distances. According to WTAC (2022) report, adult literacy stands at only 22% in the zone, showing limited access to education in the woreda out-migration of educated youth because of lack of jobs and dependable livelihoods in the district. Electric power is not expanded in the rural kebeles (villages) of Dehana; only the the woreda capit, Amde Werq has grid electricity. In addition, over 95 % of the households in the district use traditional cooking practices and cooking with firewood or cow dung. Below 4% of the households use any form of cooking energy (*WTAC*, 2022). This heavy reliance on biomass

fuel contributes to further deforestation, and air inhouse air pollution creating an adverse impact on ecosystem, health and lively hood that further exacerbates the food insecurity situation.

4.1.5. Climate Change Vulnerabilities

Climate change has a huge effect on Dehana. The weather has a big effect on the local community's food security and way of life, and there is little buffer against the adverse impact of climate change and its repercussions in the district. Frequent drought and failed rainy seasons have caused thousands of people to experience crisis. For example, records show that from 2018 to 2020, consecutive failed rainy seasons caused severe food shortages and the need for emergency food aid in several kebeles of the Dehana district. Sadly, climate model projections for northern Ethiopia show that temperatures will rise and rainfall will become even more unpredictable in the long term. Such developments could lead to more frequent and severe droughts and failed rainy seasons. For Dehana, the increased variability could make the soil even drier and shorten the growing season even more. Flooding and soil erosion are also becoming major concerns. When it rains after a drought, it often comes down in heavy downpours that cause flash floods on bare hillsides. These phenomena wash away topsoil and seedlings, which makes recovery time longer and difficult. The woreda also has trouble in adapting to climate change because of its structure. The residents do not have resources to invest in resilience because they are poor, and the local institutions are weak and do not have the required capacity. In addition, financial resources allocated for the overall annual implementation of development activities in the district are insufficient, and only a few households get support from the extension services. Unpublished documents reviewed indicate that the majority of development work in the local area priorities immediate benefits over long-term goals. Furthermore, issues related to administration, such as the overlapping and duplicative responsibilities between the woreda and higher levels of bureaus and agencies, make the coordination of climate action difficult and misaligned. Experts also mentioned that overlapping mandates between offices frequently result in gaps or duplication of services. The contextual factors illustrate that climate change is not just an environmental issue for Dehana; it serves as a trigger for socio-economic crises.

4.2. Local Climate Adaptation Practices

In recent years, Dehana Woreda has implemented a range of climate adaptation and resilience measures. These efforts were part of a local adaptation program funded by development partners, aimed at helping the community adapt to climate changes and recover from climate-related challenges while also encouraging sustainable development. The proposed interventions in Dehana can be categorized into four broad areas: (a) watershed rehabilitation and natural resource management, (b) climate-smart agriculture practices, (c) Clean Energy adoption: renewable energy and clean cooking solutions, and (d) Livelihood: local economic diversification and value chain development. The interventions were designed with intended objectives and implemented through a participatory and approach by involving local communities. Together, they form an integrated approach to strengthen livelihoods, and climate resilient adaptive capacity of the local economy in the face of climate change.

4.2.1. Watershed Rehabilitation and Natural Resource Management

This component focused on restoring degraded landscapes and improving the natural resource base (soil, water, vegetation) that underpins agriculture in Dehana. The interventions followed a watershed approach, targeting entire micro-catchments for rehabilitation. Technical measures included construction of soil and water conservation structures – for example, hillside terracing and soil bunds were built along slopes to slow runoff and reduce erosion, while stone check-dams and gully plugs were installed in gullies to halt their expansion. Communities also established area enclosures (protected hillsides) where grazing and fuelwood collection were banned to allow natural regeneration of vegetation. Within these enclosures and on communal lands, thousands of tree seedlings were planted (primarily fast-growing indigenous species and fruit trees) to reforest bare areas and provide future resources. Water harvesting structures were introduced as well: small earthen dams and pond reservoirs now capture seasonal runoff, increasing water availability for livestock and irrigation in dry periods. The overarching objective of these measures was to improve water retention and rehabilitate ecosystems so that farmland becomes more productive and less vulnerable to drought. Community members report visible benefits: springs and streams that used to dry up are now flowing longer into the dry season due to better upstream infiltration (a change noted in focus group discussions with farmers in a treated watershed). Likewise, hillsides that were once brown are turning green with new shrubs and trees. Socially, the watershed work mobilized large numbers of local

people: villagers contributed labor through organized cash-for-work programs (many funded by the PSNP or the project itself), earning income while constructing terraces and dams. Local watershed management committees were formed to plan activities, ensure equitable participation, and maintain the structures. These committees include elderly and youth representatives and work closely with the Woreda Agriculture Office experts. Regular training and demonstrations were provided. For instance, farmers learned improved hillside farming techniques (such as planting fodder grasses on terraces) from extension agents. By combining technical solutions with community stewardship, this component has aimed to strengthen the natural resource base as a foundation for long-term resilience. Rehabilitated watersheds are expected to reduce soil loss, increase soil moisture, and ultimately boost agricultural yields in the coming years.

4.2.2. Climate-Smart Agriculture (CSA)

The second component of the adaptation interventions centered on making agriculture in Dehana more resilient to climate variability. This involved introducing climate-smart farming practices and technologies to enhance productivity under erratic rainfall and to diversify the farming system. One major focus was on improving crop varieties: farmers were supplied with drought-tolerant and early maturing seed varieties (for staples like sorghum, maize, and wheat) to replace traditional seeds that often failed in poor rainfall years. Alongside this, the project promoted crop diversification, which in turn encourages households to plant higher-value or commercial crops such as potatoes, legumes, and vegetables in suitable areas. Farmers received training in improved agronomic techniques: for example, conservation agriculture methods (minimal tillage, crop residue mulching, and crop rotation) were demonstrated to preserve soil moisture. The introduction of small-scale irrigation was another key element – in select valley bottoms with water potential, the project helped farmers install treadle pumps and motor pumps to irrigate vegetable plots or constructed communal hand-dug wells for group irrigation schemes. Although only a limited number of households could access irrigation, these pilots showed promising results (irrigated vegetable gardens yielded income during the dry season, as noted in one case narrative of a women's group who started selling onions and tomatoes). To support rainfed agriculture, water harvesting techniques were also taught, such as rooftop rainwater collection and on-farm ponds, enabling supplemental watering of crops during dry spells.

Importantly, the initiative embedded training and extension support in these agricultural interventions. Agricultural extension workers and project agronomists conducted farmer field schools and demonstration plots in the target kebeles (e.g. showcasing the performance of improved vs. local seeds). They also trained lead farmers who then coached their neighbors on practices like compost making, proper planting density, and pest management. According to project reports, over 200 households in Dehana directly adopted various sustainable and climate-resilient agriculture practices, including beekeeping and small livestock improvements, through this component. Beekeeping, in particular, was promoted as a complementary livelihood: modern beehives were introduced, and farmer groups (including landless youth) were trained in apiary management and honey processing to take advantage of Dehana's strong honey production potential. The objective of all these efforts was to increase food production and farm income despite a changing climate, by both reducing sensitivity to drought (through hardier crops and water management) and by diversifying livelihoods away from solely rainfed grain farming. Early outcomes have been positive – many participating farmers reported higher yields or harvests even in below-average rainfall years, and some have generated new income from horticulture or honey. Nonetheless, these practices require sustained support. Challenges such as input shortages (e.g. not enough improved seeds for all farmers) and occasional reluctance to change traditional methods have been noted. Still, the CSA interventions mark a critical step toward more adaptable agriculture in the woreda.

4.2.3. Renewable Energy and Clean Cooking Solutions

Another element of the adaptation interventions involved expanding sustainable energy access in the community was to improve livelihoods and to reduce pressure on the environment. The identified activity under this component was a large-scale dissemination of improved cookstoves. Roughly 1,450 households in Dehana received fuel-efficient biomass stoves or ethanol/biogas stoves. These stoves (of various models, such as the popular "Mirt" and "Gonzie" stove for injera baking) use less firewood than traditional open-fire cooking. By supporting households away from three-stone fires. The intervention aimed to reduce deforestation (lowering wood consumption) and also deliver health benefits (less indoor smoke) and labor savings for women (who spend long hours collecting firewood from remote areas from their residence). Community members received training on how to use the new stoves. Support was provided to a few youth groups to start businesses producing mud brick stoves and selling them in local markets, thereby creating green jobs.

In addition to cookstoves, the initiative piloted other renewable energy technologies on a smaller scale. Dozens of solar lanterns and solar home lighting systems were distributed to households and schools that have no electricity, illuminating homes at night and enabling children to study longer during the night. A few communities received solar-powered water pumps to extract groundwater for domestic use and irrigation, indicating the potential of solar energy to ease water access issues. The project also introduced solar chargers for mobile phones and rechargeable lanterns, which were warmly welcomed in villages lacking grid power. Moreover, partners experimented with installing a micro-hydro generator on a small river in one kebele to provide off-grid electricity; however, due to the seasonal flow of rivers in Dehana, this pilot had limited success. The overarching goal of the energy component was to promote low-carbon, locally affordable and accessible resilient energy solutions that improve quality of life and reduce environmental stress.

4.2.4. Local Economic Diversification and Green Value Chains

Another component of the climate adaptation interventions in Dehana was local economic diversification and green value chain. This was aimed at strengthening the local economy through diversification of climate-resilient livelihoods and value chain development to cope with the adverse effects of recurrent drought and seasonal rain failings. Considering the heavily reliance on traditional farming practices, this measure introduced to generate an alternative income source. One major focus was on adding value to the honey value chain, given Dehana's comparative advantage in beekeeping. The initiative was supported to establish cooperatives for honey producers, including training to improve honey harvesting techniques and provision of modern beehives as mentioned. It also facilitated links between local beekeepers and external markets: cooperative members were trained in quality control (to produce clearer, high-grade honey) and connected with buyers in regional towns. Some youths were trained in honey processing: for example, how to refine beeswax and produce honey by-products like candles or cosmetics to expand the income opportunities from beekeeping. These efforts were intended to enable communities to reap greater profits from honey, rather than selling raw honey at low prices.

Beyond honey, the adaptation initiative encouraged other climate-resilient enterprises. This included small-scale trade in drought-resistant fruit seedlings (such as apple and mango saplings) grown in community nurseries, which farmers can plant or sell. Women's groups were supported to start backyard poultry businesses with improved chicken breeds that can

thrive in local conditions; this not only provides eggs for nutrition but also extra income. Similarly, training was given on processing local products like chilies and spices for sale, and on handicrafts using sisal or other readily available materials. A few enterprising groups, assisted by micro-grants, set up grain mills and began offering milling services using more efficient diesel or solar-powered mills, thereby earning fees and reducing women's labor in manual grinding. Financial services were also introduced: village savings and loan associations (VSLAs) were formed to help community members save earnings from these new ventures and reinvest in their farms or businesses.

4.2.5. Design and Coverage

The climate adaptation interventions in Dehana were implemented with support and participation from various actors. Two particularly vulnerable kebeles, Shimamdan and Wizaba, were pilot sites where all components were introduced. The design was such that the technical measures were paired with social and capacity-building measures. For example, each tangible input (be it a seed variety, a stove, or a beehive) came with training and follow-up by extension agents or project staff. Community participation was identified as an important aspect at every stage: from planning to execution phases. Efforts were made to involve vulnerable community members. Women-headed households were prioritized for improved stoves and credit support, recognizing their vulnerability. Youth groups were the primary targets of livelihood start-ups (like honey cooperatives and nursery enterprises), intended to address rural youth unemployment.

In terms of coverage, the program reached a significant portion of the woreda's population. Over 2,000 households (out of roughly 26,000 total households) directly benefited from one or more adaptation interventions. These included 500 households involved in watershed rehabilitation activities, about 200 adopting climate-smart agriculture innovations, and the largest group of about 1,450 households receiving improved energy technologies (many received stoves). The geographical coverage spanned several kebeles across the woreda (not only the two pilot kebeles), focusing on those identified as most climate vulnerable. As resources were limited, the interventions did not cover every village uniformly; instead, clusters of villages were selected for intensive work to serve as learning sites for eventual scale-up.

4.3. Stakeholder Landscape and Governance Dynamics

The implementation of the climate adaptation interventions in Dehana involved a complex landscape of stakeholders, from local community groups up to national ministries. Understanding the roles, interactions, and power dynamics of these actors is crucial to assessing how effectively the interventions were delivered and sustained. This section maps out the key stakeholders in the design and roll-out of the adaptation program and analyzes the governance framework that includes coordination structures, participation approaches, and accountability and learning processes. It also discusses challenges faced during stakeholder collaboration and how these relate to broader governance framing to the national context in Ethiopia's climate adaptation efforts.

4.3.1. Key Actors and Institutional Arrangements

At the heart of project implementation in Dehana, the local government has been partnering with non-governmental organizations (NGOs). The program was run by the woreda offices in collaboration with an international NGO (DanChurchAid) Action for Development (AFD) and the Ethiopian Evangelical Church Mekane Yesus-Development and Social Services Commission (EECMY-DASSC). These NGOs brought in financial resources, technical expertise, and project management. Whereas the local government takes overall coordination and leadership. In this regard, the Dehana Woreda Administration and sector offices were central stakeholders. The Woreda Administration (led by the Woreda Chief Administrator and council) provides overall oversight, ensuring the project is aligned with local development plans. Specific sector offices such as the Woreda Office of Agriculture and Natural Resources, the Water Office, and the Energy desk (under the woreda administration) are involved in technical guidance. On top of that the Wag-Himra Zonal Administration and technical departments at the zone level play a supportive role. They receive information and participate in monitoring visits as needed.

An institutional arrangement was established in the form of a Woreda Steering Committee for the adaptation indicatives project. This committee typically comprises the Woreda Administrator (chair), representatives from each relevant Woreda office, the NGO project manager, and sometimes community representatives or kebele leaders from target areas. The Steering Committee met periodically to review progress, coordinate activities across sectors, and resolve any implementation issues

4.3.2. Community Participation and Local Ownership

The climate adaptation interventions were framed as "community-driven and locally led adaptations", seeking to empower the communities to guide and eventually take ownership of the adaptation initiatives. Reports show that (unpublished), during intervention design, consultations were held in which farmers, elders, women, and youth articulated their needs and priorities. This is designed to reinforce buy-in and ownership by the local community for better implementation.

4.3.3. Participation and Power Dynamics

Despite an ethos of participation, real power dynamics influenced the governance process. The local elite (including kebele leaders, male elders, and those with better-off status) often had stronger voices in decision-making. There were reports (via anonymous feedback during evaluation) that in some cases, beneficiary selection was influenced by local politics; for example, close family members or relatives of kebele leaders were more likely to be on the list for receiving certain benefits, though overall targeting was pro-poor. This indicates that petty elite capture, while not rampant, was not entirely absent.

On a larger scale, the interest and power between government needs and development partners also came into play. The local government led the initiative with external support. However, partners come with their own vested interest as they do have the upper hand on the funds and thus have notably influence say in technical decisions.

4.3.4. Knowledge Sharing and Scaling-Up

A notable governance dimension of the during the adaptation practice is how knowledge and learning is being managed locally. The interventions were expected to produce lessons that could inform wider adaptation efforts. To this end, knowledge sharing occurred at multiple levels. For instance, peer exchange with farms was encouraged: model farmers and early adopters were facilitated to showcase their success to others (for example, through field days in a model watershed where farmers from other kebeles came to observe terraces and orchards flourishing). The implementing partners documented case stories of individual households such as a woman who started an injera baking business with an efficient stove to illustrate the human impacts. These stories and data were compiled into reports and disseminated to regional and national stakeholders.

4.3.5. Local Governance Dynamics

Ethiopia is reinvigorating its Climate Resilience and Green Economy (CRGE) governance framework based on the new definition of powers and duties of the government's organs in proclamation 1263/2021. The Federal Democratic Republic of Ethiopia (FDRE) Ministry of Planning and Development (MoPD) is mandated to coordinate the sectoral government organs to implement and manage a climate resilient green development strategy under this governance framework. The governance architecture of Ethiopia's Climate Resilient Green Economy (CRGE) framework is designed to ensure coherence between federal policy direction and regional contexts.

At the regional level, planning or finance bureaus mirroring the federal CRGE governance framework, are mandated to contextualize the guiding federal CRGE governance architecture to their local realities. The regional bureaus formulate and implement context-specific CRGE strategies in the light of the federal policy while ensuring responsiveness to local ecological, socio-economic, and institutional contexts. The regions thus exercise a degree of autonomy in framing and defining their priority sectors, investment pipelines, and adaptation interventions while ensuring policy and reporting coherence with federal governance mechanisms. Sub-national CRGE steering committees further facilitate horizontal coordination among bureaus and agencies, academia, CSOs, and development partners to promote coordination, synergy and reduce policy fragmentation.

At the woreda (district) level, CRGE governance is operationalized through Woreda Offices finance or planning, or any other sector relevant to the woreda context may serve as the implementation entity of CRGE strategies. These local structures are responsible for planning, executing, and monitoring adaptation and mitigation interventions in collaboration with communities, civil society, and development partners. For instance, in Dehana Woreda (Wag Himra Zone, Amhara National Regional State), CRGE implementation is localized through integrated watershed management, climate-smart agriculture, and livelihood diversification initiatives that reflect both the national adaptation goals and the specific vulnerabilities of the woreda.

This multi-layer, and multi-level governance architecture ensures that the CRGE framework functions both from top-down and bottom-up, enabling federal institutions to provide policy coherence and financial mechanisms, while regional and woreda administrations tailor interventions to local climate realities. Such vertical and horizontal integration and

coordination enhance the effectiveness of Ethiopia's climate governance functioning system by promoting context-specific implementation, institutional learning, and accountability across governance all levels.

For the case of Dehana, there is woreda steering committee for cross-sector coordination. For instance, the Agriculture Office and Water Office coordinates small irrigation schemes, and the Energy desk and Natural Resources unit coordinates the integration of tree planting with fuel-efficient stove distributions.

CHAPTER FIVE

5.1. Framing the Feedback Dynamics of the Underlying Adaptive capacity of Dehana District

The dynamics of the feedback loop (Figure 3) illustrate the underlying causal relations of Dehana Wodera (district) adaptive capacity and resilience budling, derived from key informant interviews conducted with the selected sample from the two Kebeles (neighborhoods) of the district, along with targeted focus group discussions and case stories chosen for this study. Key 'outcome' indicators were gathered from the district project documents, baseline study report (2022) for the project implementation focusing on locally led adaptation practices in the district, the annual monitoring and evaluation report, the mid-term review of project implementation, as well as directly transcribed from key informant interviews, focus group discussions, and case story notes.

Furthermore, when evaluating the effectiveness of climate actions, certain outcome indicators are incorporated into the feedback loop dynamics to measure progress and their intended effects on the key outcome measures (**figure 6).**

Trust Decay Loop: This dynamic illustrates a **reinforcing feedback loop** in which conflict and social strain continue to undermine the social fabric and coexistence of the local community. As tension and conflicts over scarce resources intensify, the existing social cohesion deteriorates, weakening use of governance platforms and thereby deteriorating trust in government legitimacy. The intention to shy away from formal, trusted institutions erodes public confidence in government, which in turn worsens public dissatisfaction and erosion of trust. The trust decay reinforcing loop is further escalated by **Conflict- Cohesion Erosion Feedback Loop due** to **t**he deterioration of local area adaptive capacity, and vice versa.

Conflict -Cohesion Erosion Feedback loop: the dynamics in a conflict -cohesion erosion loop observed in the (**R2)**, showing conflict and social strain act as key drivers of systemic deterioration steaming from local level food in security. As disputes over scarce resources intensify, existing social cohesion erodes, reducing trust and collective action. This erosion, in turn, triggers an intension to use informal networks or unstructured platforms that lack the capacity to support inclusive decision-making and conflict resolution. Such informalities further deteriorate societal resilience and expose more vulnerability, which further weakens the local community's adaptive capacity to respond to the effects of climate change such as

recurrent drought and erratic rainfall. The decline in adaptive capacity then fuels continued conflict and tension in the local community.

Adaptive Capacity Recovery Loop (B2): This is a Balancing feedback loop (B2) showing the dyanmics when a community's adaptive capacity falls below its normal or expected level, the local community experiences higher economic and asset losses during stress enduring drought the recurring drought and erratic rainfall. These losses generate pressure and signals of the need to strengthen the existing adaptive capacity. This is further eroded by the limited adaptive capacity of the locals and lack of knowledge and awareness, which further impedes local communities' preparedness for the climate shocks, which then further deteriorates the local area's adaptive capacity because of limitations in changing the local area's adaptive capacity.

Learning Loop (R3): When the change in adaptive capacity is tiny, opportunities for adaptive learning are scarce, limiting the local community's ability to acquire new knowledge and raise awareness. The lack of knowledge and awareness left the local community unprepared for climate-related shocks and stresses, making them even less capable of responding effectively. A lack of improvement in preparedness further deteriorates adaptive capacity, exacerbating the initial weakness and trapping the community in a downward spiral characterized by limited learning opportunities, random readiness, and high vulnerability.

Subsistence Trap Loop (B2): The B2 dynamics show that a reduction in agricultural yield which stemming from huge changes in crop failure due to erratic weather conditions and recurrent drought, changes in arable land use, and declining soil fertility which leads to food insecurity. As a result, conflicts over scarce resources intensify and existing social cohesion erodes, reducing trust and collective action. This erosion, in turn, triggers a tendency to rely on informal networks or unstructured platforms that lack the capacity to support inclusive decision-making and conflict resolution. Such informalities further undermine societal resilience and increase vulnerability, leading to a lower adaptive capacity ratio (current adaptive capacity/required adaptive capacity). This undesired capacity results in huge economic asset losses, which in turn causes only minimal change in the local adaptive capacity to withstand climate shocks. As a consequence, opportunities for adaptive learning become scarce, limiting the local community's ability to acquire new knowledge and raise awareness. This further leads to a mismatch between the knowledge and skill training provided versus what is actually required (the training ratio), resulting in no tangible changes in adaptive behaviors and practices necessary to cope with the changing climate. The persistence of these

gaps sustains dominance in subsistence agricultural practices, which leads to soil erosion and a further reduction in agricultural yields, thereby exacerbating local food insecurity and intensifying conflict and social tension.

Loop (R4): Loop (R4): The reinforcing loop R4 amplifies the learning loop (R3) to further deteriorate. When the change in adaptive capacity is tiny, opportunities for adaptive learning are scarce, limiting the local community's ability to acquire new knowledge and raise awareness. As a consequence, opportunities for adaptive learning become scarce, limiting the local community's ability to acquire new knowledge and raise awareness. This process further leads to a mismatch between the knowledge and skill trainings provided versus what is actually required (the training ratio), resulting in no tangible changes in adaptive behaviors and practices necessary to cope with the changing climate. This further deteriorates adaptive capacity, exacerbating the initial weakness and trapping the community in a downward spiral characterized by limited learning opportunities, random readiness, and high vulnerability.

Reinforcing Loop (R8): The worsening of the local food insecurity situation leads to more demand for arable land, which then leads to the conversion of grazing land into arable land, reducing the area left for livestock feeding. This, in turn, increases livestock concentration per unit area for feeding, which leads to vegetation losses and consequently reduces livestock productivity because of inadequate feed due to vegetation loss. This further escalates the food insecurity situation of the local community due to poor livestock productivity. In addition to the conversion of grazing land to arable land, grazing land diminishes because of vegetation loss **(R5**) and becomes degraded land, which in turn reduces the available grazing land **(R7)** and decreases biodiversity conservation and the local area's attractiveness as a result of the absence of ecological regeneration. The pressure on this dynamic **(R5**) is, however, moving away in the very short run because of the slowed reduction of livestock heads as a result of insufficient feed due to vegetation loss stemming from the concentration of livestock per unit grazing land area **(R6)**.

The Balancing loop (B4): The balancing loop (B4) illustrates the long-term decline in attractive local area dynamics, which is primarily driven by the reduction in biodiversity conservation due to the absence of ecological regeneration, the loss of local area attractiveness due to increased degraded land area due to vegetation loss (R5), and the long-term effects of subsistence agricultural practices (B2). The decline of local area attractiveness leads to a decline of the local population as people stop coming to the place, and residents tend to leave

the area because of a lack of food availability, job opportunities, income, and availability of financial resources **(R12)**. This balancing loop (B4) shows the dynamics of the decline of local area attractiveness are somehow slowed by the ripple effects of change in the local area population, which leads to a reduction in fuelwood consumption for cooking as the population declines **(R11**), which leaves a decline in the reduction of forest land to arable land (R10). This also leads to the decline in expansion of land by converting grazing land and therefore a decline in vegetation loss that further slows down the rate of land degradation and the change in biodiversity conservation. However, this balancing loop is dominated by the exacerbated food insecurity (see subsistence loop and adaptive capacity loop) due to recurrent drought and low adaptive capacity of the local community and is further weakened by the immediate needs of land conversion and vegetation loss; therefore, its dominance is wiped out in the long run.

The growth Loop (R13): This loop reinforces the low adaptive capacity of the local community stemming from poor infrastructure development. Lack of infrastructure development leads to a decline in the ratio of infrastructure development (than it would have been to withstand climate shocks), leading to low adaptive capacity of the local community. This undesired capacity results in huge economic asset losses, which in turn causes a reduction change in the local adaptive capacity to withstand climate shocks. Consequently, opportunities for adaptive learning become declining, limiting the local community's ability to acquire new knowledge and raise awareness. This further leads to a mismatch between the knowledge and skill training provided versus what is actually required (the training ratio), resulting in no tangible changes in adaptive behaviors and practices necessary to cope with the changing climate. The persistence of these gaps sustains dominance in subsistence agricultural practices, which leads to soil erosion and a further reduction in agricultural yields. The change in agricultural yield leads to a reduction in agricultural productivity that further pushes the reduction in income level, which further deteriorates the local domestic production (GDP) and available financial resources that inhibit infrastructure development.

The reinforcing loops, the market development loop **(R14)** and the access to finance loop **(R15),** further deteriorate the vicious cycle of growth dynamics **(R13 and R14).** The market development loop **(R14)** illustrates how limited market access arises from inadequate infrastructure development (roads, water access systems, irrigation technologies and equipment, beehives, early warning systems, and watershed management), which results in decreased investment flow. This reduction in investment leads to fewer job opportunities,

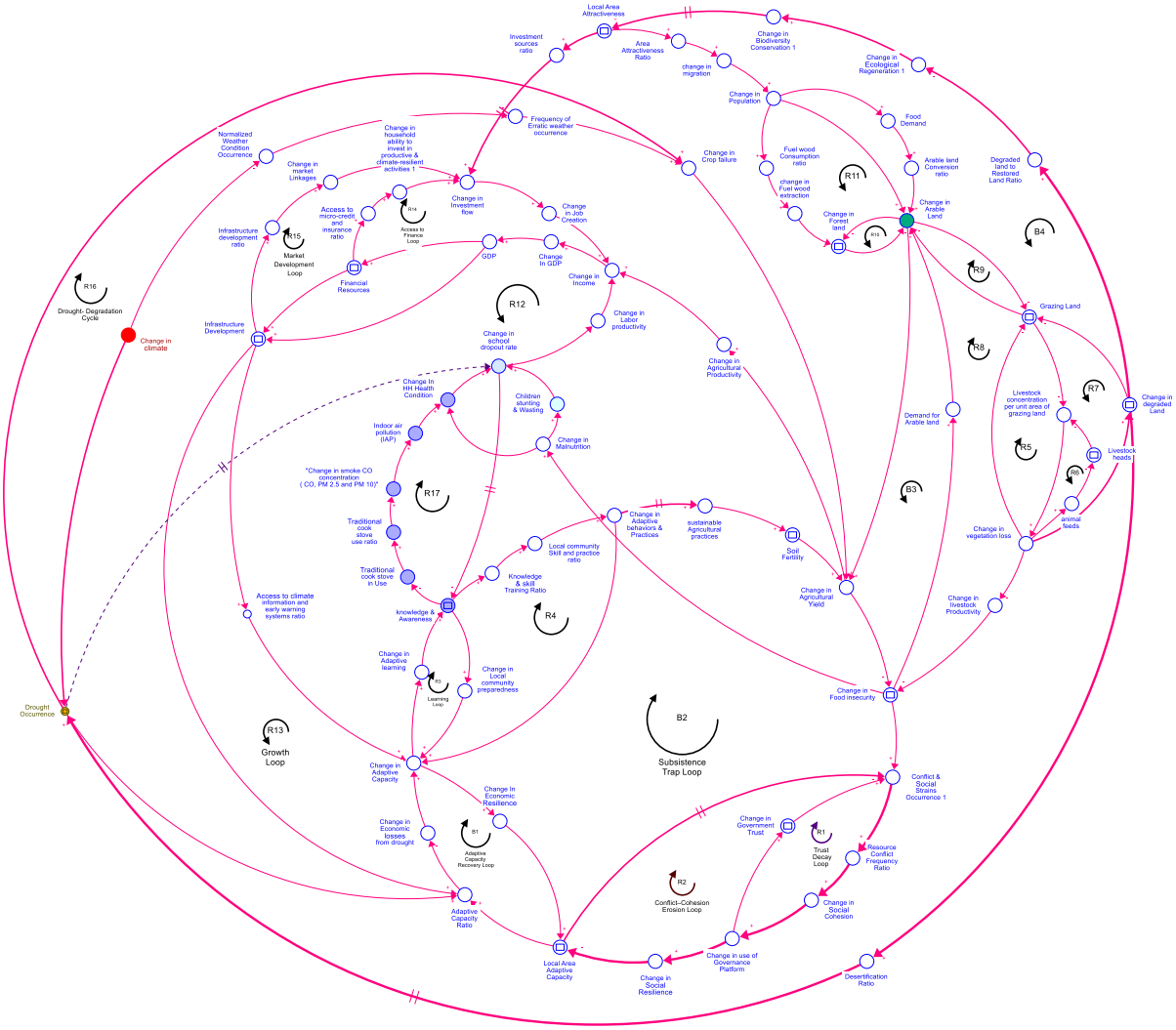
ultimately lowering household incomes and consequently decreasing the local GDP. The reduction in local GDP leads to further drainage in available financial resources, which further inhibits infrastructure development.

The deterioration of financial resources reduces access to financing from microcredits and insurances, which further inhibits change in household ability to invest in productive and climate-resilient activities, leading to reduced investment that further weakens income (**R14: Access to Finance Loop**).

Drought- Land Degradation Cycle (R16): Recurrent drought reduces agricultural yield and thus exacerbates food insecurity due to crop failure and erratic rainfall. This further leads to the expansion of arable land with traditional agricultural practices that leave the land increasingly exposed to wind and water erosion, accelerating the processes of land degradation and desertification, which deepens desertification and thereby intensifies drought occurrence and its reduction effects on agricultural productivity that further worsens food in security in the long term**.**

The learning loop (R3) triggers the use of traditional cookstoves by households using the fuel wood collected from the forest. These practices lead to the emission of toxic gases (CO, PM 2.5 and PM 10), which lead higher indoor pollution, adversely impacting the health of households, particularly women and children, leading to school dropout rate, and decreasing knowledge and awareness of the community at **large (R17),** and decline in labor productivity in the long run. At the same time, children become malnutrition because of the lack of access to food resulting in children wasting and stunting of the children which subsequently contributes to increased school dropout rates, hence diminishing knowledge acquisition, and long-term labor productivity gains.

Figure 6: A causal Loop Diagram Portraying the feedback dynamics of the Adaptive Capacity Phenomenon in the Dehana District



(Source: Author computation using Stella Architect 3.8)

5.2. A Dynamic Performance Governance Analysis of Adaptive Capacity to Climate Change in Dehana District

The Dynamic Performance Governance Approach is employed to assess (1) adaptive capacity dynamics and (2) the effectiveness of climate actions supported by statistical analysis, as shown in the next sections. Due to the dynamic, ongoing, and complex nature of climate change and the effectiveness of its response measures, DPG is well-equipped to comprehensively analyze the underlying problems, outcome measures, roles of various governance layers, stakeholders involved, and drivers of change aimed at enhancing adaptive capacity and overall resilience at the local level for the identified district. The DPG (figure 6 & Figure 7) framework designed for the district depicts to represent the underlying problem dynamics **(current scenario)**

considering all the efforts which have been undertaken for climate adaptions of no effects on adaptive capacity and building community resilience at the local level.

The DPG illustrated in Figure 7 presents aggregate structures as specified in the planning, policy, and roadmap documents for the purpose of comparison, assessment, and analysis of performance measures relative to the established targets and societal expectations. The causal relation between the strategic resources exists in Dehana District, performance drivers and end results (outputs, intimidate outcomes, and final outcomes) will focus on the key final outcomes that this research is interested in based on the GPG framework, as the detailed dynamics of the underlying causal relations have been discussed under section **5.1.**

As shown in figure 7, the change in Dehana's adaptive capacity is influenced by changing local community preparedness and changes in behavior to adapt to climate change and practices at the local level. This change is induced by the existing knowledge and awareness, the frequency of drought occurrence, and the existing local infrastructure, as gauged by the key performance drivers: functional early warning system information service ratio, local community awareness ratio, and adaptive capacity ratio, respectively (B1& R3). The change in adaptive capacity further leads to the change in adaptive learning and change in economic resilience.

The Change in Dehana district economic resilience impacts local attractiveness, which in turn affects the population dynamics (B4). Migration patterns indicate that younger individuals are more likely to remain in the woreda and aspire to build assets and families when economic conditions are favorable relative to neighboring districts. This finding has been validated through individual interviews and focus group discussions.

The attractiveness of the Dehana district environment leads to changes in various investment sources, which enhances each household’s ability to invest in tangible climate adaptation activities. This, in turn, results in increased job opportunities that boost income and subsequently affect GDP (R12). The change in investment flow is also attributed to the change in market linkages (R15 & R14) due to available access to infrastructure development compared to the desired infrastructure required standards, which is also impacted by the economic ability (GDP) and financial resources availability and the budget allocated to the district from the regional government or the direct budget from the federal government budget for climate-proof infrastructure development.

The Balancing loop (B4): The balancing loop (B4) illustrates the long-term decline in local area attractiveness dynamics, which is primarily driven by the reduction in biodiversity conservation due to the absence of ecological regeneration, the loss of local area attractiveness due to increased degraded land area because of vegetation loss (R5), and the long-term effects of subsistence agricultural practices (B2). The decline of local area attractiveness leads to a decline of the local population as people stop coming to the place, and residents tend to leave the area because of a lack of food availability, job opportunities, income, and availability of financial resources **(R12)**. This balancing loop (B4) shows the dynamics of the decline of local area attractiveness is somehow slowed by the ripple effects of change in the local area population, which leads to a reduction in fuelwood consumption for cooking as the population declines **(R11**), which leads to a decline in the reduction of forest land to arable land (R10). This also leads to the decline in expansion of land by converting grazing land and therefore a decline in vegetation loss that further slows down the rate of land degradation and the change in biodiversity conservation. However, this balancing loop is dominated by the exacerbated food insecurity (see subsistence loop and adaptive capacity loop) due to recurrent drought and low adaptive capacity of the local community and is further weakened by the immediate needs of land conversion and vegetation loss; therefore, its dominance is wiped out in the long run.

The causal chain depiction of the growth Loop also shows change in adaptive capacity of the local community stemming from change in infrastructure development. Availability of infrastructure development leads to a change in the ratio of infrastructure development, leading to a change in adaptive capacity of the local community. This (un)desired capacity results in huge change in economic asset losses, which in turn causes a change in the local adaptive capacity to withstand climate shocks. Consequently, opportunities for adaptive learning become changing, affecting the local community's ability to acquire new knowledge and awareness. This further leads to a change in the knowledge and skill training provided versus what is actually required (the training ratio), resulting in the changes in adaptive behaviors and practices necessary to cope with the changing climate. The persistence of these gaps sustains dominance in subsistence agricultural practices, which leads to changes in soil erosion and a further change in agricultural yields. The change in agricultural yield leads to a change in agricultural productivity that further pushes the change in income level, which further affects the local domestic production (GDP) and available financial resources that changes infrastructure development.

The change in income at the household level also heavily relies on the change in agricultural productivity stemming from agricultural yield (land productivity-mainly crops), livestock productivity, and labor productivity. The change in crop yield is influenced by crop failures caused by land degradation, which includes alterations in groundwater recharge and soil fertility; these factors depend on how resources are used for biodiversity conservation and traditional agricultural practices, as well as the frequency of droughts and erratic rainfall. The availability of arable land for production is also affected by its conversion to degraded land, grazing land, and other land uses in the district. This dynamic change is supported by a study showing that Ethiopia, especially the northern part of the country, has experienced severe drought and famine in the past century, with the ongoing drought being the most severe in the last 40 years (World Bank Group, 2024). Six consecutive poor or failed rainy seasons have left over 22 million people food insecure and caused significant livelihood losses in drought-affected regions. According to the study, the drought has led to reduced consumption by 15%, insecure access to water for 13 million people, 1.4 million children at risk of dropping out of school, and the death of 4 million livestock. Economic losses from a drought event with **a 1-in-5-year** return period are estimated at over $1 billion, rising to $3 billion for a **1-in-100-year** event.

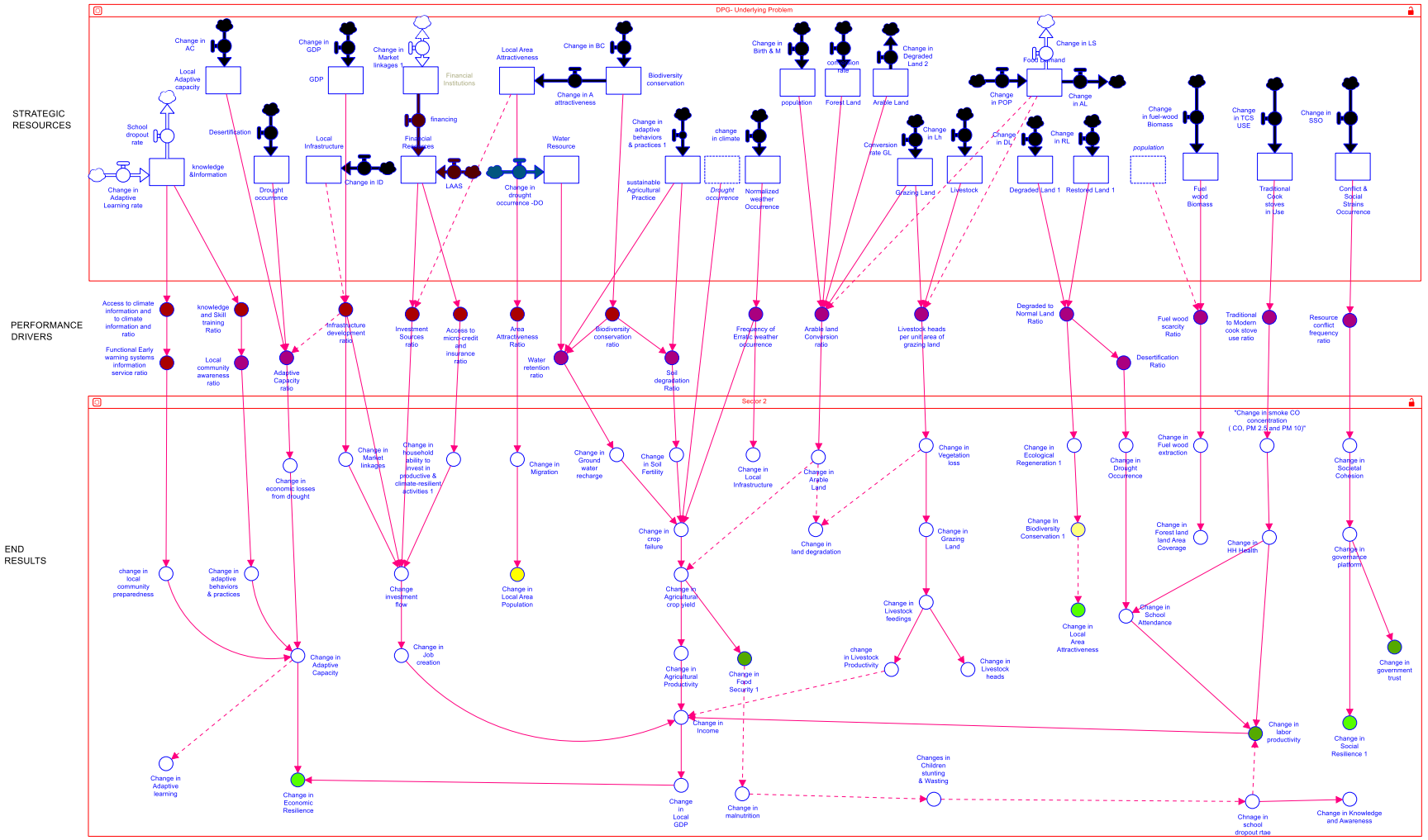
Similarly, income changes are influenced by the availability of job opportunities that arise from shifts in investment flow, which is in turn impacted by infrastructure development and changes in market linkages. The household investment capacity is affected by the availability of financial resources.

The change in crop yield also affects the change in the local food insecurity situation, which pushes the change in demand for arable land, which then leads to the change in conversion of grazing land into arable land, thereby changing the area left for livestock feeding. This, in turn, affects livestock concentration per unit area for feeding, which leads to changes in vegetation losses and consequently affects livestock productivity because of changes in feeding due to vegetation loss. This further affects the food insecurity situation of the local community due to the change in livestock productivity. In addition to the conversion of grazing land to arable land, grazing land changes because of vegetation loss (R5) and becomes degraded land, which in turn affects the available grazing land (R7) and decreases biodiversity conservation and the local area's attractiveness as a result of the absence of ecological regeneration. The pressure on this dynamic (R5) is, however, moving away in the very short run because of the temporal

reduction of livestock heads as a result of change in feed due to the change in vegetation loss stemming from the concentration of livestock per unit grazing land area (R6).

The DPG depiction of the causal chain for the learning loop (R3) shows that (R3) affects the change in use of traditional cookstoves by the households using the fuel wood collected from the forest. These practices lead to the change in emission of toxic gases (CO, PM 2.5 and PM 10), which lead change in pollution, impacting the health condition of the households, particularly women and children, leading to the change in school dropout rate, and significant change in knowledge and awareness of the community at **large (R17),** and the change in labor productivity in the long run. At the same time, children would experience change in malnutrition because of the change in access to food resulting in children's change in wasting and stunting of the children which subsequently contributes to the change in school dropout rates, hence affecting knowledge acquisition, and changes in long-term labor productivity gains.

Figure 7: A Dynamic Performance Governance Depiction of the state of Adaptive Capacity Phenomenon in the Dehana District



Source: Author computation using Stella Architect 3.8 Software

The study also extensively reviewed the three-year district Locally Led Adaptation Project Plan, which has been implemented from 2021 to 2024 across the district of Dehana and its nearby provinces. The review aimed to diagnose how well the plan and its implementation framework incorporated the intended outcome measures derived from existing strategic resource use, along with identified performance drivers, to track implementation performance and facilitate ongoing monitoring and learning processes during policy revision and planning cycles.

The review document shows that objective of the overall plan was to improve the resilience of rural communities to the impacts of climate change and enhance income generation from sustainable, resilient livelihoods, jobs, and enterprises. Therefore, the DPG employed for this study examines the extent to which local project documents and policies consider measurable and credible levels of measures (Strategic Resources, Performance Drivers, and outcome measures at output, intermediate outcome, and final outcome levels) and assesses them against the measures identified by local communities, including outcomes focusing on governance.

Based on the assessment of the three-year program for the district, it indicates that of the three stated "outcomes," only two correspond to the final outcome categories expected under the DPG framework: one aligns more with an intermediate outcome and another with a final outcome. The initial measure, presented as communities managing local natural resources sustainably to improve climate resilience, appears to be more of an output (the immediate effect of program activities) rather than an outcome. On the other hand, the result characterized by communities adopting varied climate-adaptable green livelihoods signifies an intermediate outcome (anticipated behavioral changes). The third result, framed as community-led adaptation actions and green innovations that inspire and influence policy, closely aligns and fits with the DPG framing of outcome measures, and can therefore be regarded as an outcome (Table 2).

Table 2: Identified outcome from the District Locally Led Adaptation Program

Outcome	*Measures*
Outcome 1	*Communities manage local natural resources sustainably for enhanced climate resilience*
Outcome 2	*Communities take up diversified climate adaptable green livelihoods, jobs and enterprises, based on sustainable utilization of natural resources*
Outcome 3	*Three Community-led adaptation actions and green innovations inspire and influence local, national and global solutions and policy arenas in the field of climate change adaptation, especially with a focus on locally led adaptation and local ownership*

Source: District three Year Program/Project

CHAPTER SIX
RESULTS AND DISCUSION

6.1. Introduction

This chapter presents findings from comprehensive statistical analysis, focus group discussions, case studies, and enhanced depiction of Dynamic Performance Governance (DPG). It illustrates the feedback dynamics that may break vicious cycle of the district's adaptive capacity (Figure 6 &7) into the virtuous cycle the adaptive capacity (Figure 9 &10) and thereby enhancing the overall local society wellbeing through improved resilience in the local economy, people and ecosystem. The policy levers considered in the enhanced DPG are grounded empirical findings (see the following sections) derived from statistical analysis, key informant interview, focus group discussions, case stories and similar comparative research conducted in similar context and timeframe.

6.2. Socio Economic Characteristics of the Study Population

Before examining specific intervention areas, it is important to understand the background of the surveyed community. The household survey reveals a population typical of rural Waghimra. About 62% of respondents were male, suggesting that men often represented the household in this survey (table 3). The age distribution was centered in the prime working years: a majority (54.9%) of respondents were between 35–49 years old, with about 29% younger than 35 and only 16% aged 50 or above. Most households lie in the moderate size category; over two-thirds (68.7%) of families had fewer than 6 members, while large households (8+ members) were relatively small (4.9%). These characteristics indicate that climate adaptation initiatives targeted primarily middle-aged, mid-sized households, who are active in livelihood practices and communal life. Such a profile is workable for labor-intensive adaptation activities, as most members are in their economic productivity prime.

Education levels among participants were very low, underscoring the challenges for capacity-building. Nearly three-quarters of respondents (74.3%) have no formal education, and only about 5% attained secondary school. This emphasizes the importance of awareness creation using accessible, non-technical communication in project training. The socio-economics characteristics data shows that the local communities are heavily agrarian: subsistence farming is the main stay for the larger community. About 43% of respondents reported farming as their sole occupation, and an additional 35% practiced mixed farming with livestock rearing.

Smaller fractions engaged in farming plus day labor (15%) or petty trade (2%), and virtually none had purely non-farm jobs. In total, over 95% of households depended on agriculture (farming, often with livestock or occasional labor) for their livelihood. This strong dependence on climate-sensitive livelihoods means that any improvement in agricultural resilience would directly enhance household well-being. It also means off-farm income sources were very limited at baseline, a point that the interventions focusing on livelihood diversification efforts sought to address.

Prior to the adaptation measure implementation period, household income levels were significantly low and similar between households, highlighting the community's economic vulnerability. For instance, the findings show that about 82% of local households earned monthly income between ETB 1,000-4,999 before the intervention, while about 6.7% of the households earned less than ETB 1,000 per month. Close to 11% of the households earned monthly incomes above ETB 5,000. This shows that households had little financial buffer against shocks during climate stress. In focus group discussions (FGDs), community members described how a single poor harvest or loss of livestock could be devastating in this context, underscoring the need for the broader support. Indeed, women participants in Wizaba Kebele recalled times when "we could barely afford two meals a day, let alone invest in our farms" (FGD-Wizaba), highlighting the precarious food security situation during pre-intervention. Average food expenditures reflected this vulnerability: over 72% of households spent only ETB 1,000–4,999 per month on food before the project, and almost no one (under 2%) could spend beyond ETB 10,000 on food. As one elder in a focus group remarked, *"Many families were eating the same basic staples every day, and sometimes we had to skip meals in the dry season"*. These qualitative finds collected from KII and FDG align with the quantitative finding in that the average number of meals per day for a household was close to 2.65 (twice per day) without the introduction of the adaptation measures.

As it can be seen from the empirical findings, the baseline profile indicates that the local population is highly vulnerable to any adverse impacts of climate change; especially for drought, erratic rainfall and floodings: limited capacity, heavily reliance on rain-fed subsistence agriculture, can further exacerbate the chronic food insecurity and local adaptive capacity.

Table 3 : Socio-Economic and Demographic Profile of Respondents

Variables	Category	Frequency	Percent
Gender	Male	177	62.3
	Female	107	37.7
Age	<35	83	29.2
	35-49	156	54.9
	50-64	39	13.7
	>60	6	2.1
Household Size	<6	195	68.7
	6-8	75	26.4
	>8	14	4.9
Education Level	No formal education	211	74.3
	Primary	58	20.4
	Secondary	15	5.3
Main Occupation	Farming	122	43.0
	Farming and livestock rearing	100	35.2
	farming and business	6	2.1
	Farming and daily laborer	43	15.1
	Daily labor	12	4.2
	other	1	0.4
Income Before Intervention	<1000	19	6.7
	1000-4999	234	82.4
	5000-10000	26	9.2
	>10000	5	1.8
Income After Intervention	<1000	5	1.8
	1000-4999	214	75.4
	5000-10000	51	18.0
	>10000	14	4.9
Average Monthly Food Expenditure Before Project (in ETB)	<1000	4	1.4
	1000-4999	205	72.2
	5000-10000	64	22.5
	>10000	11	3.9
Average Monthly Food Expenditure After Project (in ETB)	<1000	2	0.7
	1000-4999	221	77.8
	5000-10000	51	18.0
	>10000	10	3.5

6.3. Climate-Resilient Agriculture and Food Security

Agriculture was a cornerstone of the climate adaptation efforts in the district, with interventions ranging from improved crop varieties to small-scale irrigation and soil conservation. Quantitative results and qualitative insights consistently indicate improvements in agricultural productivity and food security. One of the examples was on household food security: the average number of meals consumed per day increased from 2.65 before the project to 3.40

after, a notable improvement (mean +0.75 meals, $t = –22.59$, $p = 0.000$). In practical terms, many families who previously could only afford two meals a day were able to eat three meals after the intervention, indicating a reduction in food insecurity and improved nutrition. This quantitative trend was vividly reinforced by community narratives. *"Now we rarely go to bed hungry,"* explained a women's FGD participant in Shimamdan[1], *"even in the dry season we manage to have at least injera with some vegetables for dinner."* Such accounts illustrate how improved agricultural output translated into tangible welfare gains. Indeed, adaptation measures like introducing drought-tolerant crops and kitchen gardens were frequently cited in FGDs as reasons for more consistent food availability. This aligns with key informant reports that drought-resistant crop seeds provided by the initiatives were "instrumental in helping local farmers adapt to changing climate conditions", particularly in areas hit hard by erratic rains. In East Bale (a comparison zone in the case study) these seeds proved vital during drought, and in Waghimra a similar approach of distributing climate-resilient crop varieties helped stabilize yields. By the end of the intervention, both survey data and community testimonies confirm that chronic hunger had largely been eliminated, and the community's nutritional status improved which is an essential element of resilience.

Another major agricultural achievement was the expansion of irrigated farming, which promoted year-round production. The average land area under irrigation per household more than doubled, from 0.04 hectares before adaptation practices to 0.09 hectares after the intervention (mean increase 0.05 ha, $t = –7.56$, $p = 0.000$). Although the absolute sizes seem small, even fractions of a hectare of irrigated land have a huge impact in this semi-arid region. With new water harvesting structures and irrigation schemes, many farmers can now cultivate vegetables or fast-maturing crops during the dry season, whereas before they were completely dependent on rainfall. Key informant interviews underscored this transformation: the project's Waghimra coordinator noted that initiating effective small-scale irrigation "played a central role in modernizing traditional farming methods and reducing the community's dependence on seasonal rainfall". Community members in FGDs described how communal labor was organized to dig ponds and canals, and how water user committees were formed to manage these new resources which are positive signs of participation. As a result, previously barren dry-season plots are now green with onions, tomatoes, or forage crops. "*We have vegetables in the dry months now, which was unheard of before,*" said one farmer in Wizaba, who also noted that surplus harvests from irrigated plots were sold for extra income. This irrigation-driven

boost in production not only improves food security but also provides a buffer against drought years, thus directly increasing adaptive capacity. The qualitative evidence of enthusiastic uptake of irrigation corresponds with the quantitative result that 47% of households in the survey perceived a "Very High" improvement in community cooperation and resource sharing, partly attributed to collective irrigation management. It appears that working together on irrigation and water conservation forged stronger community bonds – an important social co-benefit analyzed in the later in Sections.

Alongside irrigation, the interventions focused on soil and water conservation (SWC) techniques such as terracing, composting, mulching, and check-dams to improve land productivity. Similarly, the results are also encouraging about 67.6% of households adopted at least one SWC technique. Focus groups confirmed that farmers observed tangible benefits from these practices. *"My yields increased after I started composting and mulching – the soil holds moisture better now,"* explained a farmer from Shimamdan, echoing a common sentiment that conservation measures led to healthier crops despite variable rainfall. Notably, adoption of these climate-smart practices was inclusive across genders: approximately 69% of male participants and 65% of female participants implemented SWC, a difference that is not statistically significant. In other words, women kept pace with men in applying new farming techniques, defying the typical gender gap often seen in agricultural practices in Ethiopia. This outcome indicates that adaptation measures encouraging results. As the survey data showed, there was no meaningful gender disparity in adoption ($\chi^2 = 0.374$, $p = 0.541$), and women in FGDs consistently reported being involved in demonstration plots, farmer field days, and decision-making on their farms. For example, one female FGD participant noted that *"the trainings were scheduled at times we [women] could attend, and we formed our own groups to practice making compost."* This enabled female-headed households to benefit equally from the adaptation practices. The inclusive planning of these activities; from scheduling to forming women's sub-groups was thus critical to their scaled adoption. It also enhances sustainability: by empowering both women and men, the community doubles its pool of knowledge and labor for maintaining SWC structures in the long run. A key informant from the community even observed that women's involvement in watershed activities has "offered them training and job opportunities," which in turn boosts their confidence and stake in sustaining these efforts. This illustrates how climate adaptation under broader participation can reinforce each other.

[1] *Note: Shimamdan and Wizaba are the two kebeles (communities) in Dehana Woreda, Waghimra, where the project was implemented*

Table 4: Improvements in Household Income, Food Security, and Livelihoods (Paired T-Tests)

Variables	Before the Project		After the Project				
	Mean	Std. Error	Mean	Std. Error	Mean Difference	t-value	P-value
Household Monthly Income	2868.85	109.3	4002.71	161.84	1133.86	-11.15	0.00
Number of Meals Per Day	2.65	0.03	3.40	0.04	0.75	-22.59	0.00
Total Household Expenditure on Agricultural Input (in ETB)	3128.47	233.41	3079.06	176.41	-49.41	0.27	0.78
Number of Income Sources Before Project:	1.48	0.03	2.47	0.04	0.99	-42.44	0.00
Total Area of Land Under Irrigation (in hectares)	0.04	0.00	0.09	0.01	0.05	-7.56	0.00

Interventions in crop and livestock diversification further strengthened food security. From the case study evidence, both Dehana and the comparison Bale recognized the importance of diversifying into vegetable, fruit, and new crop varieties. In Dehana, key informants highlighted a significant uptick in fruit production: distribution of mango, papaya, and other fruit seedlings has led to noticeably higher yields of these crops. Farmers who traditionally grew only staples like sorghum or teff are now cultivating fruits and nutrient-rich vegetables, improving household diets and creating new market products. *"We never used to grow papaya here, but now many of us have papaya and mango trees,"* explained a young participant in a mixed FGD, who also mentioned that children are enjoying fruits that were previously rare. The diversification of crops has improved nutrition and provided extra income when surplus produce is sold. The emphasis on vegetables and fruits was a direct response to community needs: FGDs in both kebeles revealed that year-round access to diverse foods was a top priority, especially for mothers concerned about their children's nutrition. As indicated, a consistent narrative emerged that introducing climate-resilient crop varieties and diversifying agriculture proved to be a "robust strategy for enhancing economic stability and ensuring food security". This qualitative finding from the case study resonates with the statistical figures on increased meals and improved incomes.

As the findings indicated, the agriculture-focused interventions were accompanied by higher-yielding and drought-tolerant crops, soil conservation, and irrigation collectively enabled households to produce more food and reduce the risk of crop failure. This not only fed families better on a daily basis, but also built reserves (grain stores, small cash savings from produce sales) that help buffer against future climate shocks, thereby contributing to their adaptive capacity and the effectiveness and sustainability of the adaptation efforts.

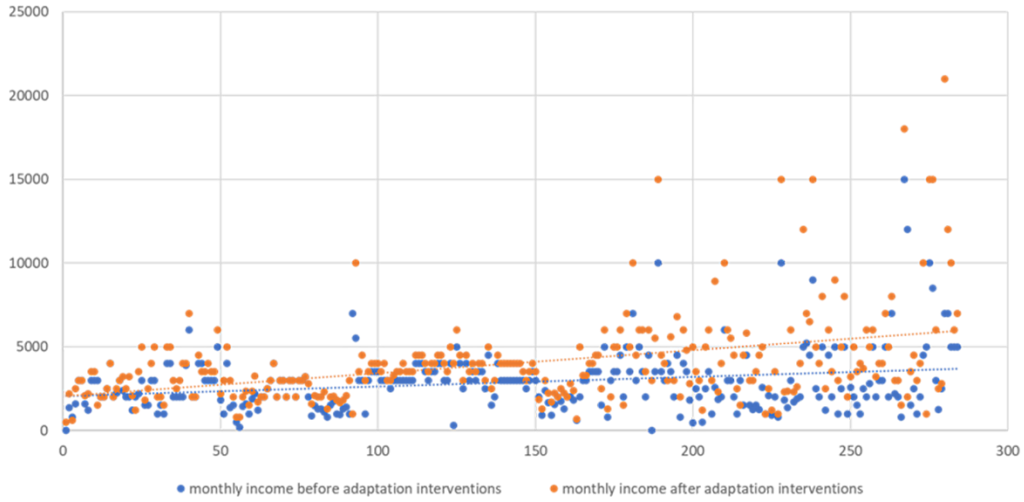
However, it is worth noting that there were variations between the two target kebeles (Shimamdan and Wizaba) on how agricultural improvements manifested, reflecting local conditions. Field observations and participant feedback indicated that Shimamdan, in which many of the new ponds and canals were concentrated and has relatively better water source, achieved particularly notable successes in irrigation and vegetable, whereas Wizaba, on the other hand, embraced tree planting and terracing on its more erosion-prone hillsides, and saw a higher uptake of fruit orchards. As one development agent explained in an interview, *"each community played to its strengths where there was water, they pushed irrigation; where there were degraded slopes, they invested labor in terracing and tree seedlings."* Both strategies led to improved food security, but through different pathways suited to each kebele's geography. Such local tailoring of interventions is a hallmark of the locally led approach and was made possible by participation of community members. The kebele-level committees could decide whether, for example, a portion of project funds would be best used to buy extra pipes for an irrigation line in one village versus more fruit seeds for another. This flexibility and local decision-making helped ensure that the agricultural adaptation measures were effective and well-adopted in each site, thereby enhancing overall project success.

6.4. Livelihood Diversification and Economic Well-Being

Improving livelihoods was a central objective of the climate adaptation measures in the district, pursued through diversifying income sources, introducing new enterprises, and integrating participants into value chains. The quantitative data show remarkable gains in household income and diversification, and these are reinforced by qualitative accounts of new economic opportunities. Statistically, average monthly household income rose from ETB 2,868 before the intervention to ETB 4,003 after, roughly a 40% increase (mean +ETB 1,134, $t = –11.15$, $p = 0.000$). This is a positive uptick, indicating that many families moved into improved income brackets during post-intervention. In fact, the share of households living in extreme poverty

(earning < ETB 1,000/month) fell from 6.7% to just 1.8%, while those earning above ETB 5,000/month nearly doubled, from 11% to 23%. The figure below (Figure 8) also shows that household incomes generally increased after adaptation interventions. The orange dots **concentration** (after adaptation) is mostly above the blue dots (before adaptation), meaning most households earned more income after the intervention. A few households show little or no change, but overall, the trend reflects a positive improvement in income levels following adaptation efforts.

Figure 8: Household Monthly Income Before and After Adaptation Interventions



source: Authors computation using SPSS 25

From the community's perspective, this income growth was life- saving and life changing notable progress. *"Our lives have improved.... we can afford basics like salt and oil more easily, and some of us even bought solar lanterns or sent children to high school with the extra money,"* said a male participant during a Kebele-level review meeting. The diversification was focused on livelihood activities such as beekeeping, handicrafts, and small trade which supported raising household earning capacity, which in turn provides a financial leverage against climate-induced losses. As incomes rose, households reported greater ability to save or invest in productive assets. For example, several focus group participants mentioned purchasing additional goats or poultry with their increased income, which further diversifies their livelihood and can be sold when they production due to crop frailer. This virtuous cycle of improved income and investment is a direct effect of livelihood diversification of the adaptation dimension.

As the study finding indicated (Figure 8), the critical aspect of community adaptive capacity and livelihood resilience is diversification, i.e. not relying on a single source of income. On average, households expanded their livelihood activities from about 1.5 sources before to 2.5 sources after the adaptation intervention (mean +0.99 sources, $t = –42.44$, $p = 0.000$). In practice, this means that many families who once depended entirely on rain-fed crop farming were able to add one or two additional income streams. The survey responses and interviews indicate that new income sources included petty trade (e.g. selling vegetables or honey), wage labor on project works, raising small ruminants or poultry, and running micro-businesses such as grain milling or shops with additional financing support from the projects run by NGOs. *"I used to only farm, but now I also earn from chickens and a small shop we started with a cooperative,"* explained a woman in an FGD, who credited the business training and a small seed grant for enabling her group to open a grain mill in the village. Diversification is a well-known resilience strategy, as it spreads risk: if one source (like crops) fails due to drought, others (like livestock or trade) can sustain the family. This outcome was recognized by community members; as one key informant in Dehana noted, *"before, a bad harvest meant hunger for everyone here, but now some people have goats, some run small shops, so we have other options to get by."* Such improvements directly contribute to the effectiveness and sustainability of LLA interventions, as economically diversified households are more likely to maintain and invest in adaptation practices (since they can afford to and have a longer planning horizon when not on the brink of crisis).

Importantly, these livelihood gains were achieved without increasing financial burdens on the poorest. Survey data showed no significant change in households' out-of-pocket spending on agricultural inputs, rather it remained roughly ETB 3,100 per season before vs after the project (no significant difference, $p = 0.78$). In other words, families did not have to *spend* more to *earn* more, suggesting that the project's support (subsidized inputs, training in low-cost techniques, etc.) was effective. A male farmer from Wizaba commented in an interview that *"the new crops and methods didn't cost us extra money. We used seeds and compost training instead of expensive fertilizer from NGO project support."* However, external dependency on inputs and running costs does not reflect an important principle of locally led adaptation: making the best use of local resources and knowledge to improve livelihoods even though they use local inputs (purchased) inputs that might not be the commendable and sustainable approach for poor communities.

By keeping input costs stable while increasing outputs, the project ensured that even low-income households could participate and benefit. This approach also aids confidence in farmers as they are more likely to continue a practice if it doesn't require unaffordable investments.

One of the notable new livelihood avenues introduced was beekeeping, which exemplifies how an environmentally friendly practice that also generates income to the households. In Dehana's two kebeles, modern beehives and training were given to interested households, albeit at a pilot scale. According to the intended timeline of project intervention, nearly 11.4% of households in the target kebeles had adopted beekeeping as a supplementary livelihood. While this adoption rate is modest, the qualitative evidence suggests that those who did participate in the innervation project found it valuable. According to one key informant, *"We have got about 60 modern and 30 local beehives to groups of households… I currently own and maintain five beehives"* (from Dahna woreda). He noted that beekeeping has the potential to "further enhance their income and diversify their agriculture". Focus group participants supplemented these benefits, mentioning that the hives yielded honey both for the family consumption and for sale in local markets. They also valued that beekeeping does not require large land or water resources, making it suitable even for land-scarce families. In the words of a mixed FGD participant, *"Though not many of us keep bees yet, those who do are earning money without cutting trees, it's good for us and the environment."* In both cases beekeeping was highlighted as an "economically and environmentally friendly practice" in Waghimra, Dehana district. The relatively low adoption was attributed to the novelty of the practice and limited initial resources (only so many hives to distribute), but the participants expressed hope to expand it. It diversifies income in a climate-resilient manner (honey production is less climate-dependent than crops) and, as noted, has positive side-effects like pollination of crops and incentive for forest conservation (since bees thrive with more flowering trees, communities have a reason to plant and protect them).

Another livelihood intervention was the promotion of sustainable energy enterprises, which had economic, social, and environmental dimensions. The fuel-saving cookstoves and solar lamps as both a climate adaptation and a micro-enterprise opportunity were introduced to the local community. According to the case study, the distribution of fuel-efficient stoves has yielded multiple benefits: it significantly "curbed firewood demand, thereby reducing pressure on local forests and mitigating deforestation". This was confirmed by women in FGDs, who reported that the improved stoves use far less wood than traditional three-stone fires. *"Before,*

I had to gather firewood every other day; now a bundle lasts me a week with the new stove," one woman explained, noting that this also saves her time and labor. Some community members have turned this into a small business by selling surplus firewood saved or by becoming local retailers of efficient stoves and solar lanterns (which the project introduced to replace kerosene lamps). These energy-related enterprises remain nascent, but they show promise. For example, youth groups in Wizaba were trained to assemble solar lamp components, providing them with a skill and a potential income source, while helping households access affordable lighting. Although quantifiable data on increased income from these specific activities is limited, qualitatively the "introduction of clean energy technologies" was cited as a win-win: reducing environmental degradation and opening avenues for community entrepreneurship, and health benefits.

Overall, the synergy between quantitative economic gains and qualitative testimonies of livelihood improvements indicates a picture of positive change. Households are earning more income from diverse resources, which enhances their adaptive capacity and resilience to climate and economic shocks. These improvements are acknowledged by the community: in the survey, over 94% of respondents reported being "satisfied" with the locally led adaptation intervention results on their livelihood. Many specifically cited livelihood benefits as a reason for their satisfaction. Notably, even typically marginalized groups benefited. Non-group members (households not initially part of community associations or cooperatives) were *optimistic and report* that the adaptation measures had a positive impact on their well-being (55.7% of non-group households, vs 42.8% of group members). This suggests the intervention successfully reached those who were perhaps economically or socially on the periphery. However, the adaptation practices had also challenges. About 5-6% of the respondents remained neutral about the benefits, and a handful of households felt little impact.

6.5. Natural Resource Management and Sustainable Energy

This section discusses outcomes related to natural resource use and management, including watershed conservation, reforestation, and energy, which are especially important for the immediate use and long-term sustainability of livelihoods in the district.

The integrated watershed management entailed activities like hillside terracing, gully rehabilitation, tree planting, and protecting areas from grazing for rehabilitation and regeneration. FGDs and case studies indicate that these efforts were very successful in both

target kebeles. *"We have seen the bare hills turn to green again,"* said an elder from Shimamdan, referring to the area where farmers built stone terraces and planted tree seedlings. Key informants indicated that hillsides that were once open to free grazing were designated as protected areas by the community watershed committees, with villagers agreeing to controlled cut-and-carry feeding for livestock. This has supported regeneration of vegetation (slow) and improved water retention in the soil, as evidenced by springs that didn't dry up as early as in past droughts (an observation shared by participants). Quantitatively, while the survey did not measure ecological metrics directly, the high adoption rate of soil and water conservation techniques (67.6%) may serve as a proxy indicator of environmental management practices existence. The case study noted that that these sustainable practices (from SWC to afforestation) may have resulted in notable improvements in soil fertility, erosion reduction, and agricultural productivity which form the bedrock *for sustained success and resource preservation*.

One of the key factors for the notable improvements in these adaptation initiatives was attributed to consultation and discussion during implementation. Though top-down, the consultative process tried to engage local institutions and actors in the adaptation space working in the area and empowered local institutions. However, the participation of local communities in the project initiation and design was sparse as well as largely donor dependent in financing during the start-up. In FGDs, however, participants repeatedly referred to the conservation structures as "*our work*" and "*our responsibility*" because of a series of consultations and awareness creations, indicating that awareness may play a substantial role in getting local buy-in and acceptance for better project implementation. However, many communities perceive and feel it as externally imposed for various reasons.

The study found that involving the local community not only generated employment (through food-for-work or cash-for-work on these projects) but also cultivated a deep understanding of the importance of preserving natural resources. That understanding may translate into community-enforced rules to sustain the gains (for instance, bylaws against cutting trees in reforested areas), which may warrant the intervention's long-term sustenance and practicality. The study infers that that engaging the local community in the implementation of adaptation performance governance could enhance both the effectiveness of the operationalization (more thorough implementation) and sustainability (continued revision and learning) of adaptation measures.

The project also paid special attention to social equity in natural resource efforts, ensuring the most vulnerable are not left behind. As noted earlier, women participated equally in SWC adoption. Key informants reported that the adaptation initiatives empowered women by creating job opportunities in different watershed activities and offering training. For example, women's groups were formed to raise tree seedlings in nurseries, an activity that provided them with income and a voice in reforestation planning. Youth were likewise mobilized in mapping watershed problems and contributed labor, gaining skills in the process. This inclusive approach is evident in the data: households with previously low social involvement showed some of the greatest appreciation for the project's impact on community cooperation. In the survey, over half (51.5%) of non-group participants reported a "Very High" increase in community cooperation and cohesion due to the project, significantly more than among group members (42.8%) (Table 6). This suggests that those who were not initially part of any collective felt a *new* sense of belonging and teamwork as a result of project activities like communal conservation work. Several villagers noted that through these efforts they got to know neighbors better and built trust. One young man from Wizaba mentioned, *"I never talked much with the older farmers up the hill before, but now we meet every week to work on the hillside and plan together."* Such strengthening of cohesion in the community is a critical but sometimes overlooked dimension of adaptive capacity and community resilience: a community that cooperates is better prepared to face natural hazards.

The provision of fuel-efficient stoves and the promotion of alternative energy were small but innovative components of the natural resource management strategy for sustainable energy and forest conservation, as introduced in Section 6.5. The heavy reliance on firewood for cooking and lighting was identified as a driver of deforestation in the area. By reducing firewood consumption by an estimated 50% per household (as reported by stove users), these stoves help alleviate pressure on local woodlands. Focus group participants also observed that since the introduction and distribution of clean cooking stoves, the nearby forests seem to be regenerating: *"We see new shoots coming up in areas we used to cut daily,"* said a woman from Shimamdan, *"because many of us switched to the improved stove and don't need as much wood."* This environmental benefit was coupled with health and labor benefits (less smoke inhalation, less time spent collecting wood). Although only a portion of households received stoves during the initial stages, their positive experience has created spillovers and demand for more clean cooking technologies. Furthermore, solar lanterns replaced kerosene lamps for

dozens of families, eliminating fumes and reducing spending on fuel. From a climate change perspective, these clean energy solutions also cut greenhouse gas emissions (firewood and kerosene produce CO_2 and soot), aligning local actions with broader mitigation co-benefits.

The study observed that natural resource management and sustainable energy initiatives have demonstrated that participation and community-driven governance can yield significant economic,social, and ecosystem benefits. By engaging locals in protecting and wisely using their natural resources, the project not only improved the immediate environment (more trees, less erosion, conserved water) but also instilled a conservation ethic and cooperation that will underpin the long-term sustainability of these efforts. As one community leader put it in a KII, *"The greatest change is that people now understand why we must take care of the land. We did this work ourselves, and we know it's our responsibility to keep it going."* This attitudinal shift is from our day-to-day needs for (short-term) exploitation of resources to sustainable co-benefits for the future.

6.6. Adoption of Climate Smart Agricultural Practices

One of the important dimensions that helps the localization of adaptation practices is the adoption rate of innovative climate-smart adaptation practices. In this study, a key practice assessed was the introduction of soil and water conservation (SWC) techniques (terracing, composting, mulching, and small-scale water harvesting).

Table 5 shows the adoption rate of SWC techniques. The results show a high overall adoption rate of SWC practices and no significant gender gap. Out of 284 households, 192 (67.6%) adopted at least one soil and water conservation technique (while 92 did not). The adaptation rate by gender is not discouraging (of the total adopters 63.5% were male and 36.5% female) showing encouraging participation from female headed households). In other words, nearly 69% of all male participants and 65% of all female participants adopted the practices, a difference that is not statistically significant ($\chi^2 = 0.374$, $p = 0.541$). This finding demonstrates that technology outreach and training were gender balanced. Both men and women were engaged and empowered to try the new conservation measures. In many rural contexts, women can face barriers to adopting agricultural innovations (due to land access, labor, or cultural norms); however, the findings suggest that suggest women kept pace with men in implementing SWC. This may likely indicate deliberate targeting of women in technology adoption process.

Another finding regarding the technology adaptation is that it directly associates with skill training. Accordingly, for those trained in technology adoption, the adoption rate is high, and it is statistically significant ($\chi^2 = 26.223$, df = 5, p = 0.000). Households that did not adopt SWC practices were far more likely to report having learnt no new skills. In fact, among those who gained 0 new skills, 18 out of 26 (69%) did not adopt the techniques. By contrast, the vast majority of those who acquired new skills went on to implement the practices. For example, 95 households gained 1 new skill, and of these, only 28 (29%) did not adopt, meaning about 71% adopted. Similarly, of the 66 households that gained two new skills, only 41% failed to adopt them (59% adopted).

Conversely, a small subset of participants who ended the project without learning any new skills almost uniformly did not change their practices. This could be due to either lack of access to or interest in the training, or perhaps these households were facing other constraints (labor shortages, illness, among others) that prevented both learning and adopting.

The findings indicate that changes in behaviour result from awareness creation and training, suggesting that the success rate (uptake) of technology adoption among adopters may depend on their level of education and awareness. High adoption may enhance behavioural changes resulting from perceived shifts in technology adoption, potentially increasing the chances of sustained resilience improvements.

Table 5: Adoption of Climate-Smart Practices and Influencing Factors

		Adoption of Soil and Water Conservation Techniques								
		Yes		**No**		**Total**		**Chi-**		
Variables	**Group**	N	%	N	%	N	%	**Square**	**Df**	**Sig.**
Gender	Male	122	63.5%	55	59.8%	177	62.3%	.374	1	0.541
	Female	70	36.5%	37	40.2%	107	37.7%			
Number of New Skills Gained through the Project	0	8	4.2%	18	19.6%	26	9.2%	26.223	5	0.000
	1	95	49.5%	28	30.4%	123	43.3%			
	2	66	34.4%	41	44.6%	107	37.7%			
	3	20	10.4%	5	5.4%	25	8.8%			
	4	1	0.5%	0	0.0%	1	0.4%			
	5	2	1.0%	0	0.0%	2	0.7%			

6.7. Participation, Governance, and Social Cohesion

The adaptation practices are fundamentally shaped by the roles of governance and community participation, which are overarching and cross-cutting factors in determining project outcomes. The effectiveness and sustainability of locally led adaptations in the district have strongly influenced the degree and depth of local community participation and governance frameworks. The data and interviews also show how community cohesion and local governance capacity are central for the effectiveness of climate adaptation.

One quantitative lens for participation was whether households were involved in community groups or associations during the adaptation policy framing and monitoring and evaluation of the implementation. The survey found a high approval rate of the project across the board, but with slight differences between those who were socially engaged and those who were not. As mentioned in section 6.4, households not members of any community group were actually more likely to report the very highest project impact on their well-being (56% "Very High" impact) compared to group members (43%). Likewise, non-members slightly edged out members in being "very satisfied" with the project (57% vs 51%). On the other hand, a small minority of group participants (about 15%) felt the project's impact on their household was "low" or "very low", whereas very few non-group participants felt this way. Statistically, the difference in perceived impact was significant ($\chi^2 = 14.866$, $p = 0.005$), though the difference in overall satisfaction was marginal ($p = 0.052$). These nuances suggest that the project managed to reach and impress even those who were not previously engaged in community networks, which is a positive sign of inclusivity, but also that some active community members had unmet expectations.

Qualitative discussions revealed several possible explanations. First, the selected households might have been more socially or economically marginalised at the start; for them, the adaptation intervention (support) could perhaps be the first substantial support they received, yielding notable improvements in their eyes. This proponent is supported by KII. "I never belonged to any association before, so I was on my own. When the project came, it felt like a huge change; suddenly there was help," explained a single mother in Wizaba who was not part of any prior group. These factors could explain their positive feedback. In contrast, those already active in community groups (e.g., cooperative members or water user committee members) may have started at a slightly better position or had higher expectations. They might compare the project's benefits against other development activities they've seen, and thus it

would be more difficult for them to see a notable change. As one cooperative member quipped, “We have seen many projects; we welcome this one too, but we also know its limitations.” This critical lens can be healthy, as it means engaged citizens are evaluating interventions, but it does highlight that managing expectations and ensuring transparency in decision-making is important, especially with community leaders. The project’s participatory governance structure involving community representatives in planning likely helped, but the data shows a need to continually communicate how and why certain decisions are made to maintain trust among all stakeholders.

The fact that non-group members felt so positively indicates the project did not only cater to those already well-connected. This is a key outcome for broader participation and inclusivity: the locally led approach makes deliberate efforts to identify and involve vulnerable or less organised people. The findings show that when asked about “change in community cooperation and cohesion”, the majority of respondents in both categories noted improvements, with non-group households again slightly more enthusiastic (52% of them said “Very High” increase in cohesion, vs 43% of group members; $\chi^2 = 6.032$, $p = 0.049$). Qualitative insights also suggest that the project practiced convening inclusive community discussions. For instance, one focus group participant observed, "We worked side by side – women, men, young, old, farmers with land and those with none – everyone had something to contribute." Such experiences build social cohesion. The trust and networks formed are likely to endure beyond the project; the villagers mentioned they feel more confident now to organise collectively, whether it’s for maintaining a canal or advocating for support from the government. This underscores an important point: inclusive governance mechanisms (like community forums, participatory planning committees, and inclusive FGDs) are not just procedural; they can actively contribute to the adaptive capacity of the community and resilience by strengthening the community’s social fabric.

Despite these positive trends, the feedback also highlights some challenges in inclusive governance that call for attention. The presence of about 15% of group members who felt low project impact (versus only 8% of non-members) suggests that within the organized community, some voices or needs may have been overlooked. Possibly, these were individuals who had specific expectations (perhaps a particular promised input didn’t arrive, or they compared benefits and felt theirs were less). It’s also possible they belonged to groups that didn’t function well or had internal issues. For example, one water user committee member

privately noted that *"a few of us did the work, and others took the credit,"* implying some internal governance problems. This points to the need for strengthening internal group governance and accountability. Moreover, around 9% of survey respondents reported gaining 0 new skills and most of them did not adopt any new practices. This indicates a segment of the community that was not effectively reached by capacity-building efforts. In FGDs, facilitators identified some of these households: they tended to be those facing labor constraints (e.g., elderly or disabled with no family support) or those living in more remote hamlets that were harder for trainers to visit regularly. The study emphasized consistent *and adaptable support mechanisms* are pivotal, and that empowering women and continuous learning: awareness creation, consultation are indispensable effective implementation and equitable distribution of co-benefits.

In conclusion, the inclusive planning and governance mechanisms employed in this LLA was myopic in the sense that communities started engaging only for the implementation. In addition, resources used for the adaptation are heavily relied on NGOs and other sources; however, there was no attempt to embed the available local resources to sustain the adaptation initiatives from the intangible and tangible strategic resources. Similarly, there was no clearly defined performance measure framework employed for the localization of adaptations; it was solely based on activities focused output measures and outcomes were not tracked against the target set. The targets are often set by the governments- donors, and do not reflect the intended community outcomes.

Overall, quantitative analyses derived from statistical computations and qualitative findings from KIII and FGD highlight the necessity of adaptive framing in the planning and localization of adaptation policies and practices. To achieve this, DPG framing is best suited for the framing as well as for localizing the adaptation intervention by leveraging active community participation and measuring of adaptation outcomes through an adaptive feedback mechanism. In the next sections, the study demonstrates how DPG could help local actors develop adaptation policies aimed at fostering sustainable outcomes in a local area by extending the analytical focus from the myopic and leaner view to the whole of the economy and the whole of the community, emphasizing the interplay of dynamic performance measures in the district and the pursuit of sustainable community outcomes. Furthermore, DPG will shed further light on recognizing the importance of leveraging shared strategic resources, such as environmental

quality, human capital, and social well-being, which are common goods not directly tradable in markets but essential to collective prosperity.

Table 6: Community Participation and Perceived Project Outcomes (Chi-Square Analysis)

Variables	Group	Have You Any Participation in Community Groups or Associations				Total		Chi-Square	Df	Sig.
		Yes		No						
		N	%	N	%	N	%			
Perceived Impact of Project on Household Wellbeing	Very Low	29	15.5%	8	8.2%	37	13.0%	14.866	4.000	0.005
	Low	15	8.0%	1	1.0%	16	5.6%			
	Neutral	9	4.8%	11	11.3%	20	7.0%			
	High	54	28.9%	23	23.7%	77	27.1%			
	Very High	80	42.8%	54	55.7%	134	47.2%			
Overall Household Satisfaction with Locally Led Adaptation Project	Neutral	7	3.7%	9	9.3%	16	5.6%	5.904[a]	2.000	0.052
	Satisfied	85	45.5%	33	34.0%	118	41.5%			
	Very Satisfied	95	50.8%	55	56.7%	150	52.8%			
Perceived Change in Community Cooperation and Cohesion	Neutral	13	7.0%	12	12.4%	25	8.8%	6.032[a]	2.000	0.049
	High	94	50.3%	35	36.1%	129	45.4%			
	Very High	80	42.8%	50	51.5%	130	45.8%			

6.8. Leveraging Collaborative Platforms to Detect Systemic Barriers and Foster Active Citizenship to Enhance Adaptive Capacity

In sections 5.1 and 5.3, we discussed the underlying dynamics of constraints on local climate adaptive capacity, as well as the outcome measures derived from causal relations identified during the interview process and through primary and secondary data analysis. In this section, the research will further illustrate the local adaptive capacity phenomenon against the changing climate impacts, with especial emphasis on how well the identified 'locally' led adaptation measures could enhance the learning-orientated policy framing and how collaborative

platforms activated by active citizenship may enhance participatory and network policy formulation, including identifying context-specific adaptation interventions. In addition, findings from the statistical analysis and interview process are integrated into the enhanced DPG and CLD feedback loop to examine progress and explore performance improvement caveats through a learning-orientated feedback approach (Bianchi, 2022).

Accordingly, the improved DPG and Framework, and CLD Diagram depiction (figure 9 &10) shows that investing in citizens' education and awareness creation has resulted in multiple co-benefits. It fosters changes in active citizenship by boosting civic mindedness through various policy dialogues on climate adaptation practices. The change in civic mindedness also leads to community wellness, which in turn leads to an increase in the local area's attractiveness in the long run. This intern,

The long-term improvement of local area attractiveness dynamics is driven by increased biodiversity conservation resulting from investments in restoration, which enhance ecological regeneration (R22), and by the gains in local area attractiveness due to reductions in degraded land through vegetation recovery (R5) and the long-term impacts of sustainable agricultural practices (B2). Moreover, local area attractiveness is reinforced by improvements in community wellness fostered through changes in active citizenship, which is in term driven by increased in citizens' education and awareness of adaptation practices. These changes also encourage broader policy dialogue, thereby nurturing civic mindedness (R20).

The change in active citizenship further stimulates citizens' time and commitment to build active collaboration pacts, which are critical for advancing collaborative initiatives and driving changes in laws and regulations that promote public administration openness and inclusive policy dialogue. Greater public openness improves access to information, which strengthens trust among stakeholders and encourages bureaucracies to facilitate ease of doing business for ventures and startups, thereby enhancing project implementation performance (R18). Likewise, the increased implementation of adaptation projects is supported by business ventures willing to invest in such projects which is motivated by collaborative initiatives, and joint policy actions emerging from stronger collaborative pacts, which in turn attract further investment in adaptation (R19).

Box 1: From Awareness to Action: A Farmer Story of Local Adaptation

A 36-year-old farmer in Dehana Woreda once viewed recurrent droughts and land degradation as inevitable. This perception began to change after she participated in a community-based training program under the Climate Resilient Green Infrastructure (CRGI) initiative, which focused on soil conservation, water management, and collective land restoration.

Motivated by what she learned, she joined the local watershed management group and began mobilizing neighbors to build terraces and plant drought-tolerant trees. Her leadership encouraged other women to engage in similar efforts, gradually shifting community attitudes toward inclusive participation and women's roles in land rehabilitation.

Within a few seasons, the once-degraded hillsides began to recover, soil fertility improved, and households diversified their livelihoods through vegetable farming and beekeeping. The community observed tangible changes in productivity and ecological restoration, fostering a sense of ownership and civic responsibility.

Today, this farmer represents her community in woreda-level adaptation dialogues, providing grounded insights into local resilience strategies. Her experience exemplifies how awareness creation, participatory engagement, and governance inclusion can turn ordinary citizens into active stewards of climate adaptation, reinforcing the learning-oriented principles of the Dynamic Performance Governance (DPG) framework.

According to Bianchi (2021), network policies that emphasize community outcomes can be strengthened through active citizenship and commended that leveraging active citizenship can foster community well-being and reinforce the drivers of change necessary for sustained urban growth.

The collaboration loop (R19) and governance loop (R18), both driven by active citizenship, boost job creation opportunities and further increase local income, which previously relied solely on crop yields. This increase in income leads to growth in local GDP, which subsequently raises the financing needs that can be accessed for further investment (R13-access to Finance loop) and for infrastructure expansion. This expansion enhances access to market linkages, which in turn attracts additional investment flow, creates more jobs, and generates more income (R14-Market Development loop).

Box 2: Engagement

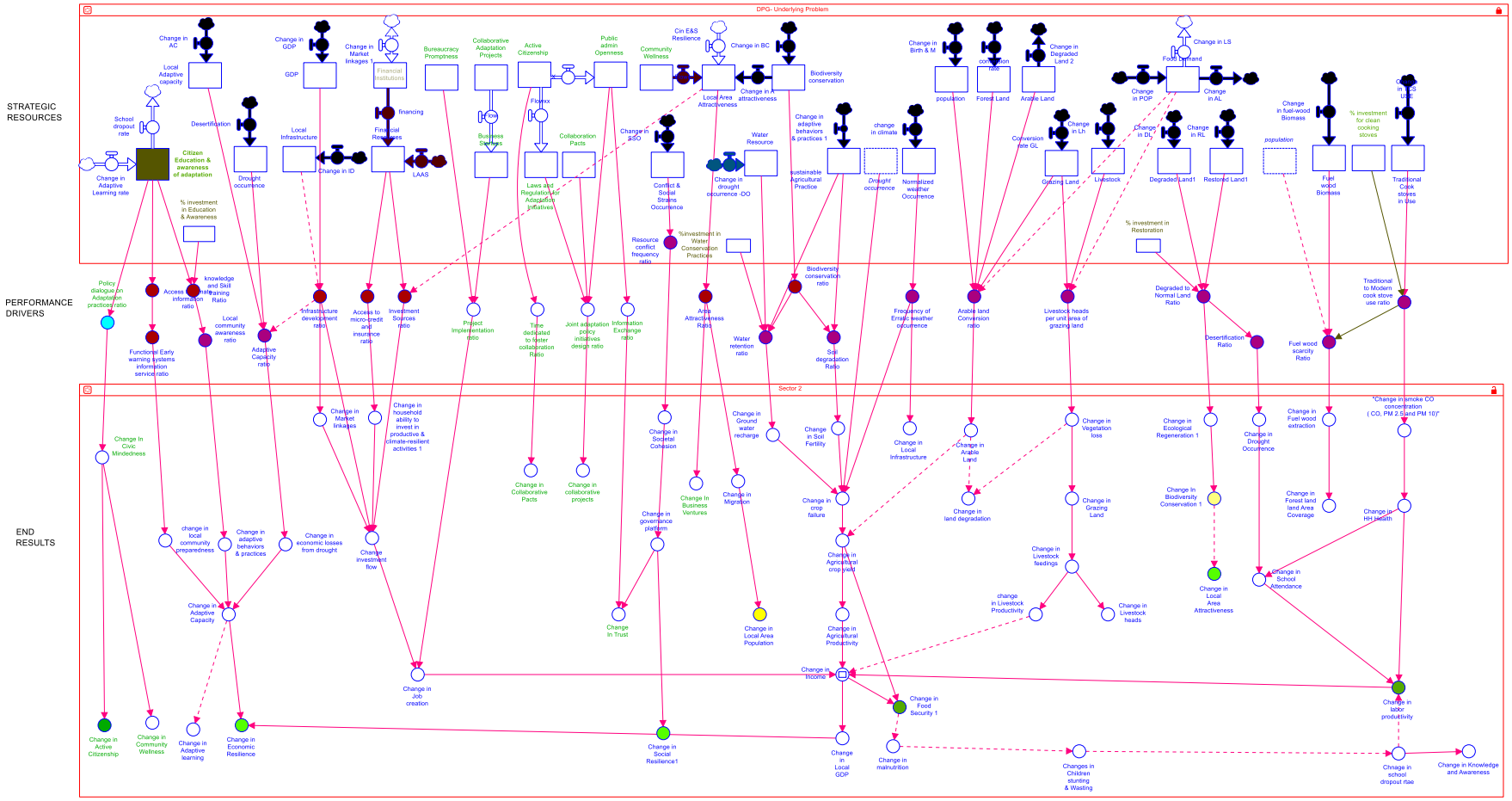
In Amba Mariam Kebele of Dehana Woreda, a small group of farmers decided to act rather than wait for external assistance. Through a community dialogue organized under the adaptation program, they recognized that their greatest resource was their engagement and participation “Tesatfo in local language”. With encouragement from local extension workers, they formed a small cooperative to rehabilitate degraded land and share new farming techniques.

Each member contributed labor, tools, or small savings to support the initiative. They began constructing terraces, planting fruit trees, and using composting methods introduced during training. The group also met regularly with woreda officials to align their work with local development plans and gain access to improved seeds and small-scale irrigation support.

Within two years, the group’s farms looked greener, and productivity improved. Families who once relied only on seasonal crops started selling vegetables and honey in nearby markets. As income rose, members invested in their children’s education and expanded small businesses. The cooperative’s success encouraged others to form similar groups in nearby villages.

Their story shows how their participation builds confidence and trust as well as learning can rebuild livelihoods. What began as a small act of unity has become a model of community-driven development that links active citizenship, local governance, and economic growth in a sustainable way.

Figure 9: Dynamic Performance Governance Depiction of dynamics of the Adaptive Capacity with Policy Intervention



Source: Author depictions using Stella Architect 3.8 Software

An increase in financial resources raises the percentage of financing allocated to clean cooking stoves, encouraging the local community to adopt clean cooking alternatives to traditional cookstoves, which significantly decreases the existing practices, such as using biomass (unsustainable) for cooking. This procedure in turn leads to a reduction in indoor pollution and improves health conditions. Improved health, in turn, contributes to a reduction in school dropout rates, thereby enhancing labor productivity in the long term.

Box 3 : A Breath of Change: Clean Energy Changes Lives

When smoke used to fill her kitchen, a mother of four in Dehana would cough until her eyes watered. Cooking the family's daily meal with firewood had always been part of life until she learned about the clean cookstoves introduced through the CRGI initiative. At first, she hesitated, unsure whether she could afford one. A local women's association helped her access a small loan from the revolving community fund.

The first day she used the stove, she noticed something different. The air was clear, and her youngest child no longer complained of burning eyes. Over time, her family's health improved, and the long hours she once spent collecting firewood were replaced by tending to a small garden behind her house. With the extra time, her children could attend school more regularly, and her household expenses dropped as less money was spent on medical visits.

Today, she often hosts neighbors curious about the stove. "It changed our home," she says proudly. "Now we cook without smoke, and my children breathe clean air, and they can study longer." Her story illustrates how access to finance, local leadership, and simple technology can create healthier, more productive, and resilient communities.

However, the policy tradeoff for the virtuous cycle of clean cooking substitution is constrained by key factors in the district, including the **affordability** of clean cooking technology (Average of USD 70/Unit Clean Cooking stove)**,** distribution and maintenance issues, local capabilities, and cultural perceptions that significantly influence the situation.

Sustainable agriculture practices, such as investment in natural resource use management, soil conservation practices such as terracing, solar pump-based irrigations, water harvesting (for dry season), can increase agricultural crop yield by enhancing soil fertility. This leads to

improvements in food security in the community. The change in food security is also attributed to increased income from various sources, including those fostered by active citizenship (R18 & R19), livestock productivity gains (R6 & R7), and the long-term effects of land use change practices (R21 & R9).

The change in food security status at the household level and in the local community would lead to a change in malnutrition, which, in turn, leads to the improvement in child wasting and stunting, thereby increasing labor productivity in the long term.

Box 4: Healing the Land through Water and Soil Conservation

In the upper hills of Dehana, land degradation had become a daily struggle. Streams that once flowed year-round had dried, and heavy rains washed away fertile topsoil. A group of farmers, supported by local development agents under the CRGI initiative, decided to take action. They began restoring the watershed through soil bunds, terraces, and small water harvesting ponds built with community labor.

At first, the effort seemed slow, but as the rainy season came, the changes were visible. The ponds captured runoff, allowing water to infiltrate into the ground. Vegetation began to recover, and the surrounding fields retained moisture for longer periods. Within two years, spring water reappeared in areas that had been dry for more than a decade.

With improved water availability, farmers were able to plant vegetables and fruit trees even during the dry months. The green cover helped stabilize the soil, and livestock productivity increased as fodder became available again. Women in the village spoke of the reduced burden of fetching water, while young people found seasonal work maintaining the terraces and ponds.

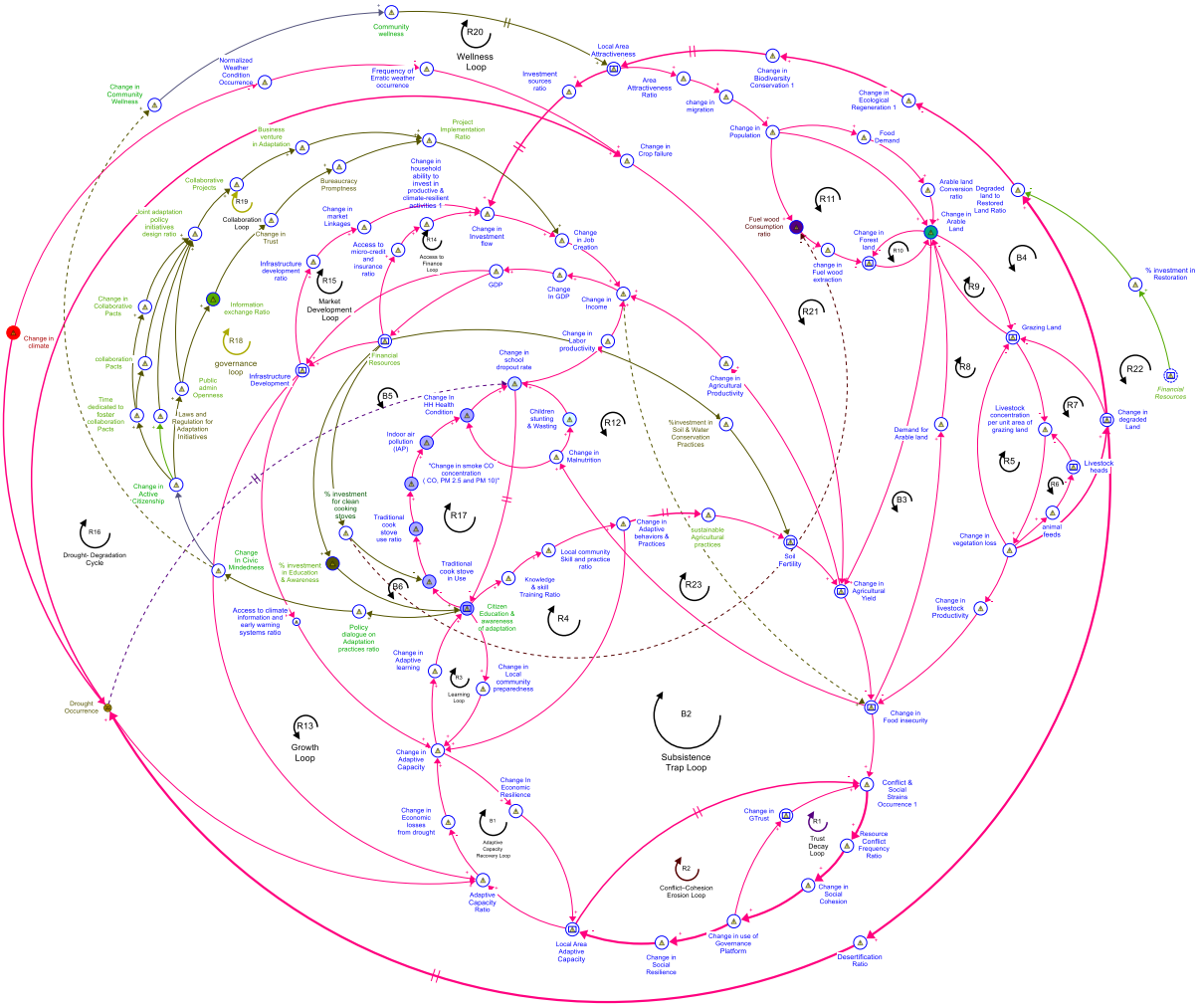
The initiative showed that restoring ecosystems can also restore livelihoods. As one elder summarized during a community meeting, “We have learned that the land listens when we care for it.” The success of this watershed effort continues to inspire similar community-driven restoration projects across neighboring kebeles.

As can be seen from the statistical analysis, DPG depictions, and casual loop feedback dynamics, education particularly citizens' skills training and awareness creation about climate impacts are critical to sustainable agricultural practices, which in turn lead to greater yields and

food security. Similar research finding showed that Ethiopian smallholder farmers with higher climate knowledge were more likely to adopt adaptive land-use practices that stabilized yields under variable rainfall (Belay et al., 2022). Likewise, Gashure (2025) found that farmer education and extension services improved crop productivity in Sidama, highlighting that awareness is a decisive factor in climate adaptation outcomes.

Education and awareness are also central to preparing communities for adverse climate shocks (R3 and R4) and enhancing local adaptive capacity, with multiplier effects on labor productivity (R17).Yona et al. (2025) also demonstrated that access to and awareness of climate information services in Ethiopia strongly supports farmers' preparedness for shocks, while Dawid and Boka (2025) indicated that households with climate knowledge adopted more diverse climate adaptation strategies, thereby boosting their adaptive capacity and resilience. Beyond individual resilience, education and awareness also foster inclusive policy dialogue that strengthens active citizenship. This in turn encourages more collaborative projects and business ventures through joint adaptive initiatives. Similar studies also showed that local governance structures with high levels of civic engagement were better at integrating adaptation priorities into policy (McNamara et al., 2020). Parsons et al. (Parsons et al., 2025) showed that participatory approaches consistently lead to more effective adaptation policies. However, another study cautions that these virtuous cycles are not automatic either. Chung (2025), argued that intra-community politics and power imbalances sometimes create "winners" and "losers" in adaptation projects, limiting the inclusivity of education-driven initiatives. Nevertheless, evidence also suggests that when education is integrated with institutional reforms and long-term governance arrangements, the positive feedback on adaptive capacity is magnified. Nath (2024), in his research emphasizes that transformative adaptation requires combining awareness-building with financial and regulatory reforms to sustain resilience over time.

Figure 10:A causal Loop Diagram Portraying the feedback dynamics of the Adaptive Capacity in the Dehana District with Policy Intervention



Source: Author Construction using Stella 3.8 Software

The other important dynamic we found that can help break the vicious cycle of myopic and disconnected systems into virtuous feedback loop adaptive capacity building and resilience dynamics is that the change in active citizenship. From statistical analysis, case stories and DPG synthesis, the change in active citizenship, emerging as a key lever triggered by civic mindedness and facilitated through collaborative platforms, is found to be crucial for breaking the vicious cycle of myopic and disconnected systems in adaptive capacity building and resilience. Similar studies by Ansell and Gash (2008), and by Emerson and Nabatchi (2015) also confirm that collaborative platforms enhance resilience by fostering trust, joint problem-solving, and institutional learning. This dynamic introduced the self-reinforcing governance loop (R15) and the collaboration loop (R19), both of which nurture business ventures and

improve the ease of doing business, thereby removing barriers to more effective adaptation project implementation. According to Bianchi (2021), such feedback loops in governance are essential in addressing complex and uncertain contexts, where traditional linear policies often fail.

This systems perspective is strongly validated by the Dynamic Performance Governance (DPG) approach, which conceptualizes such large-scale environmental challenges as "super wicked problems" lacking straightforward policy responses, thus requiring the active, integrated participation harnessed by collaborative platforms (Vignieri, 2023). Ostrom (2010) also supported local level joined actions and civic participation are indispensable for sustaining shared resources and long-term adaptive capacity and resilience building. The two investment driver loops (R15 and R19) also reinforce market development and the financing feedback loop, attracting investment flows that subsequently create more jobs and increase income. Similar studies by Adger et al. (2005) and Brondizio et al. (2009) indicated that civic engagement and institutional collaboration improve adaptive governance and investment climates, thereby strengthening adaptive capacities.

Furthermore, the resulting change in civic mindedness strengthens local community well-being, which, over the long term, enhances the attractiveness of the local area, serving as as an underlying factor in drawing desired investment inflows. According to Pelling and Manuel Navarrete (2011), such transformations in civic capacity play a key role in moving systems from reactive to proactive adaptation pathways. This proactive citizenry also helps elucidate and facilitate bridging the disconnect related to the feedback dynamics between investment flows and development outcomes (R23). Similar study findings by Bianchi et al. (2021b) confirm that such feedback structures are vital for sustaining public value creation and long-term adaptation outcomes.

Increasingly diverse and expanded investment inflows contribute to higher income levels, which, in turn, lead to notable improvements in the food insecurity situation and reductions in malnutrition by enabling access to essential food nutrients. These findings are consistent with Barrett (2013) and Tschirley et al. (2015), which indicates that change in incomes gains improve household food security and nutritional outcomes in rural economies. Moreover, increase in income enhances the share of investment allocated to climate adaptation initiatives, which further strengthens agricultural yields, livestock productivity, and biodiversity conservation through interventions such as restoration, soil and water conservation, and tree

planting. Similar evidence is found by the research conducted by Asmamaw et al. (2020), demonstrated that community-led adaptation investments enhance ecological restoration and long-term adaptive capacity and local resilience. Furthermore, similar studies employing DPG approaches also confirm that active community engagement reduces harmful factors like anthropogenic pressure, successfully limiting extinction risk (Vignieri, 2023).

However, DPG research also highlights critical trade-offs that must be managed. While these encouraging dynamics contribute to changes in population patterns that may have repercussions for local demographics, including pressure on job opportunities and food security, analogous "financially driven" governance modes (aimed at securing rapid investment for the immediate use) risk problems of social exclusion by prioritizing immediate private financial gain over long-term public value and social inclusion objectives (Bianchi, 2022; Bianchi, Bereciartua, et al., 2021b; Bianchi & Rivenbark, 2014b; Grippi, 2023b). Similar studies by Bulkeley et al. (2010) and Chu et al. (2016) also found that investment-led adaptation, if not coupled with equity safeguards, may exacerbate social inequalities and exclusion. This conflict between securing short-term liquidity (e.g., selling assets quickly) and maximizing long-term capital gains remains a major trade-off in policies leveraging investment for local community development. Therefore, managing the embedded complexity and these inherent financial-versus-social trade-offs requires careful attention in future policy, socioeconomic planning, and monitoring and evaluation processes.

In summary, Collaborative platforms offer a programmatic solution to overcome systemic investment barriers**.** Activated by active citizenship stemming from civic mindedness, collaborative platforms become mechanisms for mobilizing diverse investment sources, and finance sources for collaborative projects designed through policy dialogues at the local level. They drive systemic reforms reforming the existing laws and regulation barriers (governance loop-R18) in support the design and implementation of collaborative projects (R19) in adaptation and resilience. Unlike fragmented project-by-project approaches we saw in the underlying drivers of change for low adaptive capacity, Collaborative platforms support integrating policy, investment, and capacity-building activities under a single, locally led programmatic approach. By aligning finance behind adaptation and resilience priorities and taking a coherent and coordinated approach, collaborative platforms can reinforce the ownership (R18 and R19), local buy-in, make strategic use of scarce public resources, reduce

transaction costs and unlock the scale of finance and investment needed to protect vulnerable communities and economies from climate impacts.

6.9. Synthesis of Findings and Implications

6.9.1. Development Perspective

From collaborative platform lens, the researcher found that there was little attempt to set a shared target for the whole of society collective outcomes. Rather the targets in the program document were cascaded from top down, and for the specific intervention such as locally led adaptation, the targets are solely framed and set to meet the financiers (donors) intended purposes rather than shared focusing on shared community outcome.

The project intervention for locally led adaption measures focuses on monitoring the routine of identified activities: it lacks key performance measures (indicators), expected output and intermediate outcome of the intended interventions; it has only one final outcome identified without having the causal chains from the activity to final outcome level.

As underpinned by the key informant interview, adaptive learning is crucial to preserve the environment and mitigate the severe consequences of prolonged drought in the area. A key informant says "…*because of the drought we had no production in the past Years, but we recently did only see minimal effect on our production as we started at least learned how to keep our natural resources because of awareness creation and trainings from the project intervention". "For example, the area closure we do have now be used to feed our livestock".*

Across the quantitative outcomes and community feedback, the adaptation interventions demonstrate commendable success in strengthening local adaptive capacity and resilience in Dehana Woreda,Waghimra Zone, Amhara national regional State. Households have higher incomes, better food security, more diversified livelihoods, and greater access to irrigation than before, all achieved without increasing their financial strain – a combination that speaks to improved and sustainable intervention design. These improvements correspond directly to the project's goals of reducing vulnerability and enhancing adaptive capacity. Moreover, over 95% of participants are satisfied with the project, reflecting a high level of community approval and likely cooperation in maintaining the results.

Social dimensions of resilience, such as community cohesion and collective action, have been reinvigorated to some degree, indicating that the adaptation efforts can not only improve

individual household circumstances but also contribute to the *fabric of the community wellness initiated through active citizenship*. Households who were previously not engaged in local groups now feel more connected and supported, which bodes well for future community-led efforts (they may be more inclined to join cooperative activities or local associations hereafter).

Importantly, the discussion has highlighted a few areas for continued attention – the limitations are as instructive as the successes. Not every household felt the same level of benefit: a small minority did not perceive improvements, and about one-third have yet to adopt the new practices. These outliers suggest that even in a well-implemented project, there will be variability in outcomes. Factors such as initial social status, access to information, or specific household constraints (e.g. labor shortages, as could be the case for the very elderly or female-headed households with many dependents) might explain why some did not benefit as much.

From a policy and broader development perspective, this case study provides evidence that adaptation initiatives can deliver concrete socioeconomic gains in climate-vulnerable settings. By empowering communities through skill-building, leveraging local knowledge, and fostering collaboration, such projects can achieve outcomes that top-down interventions often struggle with, notably high adoption rates and wider community buy-in. The results support scaling up similar models in other regions: interventions that combine livelihood diversification, climate-smart agriculture, and community organization can substantially increase resilience at the grassroots level. Additionally, integrating monitoring and evaluation metrics for end results measures of output and outcome as depicted by the DPG framework provides a comprehensive understanding of the feedback loop dynamics.

6.9.2. Localization of SGDS Perspective

In addition to the feedback dyanmics outlined in the previous chapters, mapping of climate adaptation interventions against the Sustainable Development Goals (SDGs) with their magnitude of effects on each SDGS reveals a multidimensional pattern of their co-benefits, showing that adaptation actions help countries simultaneously advance multiple development priorities ranging from poverty alleviation, climate change, health and education, among other.

The mapping of intervention against the SDGs, and linkages shows that climate adaptation is not just an environmental issue; it is also a systemic driver of the social, economic, financial and institutional changes needed to achieve the development goals set out in the SDGs. Of the 15 interventions assessed, 11 were elicited using the DPG framework, and the majority

demonstrate high (4) to maximum (5) effects across several SDGs, highlighting the broader integrative potential of adaptation measures when effectively implemented through the dynamic performance governance approach (Appendix C).

As shown in figure 11, the most significant findings emerge in relation to the environmental and climate-related adaptation interventions, particularly Watershed Rehabilitation and Natural Resource Management (NRM) and Climate-Smart Agriculture (CSA). These interventions could result in the highest effect on Climate Action (SDG13), illustrating their critical role in building local ecosystem resilience and climate adaptive capacity. Watershed rehabilitation also can produce a similar effect on Clean Water and Sanitation (SDG6) and Life on Land (SDG 15), indicating its potential to restore ecological balance, ensure water availability, and protect local ecosystems, thereby enhancing productivity and agricultural yield. Similarly, CSA records maximum influence on Zero Hunger (SDG2), which is critical for the local community in Dehana, and has strong linkages to health, employment, and innovation. These findings emphasize that locally grounded adaptation interventions are critical for simultaneously addressing food security, water resource stability, and economic, social, and climate resilience by enhancing overall adaptive capacity.

Investment in clean cooking also emerges as a significant accelerator for achieving the sustainable development outcomes. Accordingly, renewable energy and clean cooking can significantly impact Health and Well-being (SDG3), Quality Education (SDG4), and Affordable and Clean Energy (SDG 7), demonstrating that access to clean energy serves as a comprehensive enabler for the economy and society through its productive applications in agriculture, education, and health productivity improvements. The linkage between adaptation interventions with gender equality (SDG 5), innovation (SDG 9), and sustainable cities (SDG 11), linked to rural transformation, shows that the transition from traditional energy use to modern, clean cooking energy deployment and utilization directly improves social inclusion, women's empowerment, and the ability of households and communities to deal with change. Similarly, in this particular study, new investments in clean cooking achieved the highest score for social inclusion, as indicated by gender equality, demonstrating that time savings, health benefits, and increased economic participation for women are significant adaptations and co-benefits of clean energy programs. The triangulation of these linkages affirms that transition to clean energy access and gender equity are mutually reinforcing levers, and expanding and

deploying clean energy infrastructure yields trickle-down effects across the social and economic SDGs.

Similarly, another notable and interesting dynamic is the high effect of education, awareness, and community engagement interventions for adaptation. In this context, implementing education and awareness initiatives for adaptation measures could lead to significant impacts on SDG4 (quality education), SDG13 (climate action), and SDG15 & 17 (partnerships), as well as substantial benefits in poverty reduction, hunger alleviation, and gender-related SDG goals. This shows the system-wide role of ignition and the catalytic role of education in shifting adaptive behavior and enhancing local ownership of climate action for better buy-in and implementation. Similarly, community wellness exhibits broader direct and indirect effects, resulting in maximum effects on health and high effects on education, poverty, and gender. These findings demonstrate that social capital and knowledge-building interventions strengthen community resilience, enhance participation in adaptation measures, and ensure that climate policies are grounded in public values and behavioral shifts.

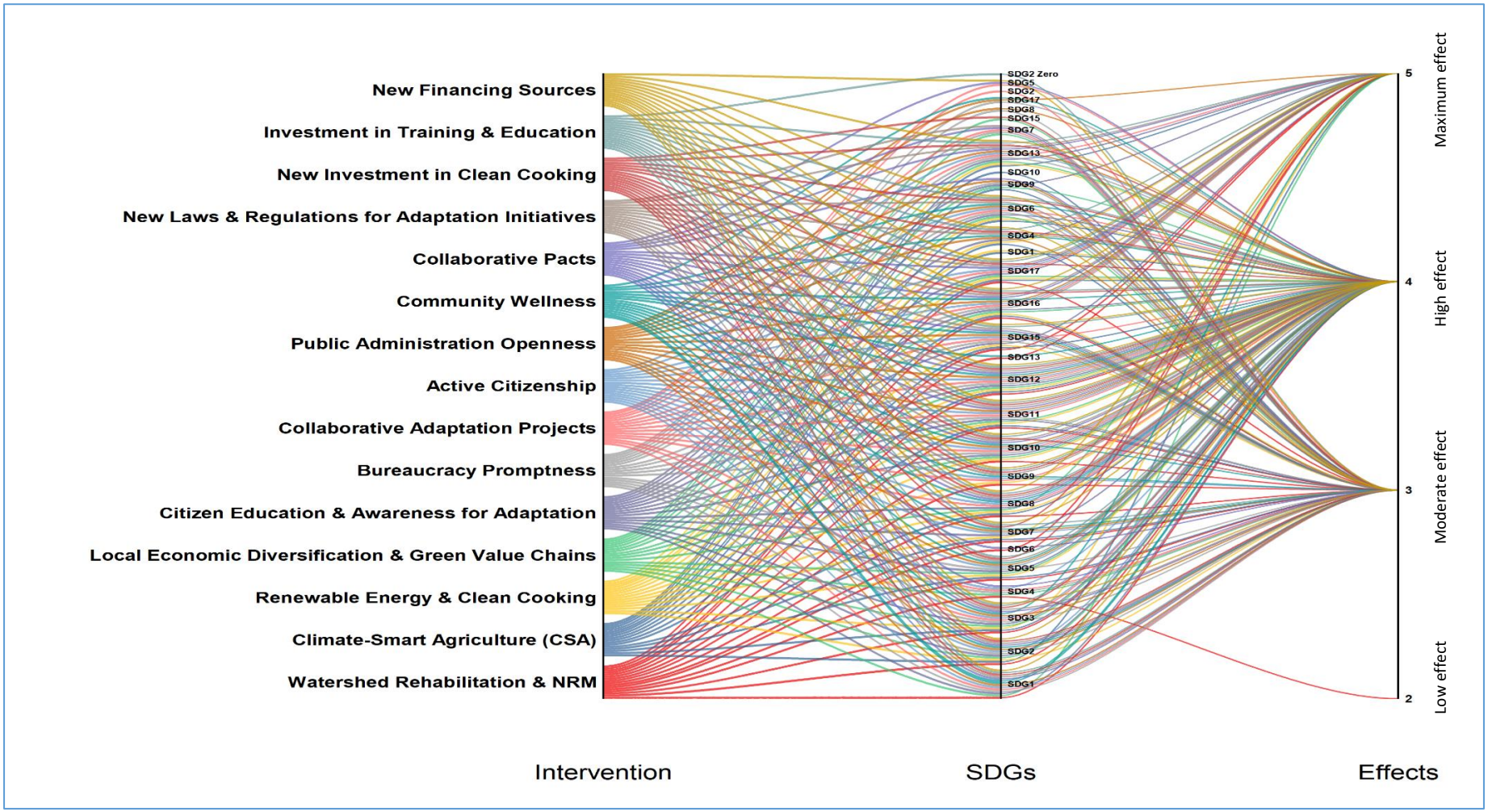
The SDGs-Adaptation measures linkage also depicts the centrality of governance, rules and regulation, collaboration and institutional reforms for joined-up policy and project initiations in operationalizing adaptation measures. Interventions such as Collaborative Adaptation Projects, Public Administration Openness, and Collaborative Pacts consistently record high or maximum effects on SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships). These dynamics also confirm that effective adaptation requires dynamic governance, active citizen participation, and inter-institutional collaboration (outside-in view). New law enactment and regulations for adaptation initiatives could result in maximum effects on SDGs 13, 16, and 17, showing that regulatory frameworks provide the backbone for sustained adaptation outcomes. Similarly, new financing sources give rise to maximum effects on SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption), SDG 16 (Institutions), and Partnerships (SDG 17), confirming that financial dimension and multi-stakeholder partnerships are key enablers for locally led adaptation measures and sustaining their developmental effects.

Interventions related to economic dimensions, especially local economic diversification and value chain gains, also have a big impact on the system. They have the largest effect on SDG1 (No Poverty) and a high effect on employment, innovation, and reducing inequality. This mapping supports the empirical finding from the statistical and DPG analysis that economic

diversification that is in line with adaptation, such as new business venture investments which resulted in job opportunities and income, such as green jobs, inclusive value chains, and low-carbon industries, is a key part of connecting resilience-building with structural economic change. However, while most interventions show strong links to social and institutional SDGs, the data also shows that they have moderate links to Reduced Inequality (SDG 10) and Sustainable Cities and Communities (SDG 11)-urbanization, which also indicates the possible trade-offs between skilled and unskilled and rural-urban transformation dynamics. The evidence confirms that even though adaptation measures have huge reinforcing feedback loop effects on the economy, environment, and society as a whole, their effects on different segments of a community or ecosystem need to be carefully governed to make sure that everyone is treated fairly, included, and integrated into system-wide shifts needed to achieve the sustainable development outcomes.

SDG 13 (Climate Action) stands out as the most cross-cutting and reinforced goal among all the interventions identified for this study. It received the most maximum effect scores from a wide range of interventions, including those related to resource management, education, governance, and financing. The finding indicates that achieving strong climate outcomes depends not only on economic and social ingredients but also on a dynamic and integrated fusion of biophysical, institutional, and behavioral interventions derived from local practices and ongoing education and training. Similarly, SGD16 (institutions) and SGD 17 (partnerships) display the densest clustering of maximum effects, highlighting that governance and collaboration are foundational for success across all other SDGs. These dynamics confirm that adaptive and dynamic governance, which is anchored in transparent institutions activated by public administration openness and ease of doing business, community participation, and multi-level financing, functions as the system through which adaptation gains are materialized and translated to tangible benefits.

Figure 11: Intervention effects on SDGs



Source: Author depiction using OrginPro2025

In SDG-Climate adaptation mapping (effect) and synthesis of effects, the findings show that climate adaptation interventions serve as an integrated dynamic of systems change, where ecosystem restoration, clean energy access and energy transition, economic and social empowerment, and governance dynamics reinforce one another. Interventions like watershed management and CSA support ecosystem resilience, while investment and financing projects catalyze economic resilience, and education, clean energy, and gender-targeted measures enhance community and societal resilience, thereby enhancing local adaptive capacity and community wellness. Governance related to institutional reforms and financing serves as an enabler that translates localized actions into systematic progress across multiple SDGs. The mapping underscores that achieving long-term adaptive capacity and sustainable development requires systemic action across economic, social, environmental, and institutional dimensions (governance). No single intervention can achieve maximum outcomes alone; rather, it is the systemic combination of natural resource management, knowledge empowerment, and governance reform that generates the highest cumulative effect on the SDGs.

Overall, the analysis indicates climate adaptation measures, when integrated across sectors, deliver notable co-benefits that cut across food security, poverty reduction, health and education, gender equality, economic growth, and institutional stability. The evidence reinforces the argument that adaptation is not just a response to climate impacts but a catalyst for sustainable development transformation by linking resilience, inclusion, and ecosystem integrity in a unified development pathway.

CHAPTER SEVEN
CONCLUSION AND IMPLICATIONS

7.1. Summary of Findings

This study investigated how adaptation interventions in Dehana Woreda have influenced local community adaptive capacity, socioeconomic resilience, income livelihoods, overall local community wellness, and governance. Accordingly, findings showed that households participating in climate adaptation practices experienced modest improvements in their crop yields and income diversification, confirming that climate-resilient practices, such as soil and water conservation, improved seed varieties, and small-scale irrigation, can boost productivity and help households cope with climate-induced disasters. However, these gains were tempered by continued climate shocks, including recurrent droughts and erratic rainfall, which undermined food security. Many households reported that, despite adopting new practices, yields still suffered when rains failed. In this regard, the DPG analysis and survey results revealed that the adoption of multiple adaptation practices was a central means to improve severe food insecurity; for example, households that combined terracing with drought-tolerant seeds or water harvesting exhibited higher outcomes in terms of food security and were able to adapt to the change than those adopting single measures.

Qualitative findings corroborated these trends. The focus group participants described broader participation in climate adaptation activities, noting that watershed rehabilitation and tree planting involved men, women, and youth alike. They also felt that local involvement increased ownership and sustainability. However, the inclusion of women and youth was uneven: women attended meetings but often lacked leadership roles, while youth appreciated new livelihoods such as beekeeping but desired more targeted skill training. Interview results from organization representatives in the district administrations and partner organizations supporting the locally led climate adaptation efforts in the district indicated that adaptation planning remained fragmented and misaligned with the desired community goal and regional and national development frameworks. Sector bureaus, such as agriculture, water, and energy, sometimes pursued climate adaptation activities independently rather than through integrated plans. This fragmentation and misalignment mirrored national assessments, which also pointed to a lack of coordination for systemic and joined-up planning, monitoring, and evaluation. Similar studies emphasized that climate change mitigation and adaptation interventions require

collaborative approaches and multilevel governance to ensure timely, well-targeted and just policy reforms, particularly at the sector level and local level (Dagne Belay et al., 2022)

The researcher further observed that the long-term sustainability of climate adaptation practices, including terraces, dams, and water pumps, was uncertain due to limited local budgets and unclear maintenance responsibilities, all of which still rely on external financing support from development partners. Households appreciated the benefits but were also equally concerned that without continued support, a sustained financing source and regular coordination and consultation, their hope could fade away, and existing infrastructure for adaptation could be degraded sooner.

Another key finding is that a possible set of trade-offs comes in the labor sector, where climate adaptation practices and building adaptive capacity necessitate skilled, trained manpower and greater awareness, but not necessarily unskilled jobs. These dynamics can create tensions and may worsen the food insecurity situation for the most vulnerable and very low-income households, and thus, there is a need for the government to actively manage the transition for workers from unskilled to skilled work.

Furthermore, the study elucidated that individual households benefiting from local adaptation measures, whether through cash transfers intended for productive input purchases or in-kind support provided by development partners, often use these resources for immediate consumption needs when faced with chronic food insecurity instead of direct investment financing or implementation. This finding aligns with similar studies by Barrett (2010) and Irz et al. (2001), which reveal that households experiencing persistent vulnerability frequently reallocate productive resources for adaptation to meet urgent subsistence demands. According to Ellis (2000), and Dercon and Christiaensen (2011), such behavior reflects rational coping strategies under extreme livelihood stress, where immediate consumption becomes a survival priority over long-term investment.

This behavioral pattern underscores a critical design gap in existing adaptation support mechanisms. Therefore, benefit packages targeting the most vulnerable households should integrate both investment-oriented assistance and additional livelihood protection measures to meet basic needs. Similar studies also support the effectiveness of linking productive safety net programs and microcredit arrangements with adaptation interventions to ensure that short-term consumption pressures do not erode resilience outcomes (Bezu & Holden, 2014; Hoddinott et al., 2012). Integrating these dual components of investment plus protection would enhance the

sustainability of adaptation benefits, enabling vulnerable households to transition from dependency to self-reliance and sustained livelihood improvement.

Finally, the research emphasizes the need for collaborative platforms which offer a programmatic solution to overcome systemic investment barriers. Activated by active citizenship stemmed from civic mindedness, collaborative platforms become mechanisms for mobilizing diverse investment sources, and finance sources for collaborative projects designed through policy dialogues at the local level. They are a vehicle for driving systemic reforms of laws and regulations to promote the design and implementation of collaborative adaptation and resilience programs. They also integrate policy, funding, and capacity-building initiatives under a unified, locally led programmatic approach, unlike the fragmented project-by-project approaches we witnessed in poor adaptive capacity drivers of change. Furthermore, collaborative platforms can increase local buy-in, make strategic use of scarce public resources, reduce transaction costs, and unlock the scale of finance and investment needed to protect vulnerable communities and their assets from climate impacts by aligning finance behind adaptation and resilience priorities and taking a coordinated approach.

7.2. Conclusions

As with any forward-looking modeling study, the results presented here are constrained by the accuracy of assumptions and reliability of the data used. While not an aspiration for the future, these results are indicative of what could be possible with early and steady implementation of climate adaptation and other feasible broader adaptations, in addition to the identified adaptation practices used as a case study for this research. At this stage, the study offers an "outside" in view of systemic analysis of the effects of reaching various outcomes across key areas most needed for budling local adaptive capacity and resilience in the long term.

The interventions have demonstrated that there is strong potential to improve local adaptive capacity and resilience to frequent droughts when multiple interventions are adopted in a collaborative manner. Soil conservation, rainwater harvesting, and improved seed varieties together led to modest increases in yields and income diversification. However, these improvements did not fully offset the effects of severe climatic stress. Therefore, there must be a broader adaptation intervention to cope with the adverse effects of drought and sudden flooding events that erode local adaptive capacity and resilience.

Climate Adaptation as a Dynamic Process: The study concludes that climate adaptation and adaptive capacity building are not static conditions. Instead, they are dynamic and complex processes that evolve with climate variability, livelihood diversification, and governance capacity. Communities benefited most when adaptation measures were combined with access to climate information and early-warning systems, as well as continuous education and training driven by civic-mindedness and active citizenship. This finding implies that adaptation strategies should be designed through joint policy dialogue to enhance the ease of implementation of project proposals.

In summary, adaptation measures in Dehana have resulted in encouraging outcomes by improving adaptive capacity through job creation and additional sources of income generated via diversification. Households are now better buffered against economic and climatic shocks, and the community as a whole has grown in cohesion and capacity to adapt. The increase in income partly underscores the effectiveness of the intervention, while the few shortcomings point to areas for refinement in future efforts. Overall, this results and discussion chapter affirms that locally led adaptation, if properly framed, can lead to tangible development outcomes in vulnerable regions, strengthening both the adaptive capacity and the cohesion of communities facing the challenges of climate change. The study's conclusions are relevant not only for Ethiopia's Dehana district but also for national level and other sub-Saharan developing nations that struggle with similar challenges, ranging from weak adaptive capacity and myopic policy and governance design to implementation as well as monitoring and evaluation capacity, and can be framed as the contextual exploration for adaptation and resilience in the policy domain.

7.3. Implications

7.3.1. Implications for Policy

Framing outcome based performance measures for local government policy formulation and monitoring and evaluation: This study, the first of its kind –applied using DPG approach in an Ethiopian context, can serve as base for framing performance governance at the local and regional level, in particular, and national level in general; the DPG provides a methodological framework for framing performance measures or indicators at different levels by structuring policy analysis around three causal layers which are critical for dynamic performance

governance: strategic resources, performance drivers, and end results (Bianchi, 2016c, 2022). Strategic resources from the underlying foundation, modeled as stocks measuring the endowment of tangible or intangible assets (such as active citizenship, knowledge, trust, or capacity) that decision-makers build up and deploy. The end-results layer outlines the expected policy results, encompassing outputs, intermediate outcomes, and final outcomes (which represent the ultimate ends a policy aims to achieve, such as a change in GDP, change in vegetation cover, change in population, or change in community wellness, etc.). Performance drivers on the other hand, as short-term measures used to track the critical success factors impacting these end results.

Integrating adaptation policy into localized development plans: Policymakers at the woreda, zonal, and regional levels may use the insights from this study to guide their adaptation planning, beginning with the identification of strategic resources in the area as well as key performance drivers, and end results. They can also leverage active community participation to integrate adaptation policy planning into their overall development plans and budget cycles. In this way, they can break the silos in their planning processes by moving from donor-dependent and short-term, project-oriented adaptation practices toward a programmatic, whole-of-economy, and whole-of-society approaches facilitated by Dynamics Performance Governance through active community participation.

Localization of SDGs and the Paris Agreement: The study employed the DPG framework, which offers a systemic approach which directly supports the localization of Sustainable Development Goals (SDGs) and the implementation of the Paris Agreement by emphasizing the adaptive feedback learning process, joint policy dialogue through active citizenship, and policy coherence and alignment – vertically coherent from federal-level policy framing towards woreda and lower levels (village) and horizontally consistent across sectors and actors. The identified strategic resources, performance drivers, and end results elicited from this study can serve as a foundation for the successful integration of adaptation practices into the overall development planning process.

The need for a programmatic approach of framing adaptation measures and diversification of financing Sources: Dedicated budget lines for locally-led adaptation should be created, complemented by mechanisms to attract private investment and microfinance for green livelihoods. Simplifying access to national and international climate funds will enable

local actors to maintain and expand CRGI infrastructure. Blended financing models, combining public subsidies with community contributions, may sustain infrastructure maintenance.

The need for due attention to the most vulnerable community members: While designing climate adaptation measures, policymakers should always consider possible trade-offs of the proposed interventions. For instance, there is a tradeoff between investment inflow and population pressure; agricultural land and grazing land; forest land and agricultural land; clean cooking stove and traditional cooking due to upfront costs and culture; financing allocation; soil water retention and short-term water availability; etc. All these could have disproportionate effects on different households with varying income status. Therefore, policy framing should carefully consider potential trade-offs during the design stage and manage them during the implementation process to minimize the unintended consequences of the climate adaptation interventions.

Education for skill training and awareness: Adaptation measures are skill intensive and require greater understanding and awareness of the practices for improved results; otherwise, they may result in exacerbating food insecurity and income inequality. Therefore, embedding skill training in the education curriculum, providing on-site job training and awareness, and linking adaptation practices with technical and vocational training programs (TEVTs)-green skilling could lead to broader buy-in, effective implementation, and sustainability resulting in an even distribution of the co-benefits from adaptation intervention outcomes within the community.

7.3.2. Implications for Practice

The Need for broader community participation and engagement in the planning, and Monitoring and evaluation cycle of adaptation programs and projects. Practitioners should emphasize participatory methods throughout planning and implementation. Community forums, participatory rural appraisals and co-design workshops leverage existing local knowledge and practices to guide adaptation measures and foster ownership.

The Role of local government ownership in collaborative platforms for sustainability: Collaborative platforms are widely understood to be government-led partnerships that align different stakeholders' needs to achieve the intended outcomes, thereby helping entities unlock resources (tangible and intangible) to support a notable change in climate action. Therefore,

government leadership and its role in the platform's functioning are critical to securing and maintaining buy-in and political appetite at the respective layers of the governance structure.

Invest in capacity-building: In addition to policy level education and curriculum revision, continuous training is essential for farmers, extension agents and local leaders. Training should cover technical skills in soil and water management, business skills for new livelihoods, and climate-information education. Training should also be tailored to women's and youth's needs of reskilling, and green skilling.

Plan for scalability and sustainability: The outcome measures and indicators developed by DPG are scalable because of DPG's universality in flexibility, robustness, and systemic approach to framing performance measures. Therefore, the local government can start with one sector for adaptation policy planning and performance measures with selected interventions, as this study demonstrated for case studies, and then scale it for the broader economy and larger sets of adaptation investment programs**.**

7.3.3. Future Research Area

As demonstrated through the Dynamic Performance Governance (DPG) framework, rules and regulations play a fundamental role in attracting investment and enabling access to finance for climate adaptation projects and programs. However, this study did not delve into identifying the specific policy and regulatory barriers that inhibit effective adaptation practices both within the study area and at the national level. Therefore, future research is commendable to systematically examine the institutional, legal, and policy frameworks that shape climate adaptation investment, focusing on how fragmented governance arrangements and unclear mandates across ministries constrain resource mobilization and coordination. In addition, this study did not disaggregate or cluster climate financing by source or mechanism. Hence, further investigation is needed to map out the potential sources of financing, be it public, private, and blended or any nature swaps, and to explore the feasibility of innovative financial instruments such as insurance bonds, resilience bonds, and micro-credit schemes tailored to local adaptation needs. Future study is also required to pilot and evaluate these financing mechanisms to generate evidence on their scalability and long-term sustainability. Furthermore, more in-depth diagnostic analysis is needed on how collaborative platforms can be effectively established, governed, and aligned with the broader national climate and development coordination systems. Understanding the institutional design, incentive structures, and stakeholder dynamics

that foster collaboration and joined up efforts between local and national platforms remains a gray area for future study. There is also pressing need for research to identify who is most food insecure or living near the poverty threshold to better design and target adaptive intervention packages that address chronic vulnerability while enhancing household resilience. Building on this, future studies should also explore data and baseline information gaps that limit evidence-based policymaking, as well as the influence of local adaptive capacity and food security conditions and social trust on data reliability and participation in adaptation programs. In general, these research directions would deepen understanding of the systemic enablers and barriers to adaptation investment, governance, and equity, thereby providing a strong evidence base for more targeted, inclusive, and sustainable climate adaptation in Ethiopia and similar contexts.

Future research, building on the DPG and causal feedback loop dynamics, may further investigate place-based stock-and-flow dynamic simulation models to augment the model-based aspect of the study and facilitate bottom-up scenario-based policy analysis and decision-making. It is recommended to further clarify and explicitly define locally led adaptation practices, as well as their theoretical contribution to the Dynamic Performance Governance framework and the broader climate governance literature, thereby elevating its status in wider academic discourse. Future research in this domain may also include multivariate or regression-based analytical tools to enhance causal inference and empirical robustness, alongside the feedback dynamics analysis using DPG to ensure closer alignment between policy implications and the empirical scope of the case study.

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APPENDICES

Appendix A: Key Informant Interview Questions Guide

i) Problem reference mode behavior framing guiding questions

1) What is the underlying current problem you are facing as for Climate change in concerned? And why it is a problem?
2) In your opinion, how the intensity of the problem has been evolving?
3) Can you quantify the any loss of livelihoods (Jobs, income, assets, etc.) due to climate change as percent of your reference or bench mark?
4) What are the key drivers for rampant environmental degradation such as accelerated land degradation and vegetation loss, soil erosion, severe drought and famine, and thereby stressing communities that are highly dependent on rained agriculture and pasture?
5) What would you think the consequences of the change in local area environmental degradation?

ii) Adaptation Policy Practices (selected based on project interventions in two climate change vulnerable sites: Waghimra Zone Dehana Woreda (District), Amhara region, Ethiopia) effectiveness diagnosis interview Questions

Selected Criteria of Evaluation	*Watershed and Natural Resource Management Activities*	*Sustainable, Diversified, and Climate Resilient Agriculture*	*Local Sustainable Energy Business Solutions*	*Engagement in Production within Value Chains*
Relevance	• How does the watershed and natural resource management approach align with the specific climate challenges	• How does the agricultural practice address the specific climate-induced disasters and risks that affect local farming practices?	• How do the local sustainable energy solutions align with the energy demand and challenges faced by the	• How does engagement in value chains contribute to enhancing the climate resilience of local producers

	faced by the communities at the local level? • How have the local ecological conditions influenced the choice of resource management strategies?	• Are traditional farming methods being integrated with modern climate smart agricultural practices? For example, use of techniques and innovations to improve resilience? • Was the training / capacity building for sustainable agriculture tailored to specific stakeholders such as men, women, youth and marginalized groups?	community, especially women and girls, youth, and marginalized groups? • Are these solutions tailored to specific stakeholders such as men, women, youth and most vulnerable group groups at the local level	and communities? • Have value chains been identified based on the unique strengths and resources of the local community? • Are these interventions tailored to specific stakeholders such as women, youth or vulnerable groups of society ?
Effectiveness	• What changes have been observed in the health of local ecosystems since implementing these management activities? • How have these activities	• What evidence exists to show increased crop yields /livestock productivity and farming production diversification as a result of adopting these climate-resilient	• What measurable reductions in greenhouse gas emissions or energy costs have been achieved through the adoption of these energy solutions?	• What evidence exists of increased market access, income growth, or value addition to local products through participation in value chains?

	contributed to minimizing the impacts of extreme weather events like floods and droughts?	agricultural practices? • How have these practices contributed to food security and livelihood improvement for local farmers?	• Can you provide examples of successful energy business models that have been established within the community?	• Can you share examples of successful partnerships established along the value chain that have benefited local producers?
Efficiency	• How do the resource management activities leverage local knowledge and practices to achieve their goals? • Are there any cost-effective measures or technologies that have been adopted to enhance the efficiency of these activities?	• Are there any notable changes in resource use, such as reduced consumption of water and fertilizers use, due to the adoption of these practices? • Have there been any shifts in labor patterns or workload for farmers after implementing these techniques? Has this affected differently women, men, and youth, the most vulnerable groups of society locally?	• How have energy-efficient technologies or practices been integrated into these business solutions? • Are there any innovative mechanisms (e.g. financing mechanisms, collaborations, capacity building) that have contributed to the effective deployment of sustainable energy solutions?	• How are value chain activities designed to minimize resource waste and optimize processes from production to consumption (i.e., production, bulking, processing, retail, consumption, waste management, etc.)? • Have there been any technology or information sharing strategies that have improved

				the effectiveness and efficiency of value chain engagement?
Outcome/impact	• Can you provide examples of tangible benefits that households or the community as a whole have experienced due to improved watershed and natural resource management? • Have these activities led to any measurable improved outcomes in water quality, soil fertility, or biodiversity conservation or re generation?	• Can you share instances of reduced crop losses or livestock mortality or increased crop production due to the adoption of climate-resilient agriculture? • Have there been positive impacts on income generation and poverty reduction within the local farming community?	• How have these energy solutions improved the overall quality of life for community members? • Have there been any observable benefits in terms of job creation, local health, income /economic growth/product ivity, or reduced energy poverty?	• Have there been improvements in livelihoods and economic stability within the community due to engagement in value chains? • How have these activities contributed to diversifying income sources and reducing dependency on climate-sensitive sectors?
Sustainability	• How are the local communities involved in	• How are local farmers being educated and trained in these	• How are the local energy business solutions being	• How are local producers being trained and equipped to

	decision-making and implementation of these management practices? • Are there plans in place to ensure the continuation of these practices in the long term, considering potential changes in climate and socio-economic conditions? • How do you see the role of organizations (e.g. government, research institution, CSO, NGOs, Donor, etc.) on the way forward to promote and support scaling-up of these practices?	climate-resilient practices? • What mechanisms are in place to ensure the continuous availability of necessary resources and inputs for sustainable farming? • How do you see the role of organizations (e.g. government, research institution, CSO, NGOs, Donors, etc.) on the way forward to promote and support scaling-up of these practices?	integrated into broader energy planning and policies? • What strategies are in place to ensure the longevity and scalability of these energy solutions? • How do you see the role of other organizations (e.g. government, research institution, CSO, NGOs, Donor community, etc.) on the way forward to promote and support scaling-up of these practices?	effectively participate in value chains over the long term? • Are there mechanisms in place to ensure fair distribution of benefits along the value chain and to prevent exploitation of local producers? • How do you see the role of other organizations (e.g. government, research institution, CSO, NGOs, Donor communities etc.) on the way forward to promote and support scaling-up of these practices?

Key lessons learned	• What key lessons have you personally learned/witnessed from participating in these resource management activities? • Are there any insights you can share about effective ways to engage local communities in sustaining natural resources? • What could have been done in a different way to enhance the engagement of local communities and maximize the impact of these activities? What is needed (in terms of governance resources, engagement with relevant	• Can you identify the best practices or innovative techniques that were crucial to the success of sustainable and resilient agriculture in your context? • What specific methods or approaches led to more productive and climate-resilient farming? • What could have been done in a different way to enhance local community participation and maximize the impact of these activities? • What is needed (in terms of governance, resources, engagement with relevant stakeholders, approaches, etc.) to scale-up these	• What best practices or innovative strategies played a key role in the success of the local sustainable energy businesses the project has supported? • Can you pinpoint specific approaches that led to positive outcome on both environmental sustainability and local economic growth? • What could have been done in a different way to increase the engagement of communities and maximize the impact of these activities?	• Could you identify the best practices or innovative interventions that yielded positive outcomes in enhancing value chain efficiencies? • What specific methods or collaborations led to improved social, economic, and environmental outcomes? • What could have been done in a different way to increase the engagement of communities and maximize the impact of these activities? • What is needed (in terms of resources, engagement with relevant stakeholders, approaches,

	stakeholders, approaches, etc.) to scale-up these practices in the communities?	practices in the communities?	• What is needed (in terms of governance resources, engagement with relevant stakeholders, approaches, etc.) to scale-up these practices in the communities?	etc.) to scale-up these practices in the communities?
"Good" Locally Led Adaptation Practices/innovative approaches	• What are the key collaborative strategies employed by successful watershed management activities that effectively engage local communities, governments, and stakeholders in preserving and restoring natural resources while ensuring sustainable livelihoods?	• How have locally-led agricultural projects integrated traditional knowledge and modern scientific approaches to enhance crop diversity, improve soil health, and develop climate-resilient farming systems, and what were the measurable positive outcomes? • What role do capacity-building and training	• What are some successful examples of locally-driven initiatives that have established community-based renewable energy enterprises, and how have these initiatives addressed both energy access challenges and socio-economic development needs? • What scalable approaches can you mention?	• Could you share instances where smallholder farmers or local producers have effectively integrated into broader value chains, and how have these collaborations ensured equitable benefits, improved market access, and enhanced the overall sustainability of the value chain?

	• What are the innovative initiatives that encourage farmers and local communities to adopt sustainable land management practices and contribute to the conservation of natural resources?	programs play in promoting the adoption of sustainable agricultural practices, and can you highlight instances where peer-to-peer knowledge sharing and farmer-to-farmer extension models have proven particularly effective?		• What are the key factors that have facilitated successful market linkages and value chain development at the local level, and how have initiatives encouraged the adoption of environmentally friendly production practices while meeting market demands?
I) Framing how dynamic performance governance can contribute to localizing strategic plans that foster sustainable outcomes	1) Have you participated in the localization of Paris agreement process/ climate adaptation plans designed at national/subnational regional level? 2) How you were selected and would other local communities get the same chance in that process? 3) What has been your role in the localization process? 4) What was the role of citizens and community members during the localization process? 5) How was the decision made in setting targets/cascading goals/? Has it been vetted with all relevant stakeholders involved in the process? 6) What could have been done differently to ensure ownership and effective localization of climate adaptation Plans 7) How might a dynamic performance framework support the identification and prioritization of key adaptation actions at the local level?			

II) Framing How DPG can help the effectivess and sustainability of Adaptation practices	1) What would you think that should be done to enhance the adaptability and responsiveness of locally led climate adaptation initiatives? Any gaps you would like to highlight in terms of finance, participation, commitment, trust, etc.? 2) In what ways would you think to governance of implementation could be framed to integrate local knowledge and context-specific nuances into climate adaptation practices? 3) Can you discuss how continuous monitoring and evaluation can contribute to the effectiveness and sustainability of local climate adaptation efforts? 4) How are the performance of Adaptation practices measured? Do you have any performance measures at the local level? 5) Do you think that the LLA outcomes contribute to the achievement of a range of SGDs and PA and underlying targets and indicators? If so, how? 6) How can a dynamic performance framework facilitate collaboration and coordination among local stakeholders, including local communities, governments, donors and private sectors, to enhance climate resilience? 7) What challenges or barriers might local communities face in implementing a dynamic performance framework for climate adaptation, and how can these be overcome to ensure long-term sustainability? 8) In your opinion what are the key success factors contributed to the positive result for the LLA Practices (if any?) Would you think the conflict hampers the implementation of the LLA policies in the local area? If so, in what way would you think it affects
III) How dynamic performance governance may contribute to localizing climate adaptation practices, improving resilience to climate change disasters and shocks and thus foster sustainable development outcomes!	1) What resources does the local community have that can be used to mitigate the adverse impact of climate change and enhance the resilience to climate disasters and shocks? 2) What is your main goal that you would want to achieved in the long-term to in relation enhancing the resilience at local level?

IV) Framing the role of active citizenship in fostering LL climate adaptation better outcomes	a) Are there any platforms where you can participate for climate policy planning/mainstreaming, implementation, and monitoring and evaluation? If so, how often you participate given the number of meetings they have annually/or bi-annual? b) How would you rate the effectiveness of the collaboration? (1-10) c) What resources would you allocate and contribute to catalyze the Locally Led Adaptation implementation in the collaborative network d) How you rate the level of trust you have on the Locally Led Adaptation governance? e) Would you get your expected outcomes after implementing the project activities

Appendix B: Socio Economic Related Interview Guide

Socio Economic Related Interview Guide

Section 1: General Information

1. Name of Respondent:
2. Gender: ☐ Male ☐ Female
3. Age: _____
4. Woreda/Kebele:
5. Household Size: _____ (Number of members)
6. Level of Education:
    - ☐ No formal education
    - ☐ Primary
    - ☐ Secondary
    - ☐ Higher
7. Main Occupation:
    - ☐ Farming
    - ☐ Livestock Rearing
    - ☐ Daily Laborer
    - ☐ Business
    - ☐ Other (Specify) _____

Section 2: Household Livelihood and Economic Impacts

1. Household Monthly Income:
    - Before the Project: _____ ETB
    - After the Project: _____ ETB
2. Change in Income due to Project Interventions:
    - ☐ Increased ☐ Decreased ☐ No Change

- Percentage of Change: _____ %

3. Number of Income Sources:
    - Before the Project: _____
    - After the Project: _____
4. Types of New Income Sources Created by the Project (Select all that apply):
    - ☐ Improved Agricultural Practices
    - ☐ Beekeeping
    - ☐ Small-Scale Business
    - ☐ Other: _____
5. Household Assets Owned (Specify Quantity for each):
    - Agricultural Land: _____ hectares
    - Livestock: _____ (Number of cattle/sheep/goats)
    - Irrigation Equipment: _____ (Number of irrigation units)
    - Agricultural Tools: _____
    - Other Assets: _____
6. Total Household Expenditure on Agricultural input (in ETB):
    - Before the Project: _____ ETB
    - After the Project: _____ ETB

Section 3: Food Security and Nutrition Impacts

1. Number of Meals Consumed Per Day:
    - Before the Project: ☐ 1 ☐ 2 ☐ 3 ☐ More
    - After the Project: ☐ 1 ☐ 2 ☐ 3 ☐ More
2. Dietary Diversity (Number of Days Consumed Per Week):
    - Cereals and Grains: _____ days/week
    - Vegetables: _____ days/week
    - Fruits: _____ days/week
    - Dairy Products: _____ days/week

- Meat or Poultry: _____ days/week
- Oil and Fats: _____ days/week
- Sugar and Sweets: _____ days/week
- Legumes and Pulses: _____ days/week

3. Average Monthly Food Expenditure (in ETB):
   - Before the Project: _____ ETB
   - After the Project: _____ ETB
4. Number of Food Groups Consumed in a Typical Week:
   - Before the Project: _____ groups
   - After the Project: _____ groups

Section 4: Agricultural Productivity and Environmental Impacts

1. Crop Yield for Major Crops (Specify for each crop type):

Crop type	Yield Before the Project (kg/hectare)	Yield After the Project (kg/hectare)

2. Number of Climate-Resilient Crop Varieties Introduced:
   - _____
3. Adoption of Soil and Water Conservation Techniques:

   ☐ Yes ☐ No

If yes, specify techniques adopted: _____

4. Number of Trees Planted as part of Project Activities:
    - _____
5. Water Harvesting Structures Constructed (e.g., Ponds, Wells):
    - Number of Structures: _____
    - Volume of Water Stored Annually (in cubic meters): _____
6. Area of Land Under Irrigation (in hectares):
    - Before the Project: _____ hectares
    - After the Project: _____ hectares

Section 5: Capacity Building and Social Impacts

1. Number of Training Sessions Attended:
    - _____ sessions
2. Type of Training Received (Select all that apply):

    ☐ Climate-Resilient Farming

    ☐ Business Skills Development

    ☐ Environmental Conservation

    ☐ Financial Literacy

    ☐ Other: _____
3. Number of New Skills Gained through the Project:
    - _____ skills
4. Household Participation in Community Groups or Associations:

    ☐ Yes ☐ No

    If Yes, specify type: _____
5. Number of Community Activities Initiated or Participated in due to the Project:
    - _____
6. Perceived Change in Community Cooperation and Cohesion (Scale 1–5):

☐ 1 – Very Low ☐ 2 – Low ☐ 3 – Neutral ☐ 4 – High ☐ 5 – Very High

Section 6: Overall Perceptions and Recommendations

1. Overall Household Satisfaction with Project (Scale 1–5):

☐ 1 – Very Unsatisfied ☐ 2 – Unsatisfied ☐ 3 – Neutral ☐ 4 – Satisfied ☐ 5 – Very Satisfied

2. Perceived Impact of Project on Household Wellbeing (Scale 1–5):

   ☐ 1 – Very Low ☐ 2 – Low ☐ 3 – Moderate ☐ 4 – High ☐ 5 – Very High

3. Recommendations for Future Projects (Open-Ended):

   _____

   _____

Section 7: Climate change and Health

a. Food Shortage, Migration, and Related Impacts

1) In the past 5 to 10 years', has your household experienced a shortage of food?

☐ Yes

☐ No

2) If yes, how often has your household lacked enough food to meet its needs?

☐ Often (most years)

☐ Sometimes (some years)

☐ Rarely (only a few times)

☐ Never

3) How has food shortage impacted your household members? (check all that apply)

☐ Children are underweight (wasting)

☐ Children have not grown as expected for their age (stunting)

☐ Adult members frequently feel weak or unable to work due to hunger

☐ No noticeable impact

4) Have any members of your household skipped meals or reduced meal size due to lack of food?

☐ Yes

☐ No

b. Health Effects of Food Shortage

1) In the past (could as long as 5-10 years), has anyone in your household experienced the following? (check all that apply)

☐ Symptoms of malnutrition (e.g., thinness, weakness)

☐ Illness related to poor nutrition (e.g., anemia)

☐ Frequent sickness or infections

☐ Difficulty recovering from illness due to weak health

☐ No noticeable health impacts

2) Have any children in your household been diagnosed with malnutrition by a health professional?

☐ Yes

☐ No

☐ I don't know

c. Coping Strategies (Begging and Other Livelihood Impacts)

1) Has anyone in your household had to ask for food or money (begging) due to a lack of food or income?

☐ Yes

☐ No

2) If yes, where do household members usually go for help?

☐ Local community/neighbors

☐ Relatives in other areas

☐ Urban centers or towns

☐ Religious or charitable organizations

3) Has your household sold assets (e.g., livestock, tools, property) to cope with food shortages?

☐ Yes

☐ No

4) Has anyone in your household taken on additional work or changed jobs to cope with food insecurity?

☐ Yes

☐ No

d. Migration Due to climate induced Food Shortage

1) Have any members of your household moved to another area due to food shortage?

☐ Yes

☐ No

2) If yes, where did they move to?

☐ A nearby rural area

☐ An urban center

☐ Another country

☐ Other (please specify): _____

3) What was the main reason for migration? (check all that apply)

☐ Lack of food in the home area

☐ Lack of income or job opportunities

☐ Poor health due to food shortages

☐ Displacement due to extreme weather events

☐ Other (please specify): _____

4) How has migration affected your household's overall well-being?

☐ Improved (better access to food/income)

☐ Worsened (disruption to family, loss of support)

☐ No change

e. Long-Term Consequences of Food Shortages and Migration

1) In your opinion, has food shortage in your area worsened over the past five years?

☐ Yes

☐ No

☐ Not sure

2) If yes, what do you think is the main cause of worsening food shortages? (check all that apply)

☐ Drought or erratic rainfall

☐ Poor soil conditions or lack of agricultural inputs

☐ Livestock loss due to disease or lack of grazing land

☐ Economic factors (e.g., loss of jobs, rising food prices)

☐ Conflict or displacement

☐ Other (please specify): _____

f. Adaptation Policy

1) Which types of climate adaptation projects are available in your area? (check all that apply)

☐ Drought-resistant crops or improved agricultural practices

☐ Water conservation and management projects (e.g., rainwater harvesting, irrigation)

☐ Early warning systems for extreme weather events

☐ Healthcare services related to climate-sensitive diseases

☐ Projects to improve food security or nutrition

☐ Other (please specify): _____

g. Impact of Climate Adaptation on Food Security and Malnutrition

1) Has your household's food security improved as a result of participating in climate adaptation projects (e.g., better farming techniques, improved food supply)?

☐ Yes

☐ No

☐ Not applicable

2) Have climate adaptation projects reduced malnutrition or hunger in your household?

☐ Yes

☐ No

☐ Unsure

3) If yes, what specific project(s) do you believe contributed to this improvement?

☐ Agriculture/farming support

☐ Food aid or nutrition programs

☐ Other (please specify): _____

h. Impact on Health (Malnutrition, Diseases, and Heat-Related Illness)

1) Since the introduction of climate adaptation projects, have you noticed any improvement in your household's health related to malnutrition?

☐ Yes

☐ No

☐ Not sure

2) Have healthcare services or support provided as part of climate adaptation projects helped reduce illness related to food-borne or water-borne diseases (e.g., diarrhea, cholera)?

☐ Yes

☐ No

☐ Not applicable

3) Has the project helped reduce cases of heat-related illness during periods of extreme heat? (e.g., better access to water, shade, or healthcare)

☐ Yes

☐ No

☐ Not applicable

i. Impact on Diseases Spread by Climate Changes (Vector-Borne, Water-Borne, and Zoonotic Diseases)

1) Has your household benefited from climate adaptation measures aimed at reducing diseases spread by insects (e.g., malaria, dengue)?

☐ Yes

☐ No

☐ Not applicable

2) Have projects related to improving water access and sanitation reduced the incidence of water-borne diseases (e.g., diarrhea, typhoid) in your household?

☐ Yes

☐ No

☐ Unsure

3) Do you believe these projects have also helped reduce health problems caused by diseases spread from animals (zoonotic diseases)?

☐ Yes

☐ No

☐ Not applicable

j. Mental Health and Well-Being

1) Have climate adaptation projects, such as community support programs or health interventions, helped reduce stress, anxiety, or other mental health issues in your household?

☐ Yes

☐ No

☐ Unsure

2) Do you feel that these projects have improved your household's overall well-being during extreme weather events (e.g., floods, droughts)?

☐ Yes

☐ No

☐ Unsure

k. Migration and Livelihood Security

1) Has the implementation of climate adaptation projects helped reduce the need for any member of your household to migrate due to food shortages or climate conditions?

☐ Yes

☐ No

☐ Not applicable

2) If migration has still occurred, do you think climate adaptation projects could help reduce future migration?

☐ Yes

☐ No

☐ Unsure

l. Long-Term Benefits of Climate Adaptation on Health

1) Do you believe that climate adaptation projects have improved your household's ability to cope with climate-related health impacts in the long term?

☐ Yes

☐ No

☐ Unsure

2) What additional support or projects do you think would further improve your household's health outcomes in the face of climate change?

☐ Access to healthcare for climate-related diseases

☐ Better water and sanitation infrastructure

☐ Improved food security programs

☐ Education on climate change and health

☐ Other (please specify): _____

B. Avoided Costs and Added Benefits from Climate Adaptation

a) Avoided Costs Due to Climate Adaptation

1) In the past year, have climate adaptation projects helped you avoid costs that would have otherwise resulted from climate-related impacts (e.g., extreme weather, crop failure, health issues)?

☐ Yes

☐ No

☐ Not sure

2) If yes, what types of costs have you avoided? (check all that apply)

☐ Healthcare expenses for climate-related illnesses (e.g., heatstroke, respiratory issues)

☐ Food purchases (due to improved crop yields or food security programs)

☐ Repairs to home or property damaged by extreme weather (e.g., floods, storms)

☐ Loss of income due to crop/livestock failure

☐ Migration or relocation costs

☐ Other (please specify): _____

3) Can you estimate the amount of money your household avoided spending in the past year due to these avoided costs? (in local currency)

☐ Less than 1,000

☐ 1,000 – 5,000

☐ 5,000 – 10,000

☐ More than 10,000

b) Added Benefits from Climate Adaptation Practices

1) Have you experienced any additional financial or non-financial benefits as a result of participating in climate adaptation projects?

☐ Yes

☐ No

2) If yes, what specific benefits have you experienced? (check all that apply)

☐ Increased crop or livestock productivity

☐ Improved access to clean water

☐ Reduction in health costs due to better health outcomes

☐ New job opportunities or income from climate-resilient activities (e.g., new crops, alternative livelihoods)

☐ Reduced need to purchase food or water

☐ Other (please specify): _____

3) Can you estimate the value of these added benefits in the past year for your household? (in local currency)

☐ Less than 1,000

☐ 1,000 – 5,000

☐ 5,000 – 10,000

☐ More than 10,000

c) *Total Economic Impact of Climate Adaptation*

1) In total, how much do you think your household has saved or gained (in local currency) in the past year due to climate adaptation practices?

☐ Less than 1,000

☐ 1,000 – 5,000

☐ 5,000 – 10,000

☐ More than 10,000

2) If possible, can you explain how you calculated or estimated these amounts?

d) Perceived Value of Climate Adaptation Projects

1) Do you believe the financial benefits of participating in climate adaptation projects outweigh the costs of participation (e.g., time, effort, or investment)?

☐ Yes

☐ No

☐ Unsure

2) How do you think these projects could further increase your household's economic resilience to climate change?

☐ Better access to resources (e.g., water, seeds, tools)

☐ More training on climate-resilient practices

☐ Financial support or insurance schemes

☐ Other (please specify): _____

Appendix C: Intervention SDG Linkage Mapping

Intervention	SDGs	Effects	Intensity of Effect	Categories
Watershed Rehabilitation & NRM	SDG1	4	Low Effect	2
Watershed Rehabilitation & NRM	SDG2	4	Moderate Effect	3
Watershed Rehabilitation & NRM	SDG3	4	High Effect	4
Watershed Rehabilitation & NRM	SDG4	2	Maximum Effect	5
Watershed Rehabilitation & NRM	SDG5	3		
Watershed Rehabilitation & NRM	SDG6	5		
Watershed Rehabilitation & NRM	SDG7	3		
Watershed Rehabilitation & NRM	SDG8	3		
Watershed Rehabilitation & NRM	SDG9	3		
Watershed Rehabilitation & NRM	SDG10	3		
Watershed Rehabilitation & NRM	SDG11	3		
Watershed Rehabilitation & NRM	SDG12	4		
Watershed Rehabilitation & NRM	SDG13	5		
Watershed Rehabilitation & NRM	SDG15	5		
Watershed Rehabilitation & NRM	SDG16	3		
Watershed Rehabilitation & NRM	SDG17	3		
Climate-Smart Agriculture (CSA)	SDG1	4		
Climate-Smart Agriculture (CSA)	SDG2	5		
Climate-Smart Agriculture (CSA)	SDG3	4		
Climate-Smart Agriculture (CSA)	SDG4	3		
Climate-Smart Agriculture (CSA)	SDG5	3		
Climate-Smart Agriculture (CSA)	SDG6	4		
Climate-Smart Agriculture (CSA)	SDG7	3		
Climate-Smart Agriculture (CSA)	SDG8	4		
Climate-Smart Agriculture (CSA)	SDG9	3		
Climate-Smart Agriculture (CSA)	SDG10	3		
Climate-Smart Agriculture (CSA)	SDG11	3		
Climate-Smart Agriculture (CSA)	SDG12	4		
Climate-Smart Agriculture (CSA)	SDG13	5		
Climate-Smart Agriculture (CSA)	SDG15	4		
Climate-Smart Agriculture (CSA)	SDG16	3		
Climate-Smart Agriculture (CSA)	SDG17	4		
Renewable Energy & Clean Cooking	SDG1	4		
Renewable Energy & Clean Cooking	SDG2	3		
Renewable Energy & Clean Cooking	SDG3	5		
Renewable Energy & Clean Cooking	SDG4	5		
Renewable Energy & Clean Cooking	SDG5	4		
Renewable Energy & Clean Cooking	SDG6	4		

Renewable Energy & Clean Cooking	SDG7	5		
Renewable Energy & Clean Cooking	SDG8	4		
Renewable Energy & Clean Cooking	SDG9	4		
Renewable Energy & Clean Cooking	SDG10	4		
Renewable Energy & Clean Cooking	SDG11	4		
Renewable Energy & Clean Cooking	SDG12	4		
Renewable Energy & Clean Cooking	SDG13	4		
Renewable Energy & Clean Cooking	SDG15	3		
Renewable Energy & Clean Cooking	SDG16	3		
Renewable Energy & Clean Cooking	SDG17	4		
Local Economic Diversification & Green Value Chains	SDG1	5		
Local Economic Diversification & Green Value Chains	SDG2	4		
Local Economic Diversification & Green Value Chains	SDG3	4		
Local Economic Diversification & Green Value Chains	SDG4	3		
Local Economic Diversification & Green Value Chains	SDG5	4		
Local Economic Diversification & Green Value Chains	SDG6	3		
Local Economic Diversification & Green Value Chains	SDG7	3		
Local Economic Diversification & Green Value Chains	SDG8	5		
Local Economic Diversification & Green Value Chains	SDG9	4		
Local Economic Diversification & Green Value Chains	SDG10	4		
Local Economic Diversification & Green Value Chains	SDG11	4		
Local Economic Diversification & Green Value Chains	SDG12	4		
Local Economic Diversification & Green Value Chains	SDG13	4		
Local Economic Diversification & Green Value Chains	SDG15	3		
Local Economic Diversification & Green Value Chains	SDG16	4		
Local Economic Diversification & Green Value Chains	SDG17	4		
Citizen Education & Awareness for Adaptation	SDG1	4		
Citizen Education & Awareness for Adaptation	SDG2	4		
Citizen Education & Awareness for Adaptation	SDG3	4		
Citizen Education & Awareness for Adaptation	SDG4	5		

Citizen Education & Awareness for Adaptation	SDG5	4		
Citizen Education & Awareness for Adaptation	SDG6	4		
Citizen Education & Awareness for Adaptation	SDG7	4		
Citizen Education & Awareness for Adaptation	SDG8	4		
Citizen Education & Awareness for Adaptation	SDG9	5		
Citizen Education & Awareness for Adaptation	SDG10	4		
Citizen Education & Awareness for Adaptation	SDG11	3		
Citizen Education & Awareness for Adaptation	SDG12	4		
Citizen Education & Awareness for Adaptation	SDG13	5		
Citizen Education & Awareness for Adaptation	SDG15	5		
Citizen Education & Awareness for Adaptation	SDG16	4		
Citizen Education & Awareness for Adaptation	SDG17	5		
Bureaucracy Promptness	SDG1	3		
Bureaucracy Promptness	SDG2	3		
Bureaucracy Promptness	SDG3	3		
Bureaucracy Promptness	SDG4	3		
Bureaucracy Promptness	SDG5	3		
Bureaucracy Promptness	SDG6	3		
Bureaucracy Promptness	SDG7	3		
Bureaucracy Promptness	SDG8	3		
Bureaucracy Promptness	SDG9	3		
Bureaucracy Promptness	SDG10	4		
Bureaucracy Promptness	SDG11	3		
Bureaucracy Promptness	SDG12	4		
Bureaucracy Promptness	SDG13	4		
Bureaucracy Promptness	SDG15	3		
Bureaucracy Promptness	SDG16	5		
Bureaucracy Promptness	SDG17	4		
Collaborative Adaptation Projects	SDG1	3		
Collaborative Adaptation Projects	SDG2	3		
Collaborative Adaptation Projects	SDG3	4		
Collaborative Adaptation Projects	SDG4	3		
Collaborative Adaptation Projects	SDG5	4		
Collaborative Adaptation Projects	SDG6	4		
Collaborative Adaptation Projects	SDG7	3		

Collaborative Adaptation Projects	SDG8	4		
Collaborative Adaptation Projects	SDG9	4		
Collaborative Adaptation Projects	SDG10	4		
Collaborative Adaptation Projects	SDG11	4		
Collaborative Adaptation Projects	SDG12	4		
Collaborative Adaptation Projects	SDG13	5		
Collaborative Adaptation Projects	SDG15	4		
Collaborative Adaptation Projects	SDG16	5		
Collaborative Adaptation Projects	SDG17	5		
Active Citizenship	SDG1	3		
Active Citizenship	SDG2	4		
Active Citizenship	SDG3	4		
Active Citizenship	SDG4	4		
Active Citizenship	SDG5	4		
Active Citizenship	SDG6	3		
Active Citizenship	SDG7	3		
Active Citizenship	SDG8	4		
Active Citizenship	SDG9	3		
Active Citizenship	SDG10	4		
Active Citizenship	SDG11	4		
Active Citizenship	SDG12	4		
Active Citizenship	SDG13	4		
Active Citizenship	SDG15	3		
Active Citizenship	SDG16	5		
Active Citizenship	SDG17	5		
Public Administration Openness	SDG1	3		
Public Administration Openness	SDG2	3		
Public Administration Openness	SDG3	3		
Public Administration Openness	SDG4	3		
Public Administration Openness	SDG5	4		
Public Administration Openness	SDG6	3		
Public Administration Openness	SDG7	3		
Public Administration Openness	SDG8	4		
Public Administration Openness	SDG9	3		
Public Administration Openness	SDG10	4		
Public Administration Openness	SDG11	4		
Public Administration Openness	SDG12	4		
Public Administration Openness	SDG13	4		
Public Administration Openness	SDG15	3		
Public Administration Openness	SDG16	5		
Public Administration Openness	SDG17	5		
Community Wellness	SDG1	4		
Community Wellness	SDG2	3		

Community Wellness	SDG3	5		
Community Wellness	SDG4	4		
Community Wellness	SDG5	4		
Community Wellness	SDG6	4		
Community Wellness	SDG7	3		
Community Wellness	SDG8	4		
Community Wellness	SDG9	3		
Community Wellness	SDG10	3		
Community Wellness	SDG1	4		
Community Wellness	SDG12	4		
Community Wellness	SDG13	4		
Community Wellness	SDG15	3		
Community Wellness	SDG16	4		
Community Wellness	SDG17	4		
Collaborative Pacts	SDG1	3		
Collaborative Pacts	SDG2	3		
Collaborative Pacts	SDG3	3		
Collaborative Pacts	SDG4	3		
Collaborative Pacts	SDG5	4		
Collaborative Pacts	SDG6	3		
Collaborative Pacts	SDG7	3		
Collaborative Pacts	SDG8	4		
Collaborative Pacts	SDG9	3		
Collaborative Pacts	SDG10	4		
Collaborative Pacts	SDG11	4		
Collaborative Pacts	SDG12	4		
Collaborative Pacts	SDG13	5		
Collaborative Pacts	SDG15	3		
Collaborative Pacts	SDG16	5		
Collaborative Pacts	SDG17	5		
New Laws & Regulations for Adaptation Initiatives	SDG1	3		
New Laws & Regulations for Adaptation Initiatives	SDG2	3		
New Laws & Regulations for Adaptation Initiatives	SDG3	3		
New Laws & Regulations for Adaptation Initiatives	SDG4	4		
New Laws & Regulations for Adaptation Initiatives	SDG5	4		
New Laws & Regulations for Adaptation Initiatives	SDG6	3		
New Laws & Regulations for Adaptation Initiatives	SDG7	3		
New Laws & Regulations for Adaptation Initiatives	SDG8	4		

New Laws & Regulations for Adaptation Initiatives	SDG9	4		
New Laws & Regulations for Adaptation Initiatives	SDG10	4		
New Laws & Regulations for Adaptation Initiatives	SDG11	4		
New Laws & Regulations for Adaptation Initiatives	SDG12	4		
New Laws & Regulations for Adaptation Initiatives	SDG13	5		
New Laws & Regulations for Adaptation Initiatives	SDG15	3		
New Laws & Regulations for Adaptation Initiatives	SDG16	5		
New Laws & Regulations for Adaptation Initiatives	SDG17	5		
New Investment in Clean Cooking	SDG1	3		
New Investment in Clean Cooking	SDG2	3		
New Investment in Clean Cooking	SDG3	4		
New Investment in Clean Cooking	SDG4	4		
New Investment in Clean Cooking	SDG5	5		
New Investment in Clean Cooking	SDG6	4		
New Investment in Clean Cooking	SDG7	5		
New Investment in Clean Cooking	SDG8	4		
New Investment in Clean Cooking	SDG9	4		
New Investment in Clean Cooking	SDG10	3		
New Investment in Clean Cooking	SDG11	4		
New Investment in Clean Cooking	SDG12	4		
New Investment in Clean Cooking	SDG13	4		
New Investment in Clean Cooking	SDG15	3		
New Investment in Clean Cooking	SDG16	4		
New Investment in Clean Cooking	SDG17	4		
Investment in Training & Education	SDG1	3		
Investment in Training & Education	SDG2 Zero	3		
Investment in Training & Education	SDG3	4		
Investment in Training & Education	SDG4	5		
Investment in Training & Education	SDG5	4		
Investment in Training & Education	SDG6	4		
Investment in Training & Education	SDG7	3		
Investment in Training & Education	SDG8	4		
Investment in Training & Education	SDG9	4		
Investment in Training & Education	SDG10	4		
Investment in Training & Education	SDG11	4		
Investment in Training & Education	SDG12	4		
Investment in Training & Education	SDG13	5		
Investment in Training & Education	SDG15	4		

Investment in Training & Education	SDG16	4		
Investment in Training & Education	SDG17	5		
New Financing Sources	SDG1	4		
New Financing Sources	SDG2	4		
New Financing Sources	SDG3	3		
New Financing Sources	SDG4	3		
New Financing Sources	SDG5	3		
New Financing Sources	SDG6	3		
New Financing Sources	SDG7	4		
New Financing Sources	SDG8	5		
New Financing Sources	SDG9	4		
New Financing Sources	SDG10	4		
New Financing Sources	SDG11	4		
New Financing Sources	SDG12	4		
New Financing Sources	SDG13	4		
New Financing Sources	SDG15	4		
New Financing Sources	SDG16	5		
New Financing Sources	SDG17	5		