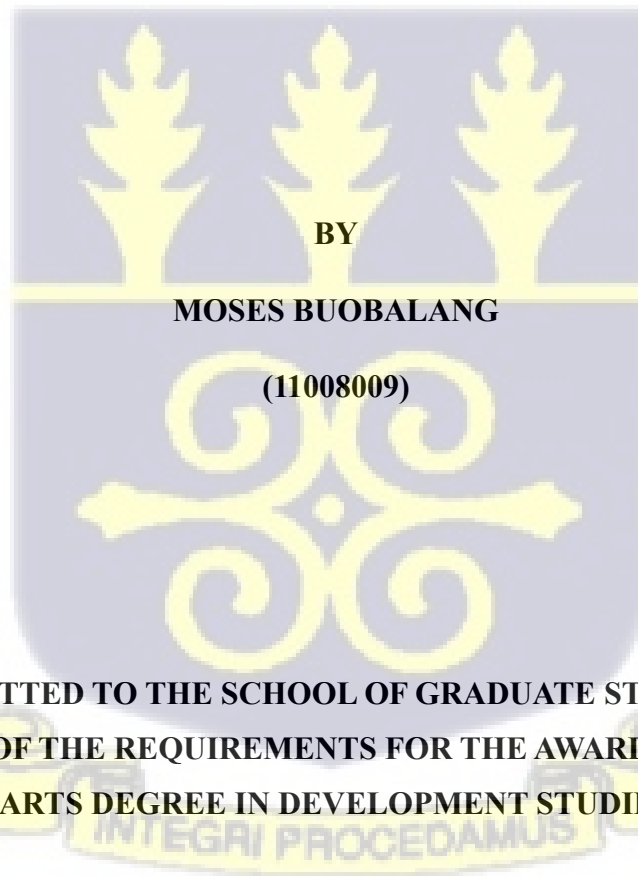


UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES

TOPIC: SUSTAINABLE DEVELOPMENT FINANCE

TITLE: SOURCE OF CLIMATE FINANCE AND ITS EFFECT ON CLIMATE ACTION AND SUSTAINABLE DEVELOPMENT: A COMPARISON OF PUBLIC AND PRIVATE CLIMATE CHANGE PROJECTS IN GA EAST MUNICIPAL ASSEMBLY(GEMA).



A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF ARTS DEGREE IN DEVELOPMENT STUDIES

INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH (ISSER)

APRIL, 2024

DECLARATION

I do hereby declare this work as mine and has not been presented by anyone for an academic award in this university or elsewhere and that all references have been duly acknowledged.

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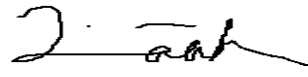
Date: 25TH APRIL, 2024



CERTIFICATION

This is to certify that this research was supervised in accordance with University of Ghana procedures

Supervisor: Andrew Agyei-Holmes (Ph.D)

Sign: 



DEDICATION

I dedicate this thesis first to God almighty for all the unexplainable events and miracles that had to bring me this far. For God and man, this work is my contribution to humanity and sustainable development.

To my beloved parents, whose unwavering love and support have been my guiding light throughout this journey. Your sacrifices and encouragement have fuelled my determination to pursue knowledge and make a meaningful contribution to the world. This thesis is dedicated to you, with deepest gratitude and love.



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ABSTRACT

In the pursuit of sustainable development, climate change presents a significant barrier with intricate linkages to many Sustainable Development Goals (SDGs). The effectiveness of projects aimed at mitigating/adapting to climate change is often contingent upon the funding sources and ownership structures involved among other factors. This study investigates the effects of climate finance on climate action and sustainable development with objectives (i) to examine how public and private climate change projects affect project design and structure in GEMA, (ii) to assess the performance of public and private owned climate change projects in GEMA, and (iii) to analyse how public and private climate change projects affect the achievement of SDGs. A case study was conducted in the Ga East Municipal Assembly (GEMA), comparing mitigation (streetlight installation) and adaptation (drainage construction) projects undertaken by the municipality (public projects) to those initiated by Homeowners Associations (private projects). A mixed-methods approach was adopted, combining quantitative surveys (120 respondents made up of 30 respondents from each of the four projects) with qualitative key informant interviews (12 stakeholders made up of 3 stakeholders from each of the four projects).

The interviews revealed significant disparities in the design of public and private projects. Public initiatives led by GEMA exhibited a structured approach to project design, involving extensive stakeholder consultations and adherence to regulatory frameworks, integrating green infrastructure for broader municipal sustainability and resilience. Private initiatives by homeowners' associations were more community-driven, emphasizing localized solutions tailored to neighbourhood-specific needs and preferences. On the performance of projects, the findings showed that both public and private projects were relevant, effective, and impactful but on different scales. Public owned projects covered broader community-wide scope while private owned projects emphasized neighbourhood level scope. However, sustainability efforts were more intentional in public projects, with GEMA implementing comprehensive maintenance plans. Also, efficiency in resource allocation was bolder in private projects compared to public projects. Regarding alignment with SDGs, both public and private projects achieved various SDGs including SDG 13, 7, 11 and 17. However, the public projects were more intentional about meeting SDGs due to the projects being integrated with national climate change policies and SDG. On the other hand, meeting some SDGs was rather unintended consequence for private projects.

In conclusion, collaborative efforts between public and private sectors are recommended to enhance effectiveness and efficiency in addressing climate change challenges. Moreover, partnerships between academia, industry, and policymakers are crucial for sharing best practices and creating an enabling environment for sustainable development.



CHAPTER ONE

INTRODUCTION

1.1 Background

The enormity of climate change challenge cannot be overstated (Haines & Patz, 2004; Leavesley, 1994; Kane, Reilly & Tobey, 1992 etc). It transcends national borders, impacting every corner of the globe and touching the lives of all its inhabitants. From the receding glaciers in the Himalayas to the intensification of hurricanes in the Atlantic, the signs of climate change are pervasive and profound (Steckel et al., 2017). The melting polar ice caps, rising sea levels, and heatwaves that were once outliers have become regular features of our climate landscape. In the face of these changes, climate change stands as one of the defining challenges of our era. The scientific consensus is unequivocal: climate change is driven primarily by human activities, particularly the emission of greenhouse gases like carbon dioxide and methane. The consequences of these emissions are not just environmental but also socioeconomic (Tol, 2009; Barnett et al., 2004). They disrupt ecosystems, jeopardize food and water security, displace communities and exacerbate inequalities (Islam, 2022; Maddison, Hamilton & Tol, 2005; Hijmans, 2003). Left unchecked, the impacts of climate change threaten to undermine progress made in health, education and poverty reduction, thus setting back decades of development efforts (Asante et al., 2015).

In recognition of the gravity of this challenge, nations around the world have rallied together to formulate strategies aimed at averting the worst effects of climate change (Ahenkan, 2020; Steckel et al., 2017). The Paris Agreement, adopted in 2015, stands as a landmark achievement in this regard. Its overarching goal to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with a preferable target of 1.5 degrees Celsius before the end of 21st century, represents a united front against climate change. But the Paris Agreement is not an isolated effort; it is part of a broader framework of international agreements and initiatives designed to stimulate climate action (Islam, 2022; Zhang et al., 2021).

At the heart of these endeavours lies climate action, a multifaceted response that encompasses mitigation and adaptation strategies (Hamilton, Maddison & Tol, 2005). Mitigation efforts aim to reduce the emissions of greenhouse gases, thereby curbing the rate of global warming. These actions span a spectrum of interventions, from transitioning to renewable energy sources and enhancing energy efficiency to reforestation and carbon capture technologies. On the other hand, adaptation strategies seek to build resilience to the inevitable impacts of climate change,

such as sea-level rise, extreme weather events, and shifts in precipitation patterns. Adaptation includes activities like strengthening infrastructure, protecting coastal communities and developing drought-resistant crops. While the goals set forth in international agreements like the Paris Agreement are aspirational, they are by no means unattainable. However, their realization hinges upon one critical factor: financial resources (Adu-Acheampong et al., 2022; Diko, 2019). The scale and complexity of climate action necessitate significant investments and without adequate financial support, the most ambitious climate targets will remain out of reach. Climate finance, the allocation of funds to projects and initiatives that tackle climate change, thus emerges as an indispensable cornerstone in the global response to climate change.

As the call for climate action intensifies, the means by which these actions are financed have come under the spotlight. Funding sources play a decisive role in shaping the scope, effectiveness, and overall impact of climate action initiatives (Islam, 2022; UNEP, 2020; UN Environment, 2018). Whether it be public funding, typically spearheaded by governments and international institutions or private capital mobilized by businesses, investors, and philanthropists, the source of climate finance is a critical determinant of the direction and success of climate action projects. The financing of climate action projects extends far beyond the mere provision of resources; it encompasses the financial mechanisms, policies, and incentives that underpin the entire climate finance landscape (Diko et al., 2021). Public financing mechanisms often involve the allocation of taxpayer funds and international aid to support climate initiatives. These resources can be substantial and play a central role in launching large-scale projects and programs. Conversely, private financing mechanisms leverage the resources of businesses, investors, and financial institutions. These sources can contribute to innovation, efficiency and the scalability of climate solutions.

Moreover, the consequences of financial decisions in the climate arena ripple beyond the realm of climate action alone. They profoundly influence broader sustainable development objectives (Schalatek & Bird, 2017; Smit et al., 2014). Sustainable development encompasses a holistic approach to societal progress, emphasizing economic prosperity, social equity, and environmental preservation. Climate action, when well-integrated with sustainable development, can yield multifaceted benefits. For instance, the transition to renewable energy not only reduces greenhouse gas emissions but also creates green jobs and improves air quality, contributing to broader social and economic goals. However, these co-benefits are not guaranteed. The type, magnitude and timing of climate investments, often contingent on the source of finance, can significantly impact whether climate projects simultaneously advance

sustainable development objectives (ODI, 2020; OECD, 2020; OECD, 2017; Sagalyn, 2007). For instance, the focus on large-scale renewable energy projects, while reducing emissions, may inadvertently overlook the local social and economic impacts in affected communities. Therefore, ensuring that climate finance is effectively aligned with sustainable development goals requires a nuanced understanding of how different funding sources and mechanisms influence the outcomes of climate projects and initiatives.

Collectively, several studies underscore the importance of enhancing financial flows, both public and private, and creating an enabling environment for effective climate change responses in Ghana. Asante et al. (2015) discuss the state of climate change finance in Ghana, analyzing the existing frameworks and challenges in accessing and utilizing funds for climate-related projects. Ahenkan (2020) provides an assessment of private sector investment opportunities in climate change mitigation, highlighting the potential of private finance in supporting Ghana's sustainability goals. Similarly, Ahenkan and Musah-Surugu (2015) examine the challenges and prospects of financing both adaptation and mitigation measures in the country, identifying key obstacles such as inadequate funding, lack of capacity, and weak policy integration. The pressing need to understand the relationship between the source of climate finance, climate action and sustainable development cannot be overstated. Climate change, as a global phenomenon with cascading impacts, requires not only immediate action but also thoughtful, informed decisions about how to deploy the limited financial resources available (Steckel, et al., 2017). Furthermore, the importance of achieving synergies between climate action and sustainable development objectives is evident in the interconnected challenges facing humanity today and especially developing countries like Ghana (Fosu Nerini et al., 2019). As the climate crisis deepens, the urgency to address its impacts and limit its progression grows. This urgency extends beyond the scientific community to encompass policymakers, businesses, civil society and individuals. It calls for informed decision-making, strategic resource allocation and a clear understanding of the implications of funding choices.

This research emerges from a recognition of the need to fill the knowledge gap surrounding climate finance's impact on climate action and sustainable development. By exploring the multifaceted relationships between funding sources, climate initiatives, and sustainable development goals, this research endeavours to contribute not only to the academic discourse but also to the practical actions taken to address climate change. The research is structured to provide a comprehensive understanding of how the source of climate finance affects the trajectory of climate action initiatives and their broader implications for sustainable

development. This study will encompass various facets of the interplay between funding sources and climate projects, from the design and scope of initiatives to their effectiveness, innovation, and alignment with sustainable development objectives.

1.2 Problem statement

Climate action, by definition, encompasses a spectrum of activities aimed at mitigating the causes of climate change and adapting to its unavoidable consequences (Diko, 2019). These actions span a wide range of interventions, from the deployment of renewable energy infrastructure and energy efficiency improvements to building climate resilience in vulnerable communities like Ghana (Fosu et al., 2019; Schalatek, 2012). At its core, climate action represents a multifaceted response to a complex and far-reaching problem. Yet, despite the critical importance of these actions, they come at a price. The implementation of climate action projects, from designing green infrastructure to initiating emissions reduction programs, necessitates substantial financial investments (Lee, Li, Yu & Zhao, 2022; G20, 2020; Pettengell, 2015; Kato, Ellis, Pauw & Caruso, 2014; Patel, 2010).

Governments, international organizations and private entities, particularly those in developing nations, often find themselves grappling with budgetary constraints that limit their ability to provide the necessary financial resources from their own coffers (Corrocher & Cappa, 2020; Hašič et al., 2015; IPCC, 2014). This funding gap underscores the importance of mobilizing climate finance from both public and private sources to bridge the divide between climate aspirations and reality. The imperative for climate finance becomes even more apparent when viewed through the lens of the Paris Agreement's ambitious goals (Schmidt-Traub & Shah, 2015). Achieving these objectives hinges on the timely and sustained investments in climate action initiatives (Diko, 2019; UN Environment, 2018). However, the nature of these investments, in terms of their type, magnitude, and timing, is often contingent on the source of finance. These variables, intricately woven into the fabric of climate finance, can significantly impact the ultimate success or failure of climate projects (Heuson, Peters, Schwarze & Topp, 2015).

Climate action, while a profound endeavour in its own right, is not a solitary pursuit. It exists within the broader context of sustainable development, a paradigm that envisions societal progress through a triad of economic prosperity, social equity, and environmental preservation (Pattberg & Widerberg, 2016). Sustainable development, in essence, seeks to balance the

imperatives of addressing contemporary needs with safeguarding the welfare of future generations. Within this holistic framework, climate action emerges as a potent tool with the potential to drive progress across multiple dimensions. The potent synergy between climate action and sustainable development hinges on the financing mechanisms underpinning climate projects (Leal, Marques & Shahbaz, 2023; Heuson, Peters, Schwarze & Topp, 2015). When well-integrated, climate actions can yield multifaceted benefits, creating positive feedback loops that extend well beyond greenhouse gas emissions reductions.

For instance, investments in renewable energy infrastructure not only reduce carbon emissions but also create green jobs, enhance energy security, and bolster local economies (Michaelowa et al., 2021; Setyowati, 2020; Cieslik, 2016). Similarly, reforestation projects aimed at carbon sequestration also preserve biodiversity, protect watersheds, and provide livelihoods to local communities (Adu-Acheampong, Kyei-Mensah & Kyerematen, 2022). The integration of climate action into the broader fabric of sustainable development holds the promise of amplifying positive outcomes, promoting social equity, and enhancing environmental stewardship. However, the realization of these co-benefits is not guaranteed (Schalatek & Bird, 2012). The way in which financial resources are allocated and managed within the climate action landscape can profoundly influence whether these actions simultaneously advance sustainable development objectives (Heuson, Peters, Schwarze & Topp, 2015). For instance, a myopic focus on large-scale renewable energy projects, while undoubtedly reducing emissions, may inadvertently overlook the localized social and economic impacts in affected communities. Conversely, insufficient investment in adaptation measures may lead to increased vulnerabilities, particularly among marginalized populations (Islam, 2022; Scandurra et al., 2020).

Several studies have contributed significantly to the understanding of how financial interventions can achieve their intended outcomes, adapt to the evolving climate landscape, and drive sustainability efforts. Climate finance effectiveness studies, such as those by Falconer and Buchner (2022), Bhandary, Gallagher and Zhang (2021), Kato, Ellis, Pauw and Caruso (2014), Forstater, Nakhooda, and Watson (2013), and Ellis, Caruso and Ockenden (2013), have collectively enriched our understanding of how climate finance initiatives can achieve impactful outcomes. Falconer and Buchner (2022) comprehensive approach emphasized stakeholder engagement, revealing that collaboration with governments, businesses, and civil society enhances the contextual relevance and impact of climate finance projects. Forstater, Nakhooda, and Watson (2013) case study of the Amazon Fund demonstrated that targeted

climate finance, guided by clear objectives and strong governance, can effectively reduce deforestation and promote sustainable land use. Kato et al. (2014) explored the scaling and replication of successful climate finance interventions, underlining their potential to accelerate climate action and sustainable development. Ellis, Caruso, and Ockenden (2013) emphasized adaptive management and monitoring processes as essential in practical climate finance implementation, recognizing the complex interactions with local communities and environmental factors. Bhandary et al. (2021) policy review highlighted the critical role of well-crafted policies in stimulating private sector investments and steering climate projects, underscoring the need for robust policy frameworks to advance sustainability. These findings collectively emphasize the significance of stakeholder collaboration, clear objectives, governance, adaptability, and effective policies in driving successful climate finance projects that contribute to environmental preservation, social equity, and economic development while aligning with broader sustainability objectives.

The Ga East Municipal Assembly (GEMA) faces significant climate challenges, including urban sprawl, rising temperatures, and increased flooding, which threaten its socioeconomic and environmental stability (Frimpong, Atiemo, & Van Etten, 2022). Climate change interventions within GEMA must balance the need for broad, government-led projects and community-driven initiatives to address these growing vulnerabilities. Urban planning efforts in Ghana often fall short in integrating climate resilience, with weak enforcement of regulations and limited stakeholder engagement compounding these issues (Cobbinah et al., 2019). Additionally, systemic barriers such as inadequate funding, institutional inefficiencies, and limited access to climate adaptation resources hinder the ability of local governments to implement effective measures (Antwi-Agyei, Dougill, & Stringer, 2015). While Ghana has made strides in climate action, including the adoption of national adaptation policies, variability in climate conditions and localized challenges, such as those in GEMA, underscore the need for targeted interventions to bridge the gap between policy and implementation (Asante & Amuakwa-Mensah, 2014). This context highlights the importance of assessing public and private climate finance strategies to ensure effective, sustainable, and equitable climate interventions in GEMA.

Amid the urgency to address climate change through both mitigation and adaptation efforts, a compelling need arises for a study comparing the effectiveness and sustainability of public versus private climate finance. Public climate finance, often channelled through governmental and international institutions, assumes a pivotal role in tackling global climate challenges,

demanding scrutiny of its efficiency, administrative accountability, and alignment with Sustainable Development Goals (SDGs). Conversely, private climate finance, primarily profit-driven, holds the potential to expedite the deployment of green technologies but requires rigorous oversight to avert market failures, ensure community co-benefits, and safeguard the environment. The urgency of this comparative study lies in recognizing the indispensable roles of both sources in achieving climate goals: public finance offers stability and long-term planning, particularly for projects with lasting benefits but delayed profits, while private finance injects innovation, efficiency, and rapid deployment capabilities. Identifying the strengths and weaknesses of each approach, this research equips policymakers, investors, and practitioners with essential insights to navigate the complexities of climate finance and steer effective climate action, transcending boundaries, sectors, and generations, to create a resilient and equitable future in the face of climate's multifaceted challenges.

1.3 Objectives of the study

- i. To examine how public and private sources of climate finance affect the design and structure of climate action initiatives.
- ii. To assess how public and private sources of climate finance influence the performance of climate change interventions.
- iii. To examine how public and private climate finance affects the alignment of climate projects with sustainable development goals.

1.4 Significance of the study

In pursuit of these objectives, this research seeks to contribute meaningfully to the dialogue surrounding climate finance and its role in advancing climate action and sustainable development. The significance of this study transcends its academic merit; it holds immense practical implications for stakeholders across the climate and development spectrum. Several key aspects highlight its significance:

- i. ***Informed Decision-Making:*** This research will empower policymakers, climate financiers, and project managers with a nuanced understanding of how funding sources affect climate action initiatives. In doing so, it equips them to make more informed

decisions when crafting climate finance strategies and directing resources towards projects that have the greatest potential for success.

- ii. ***Optimizing Climate Investments:*** The findings of this study may offer insights into strategies for optimizing climate investments. By identifying which financing models are more effective in specific contexts, stakeholders can channel resources where they are most likely to generate positive outcomes, thereby maximizing the impact of climate projects.
- iii. ***Promoting Sustainable Development:*** Sustainable development remains a global priority. This study will provide valuable insights into how climate finance can be harnessed not only for climate mitigation and adaptation but also for the broader objectives of sustainable development, such as poverty reduction, gender equality, and clean energy access.
- iv. ***Policy Enhancement:*** The policy recommendations generated by this research aim to guide policymakers and financiers in devising effective and equitable climate finance policies. These recommendations are a vital tool for ensuring that climate finance contributes positively to both climate action and sustainable development.

In summary, this research holds substantial significance by bridging the knowledge gap between climate finance, climate action, and sustainable development. It aims to offer practical insights and solutions that can contribute to more effective and integrated approaches for addressing climate change while promoting broader societal well-being.

1.5 Scope of the study

- i. ***Geographical Scope:*** This research is focused specifically on the Ga East District of Greater Accra Region, Ghana. It examines climate projects in this district funded by both public and private sources. Ga East District is known for its unique socio-economic and environmental characteristics compared to other districts in Greater Accra, which makes it an ideal case study to explore the impact of climate finance sources on project outcomes.
- ii. ***Types of Climate Projects:*** The research considers both mitigation and adaptation climate projects within the study area. It aims to provide a comprehensive analysis of the effects of public and private climate finance on a variety of projects related to waste management, energy, drainage, and tree planting.

- iii. ***Quantitative and Qualitative Analysis:*** The research combines quantitative data analysis and qualitative assessments to gain a holistic understanding of how climate finance sources influence project structures, designs, performance, and SDGs outcomes.
- iv. ***Comparison of Public and Private Climate Finance:*** This study explores the differences in project outcomes between those financed by public and private sources, considering project scope, design, performance, and SDGs contributions.

1.6 Structure of the study

This thesis is structured into five aspects. The first chapter is an introduction made up of the study background, the problem statement, the research objectives, the significance of the study, and the scope and limitations of the study. The second chapter covers literature review; discussing theoretical and empirical literature relevant to the topic. The study methodology which details how the research objectives are achieved is made up of the chapter three as the study analysis and interpretation of data is presented in chapter four. The final chapter which is chapter five summarizes the findings of the study, makes conclusions based on the study findings and provides recommendations based on the findings.

1.7 Limitations of the Research:

- i. ***Generalizability:*** The findings of this research may not be readily generalizable to other regions or countries due to the specific context of the Ga East Municipal Assembly. The socio-economic, cultural, and environmental conditions in other areas could yield different results.
- ii. ***Data Availability:*** Data limitations, particularly for privately financed projects, affected the comprehensiveness of the analysis. Private sector entities keep less data and were less transparent in sharing data on their projects, which hinder a complete assessment.
- iii. ***Causality vs. Association:*** The research identified associations between climate finance sources and project outcomes, but establishing causality is challenging. Various factors can influence project performance, and isolating the impact of finance sources may not always be straightforward.

- iv. ***Dynamic Nature of Projects:*** Climate projects are often long-term and subject to changing circumstances. This research provides a snapshot of project outcomes at a specific point in time and might not capture their full life cycle.
- v. ***Bias in Data Collection:*** Despite efforts to maintain objectivity, there might have been unintentional bias in data collection, particularly in qualitative assessments. Researcher subjectivity and the perspectives of project stakeholders could influence data interpretation.
- vi. ***Resource Constraints:*** The depth and breadth of the research were influenced by resource constraints, including time, funding, and access to certain data sources. These limitations impacted the level of detail and comprehensiveness of the analysis.
- vii. ***External Factors:*** Climate projects can be affected by external factors, such as policy changes or global economic conditions. These external factors were not fully accounted for in the analysis.

Despite these limitations, the research provides valuable insights into the effects of public and private climate finance on climate projects and their contributions to Sustainable Development Goals (SDGs) in the Ga East Municipal Assembly of Accra. The findings can inform more targeted and effective climate finance strategies and project implementations in the study area and potentially offer lessons for similar contexts.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter involves a critical summary and evaluation of existing research and scholarly articles related to the topic and research objectives. It serves several purposes, including providing context for the research, identifying gaps in the current literature, and showcasing understanding of the subject matter. This study looks at the effects of public and private sources of funding on climate action and their implications for SDGs outcomes in the Ga East Municipal Assembly of Ghana. The discussions centre on the public sector versus private sector debate to ascertain the best approach to mitigation and adaptation projects in Ghana. Literature on sustainable development, climate change, climate finance and climate change mitigation/adaptation are reviewed to see what studies has been done, how the studies were carried out, what the studies found and what gaps remain to be filled. The chapter first discusses various concepts relevant to the study as an overview and then both theoretical and empirical studies relevant to the topic under study are discussed and examined.

2.2 Overview of Concepts

Climate change, driven primarily by human activities, has emerged as one of the most pressing global challenges of the 21st century (Caney, 2015). Its far-reaching impacts, from rising global temperatures and melting ice caps to increasingly frequent and severe climate-related disasters, demand urgent and coordinated efforts on a scale previously unseen (Houghton, Callander & Varney, 1992). As the world grapples with these environmental transformations, it is becoming increasingly evident that addressing climate change is not just about preserving the environment but also about fostering sustainable development that ensures the well-being of present and future generations (Wuebbles, 2018).

Climate action, a multifaceted response encompassing both mitigation and adaptation strategies, has risen to prominence as the foundation of our collective efforts to combat climate change (Tol, Downing, Kuik & Smith, 2004). It seeks not only to reduce greenhouse gas emissions but also to adapt to the inevitable impacts of climate change, such as sea-level rise, extreme weather events and shifts in precipitation patterns. Climate action is not a singular

endeavour; rather, it encompasses a spectrum of activities and initiatives aimed at safeguarding our planet's fragile climate system (Wuebbles, 2018).

Yet, at the heart of climate action initiatives lies financial resources which is a critical factor driving the implementation of projects, the deployment of technologies, and the development of strategies to mitigate and adapt to climate change. Without adequate financial support, the lofty goals articulated in international agreements like the Paris Agreement would remain mere aspirations, lacking the means for realization (Steckel et al., 2017).

2.2.1 Climate Change: A Global Crisis

The long-term shifts in weather patterns and temperatures is termed climate change. Evidence and signs of climate change are increasingly apparent across the globe, manifesting in various climatic phenomena and environmental shifts (Thompson et al., 2002; Tol et al., 2004). From the melting of polar ice caps to the intensification of extreme weather events, these observable changes serve as stark reminders of the planet's changing climate (Thompson, 2000). Scientific consensus attributes the primary causes of climate change to human activities, particularly the emission of greenhouse gases such as carbon dioxide and methane through industrial processes, deforestation, and the burning of fossil fuels (Noguer et al., 2001). These emissions result in the thickening of the Earth's atmosphere, trapping heat and leading to a steady rise in global temperatures. The effects of climate change extend far beyond mere temperature increases, encompassing ecological imbalances, disruptions to ecosystems, rising sea levels, shifts in precipitation patterns, and exacerbation of extreme weather events. As such, understanding the evidence, causes, and effects of climate change is imperative for devising effective strategies to mitigate its impacts and foster a more sustainable future for generations to come.

2.2.2 Evidence of Climate Change

Evidence of climate change is compelling and multifaceted, drawing from a diverse array of scientific studies conducted across different regions and disciplines. Ice core analyses, as demonstrated by Thompson (2000) and Thompson et al. (2002), offer crucial insights into past climatic variations by examining isotopic compositions and trace elements within ice cores extracted from glaciers. These studies reveal significant shifts in temperature and precipitation patterns in tropical regions, providing tangible evidence of climate change's impacts on previously stable environments.

Satellite observations, as highlighted by Norris et al. (2016), provide another valuable source of evidence, capturing changes in cloud cover dynamics that correlate with global climate change trends. By analysing satellite data over extended periods, researchers can discern patterns of cloud behaviour indicative of shifting climate conditions, further corroborating findings from other sources.

Regional studies offer localized evidence of climate change and its effects on ecosystems and communities. Dash et al. (2007) document observable climate change trends in India, including alterations in temperature and precipitation patterns over the twentieth century. Similarly, Ngaina and Mutai (2013) present observational evidence of climate change impacts on extreme weather events in East Africa, where changing rainfall patterns and increased frequency of droughts and floods are observed.

Palaeoclimatological studies, such as those conducted by Scott et al. (2012), delve into the geological past to reconstruct historical climate changes. By analysing terrestrial fossil-pollen records in Southern Africa spanning thousands of years, researchers uncover evidence of climatic fluctuations and their effects on ecosystems over time. These studies provide valuable context for understanding the long-term dynamics of climate change and its potential implications for future environmental conditions.

Overall, the convergence of evidence from diverse scientific disciplines underscores the reality of climate change and its far-reaching consequences. From ice core analyses to satellite observations and palaeoclimatological reconstructions, researchers continue to refine our understanding of climate change dynamics and inform efforts to address this pressing global challenge.

2.2.3 Causes of Climate Change

The causes of climate change are multifaceted, influenced by both natural variability and human activities. Crowley (2000) delves into the factors shaping climate over the past millennium, highlighting natural phenomena such as volcanic eruptions, solar variability, and internal climate dynamics driven by ocean-atmosphere interactions. These natural influences can lead to short-term fluctuations in climate patterns, contributing to variability observed in historical records.

Stern and Kaufmann (2014) emphasize the significant role of human activities as drivers of climate change, particularly through the emission of greenhouse gases (GHGs) such as carbon

dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Industrial processes, deforestation, agriculture, and the burning of fossil fuels release vast quantities of GHGs into the atmosphere, leading to the enhanced greenhouse effect. This process traps heat within the Earth's atmosphere, causing global temperatures to rise over time.

Hegerl et al. (2019) further explore the interplay between natural and anthropogenic factors in shaping climate change over the historical record. While natural influences have historically played a significant role in driving climate variability, the rapid increase in GHG concentrations due to human activities has become the dominant force behind recent warming trends. This anthropogenic forcing has far-reaching impacts on climate systems, ecosystems, and global weather patterns. Robock (1978) contributes to the discussion by examining both internally and externally caused climate change. Internal dynamics within the climate system, such as ocean circulation patterns and atmospheric circulation changes, can influence climate variability on various timescales. External forcings, including volcanic eruptions, variations in solar radiation, and human-induced emissions, also play a significant role in driving climate change.

Ding et al. (2007) provide insights into regional variations in the causes of climate change, focusing specifically on China. They highlight the contributions of both local emissions and global factors to China's changing climate, underscoring the interconnectedness of regional and global climate systems. Matata and Adan (2018) shed light on the causes of climate change in Africa, emphasizing the complex interactions between natural processes and anthropogenic activities. Factors such as deforestation, land-use changes, and population growth contribute to GHG emissions and alter regional climate patterns, exacerbating the continent's vulnerability to climate impacts.

Overall, these studies collectively illustrate the diverse and interconnected causes of climate change, underscoring the need for concerted global efforts to mitigate emissions, adapt to changing conditions, and build resilience in the face of ongoing environmental challenges.

2.2.4 Effects and Impacts of Climate Change

The effects and impacts of climate change are increasingly apparent across various sectors, with profound implications for both human societies and natural ecosystems. Nkomo, Nyong, and Kulindwa (2006) shed light on the multifaceted challenges faced by Africa, where climate change exacerbates existing vulnerabilities in agriculture, water resources, and human health. In the agricultural sector, changing rainfall patterns, rising temperatures, and increased

frequency of extreme weather events disrupt traditional farming practices, leading to reduced crop yields and food insecurity (Van Oort & Zwart, 2018; Ngaira, 2007). These impacts reverberate throughout the continent, affecting livelihoods, exacerbating poverty, and undermining efforts to achieve sustainable development.

Moreover, the economic consequences of climate change are far-reaching, as highlighted by Tol (2018). Shifts in agricultural productivity, resource availability, and market dynamics pose significant challenges for economies reliant on agriculture, exacerbating inequalities and increasing the costs of adaptation and mitigation efforts. Bellard et al. (2012) draw attention to the threat posed to biodiversity, with climate change driving species extinctions, altering habitats, and disrupting ecosystems worldwide. These changes have cascading effects on ecosystem services, such as pollination, pest control, and carbon sequestration, upon which human societies depend for their well-being.

In addition to environmental and economic impacts, climate change poses significant risks to human health (Haines & Patz, 2004). Rising temperatures contribute to heat-related illnesses, exacerbate respiratory conditions, and increase the spread of vector-borne diseases such as malaria and dengue fever. Furthermore, changes in precipitation patterns and extreme weather events lead to waterborne diseases, foodborne illnesses, and malnutrition, particularly in vulnerable populations lacking access to clean water, sanitation, and healthcare services.

Leavesley (1994) underscores the importance of understanding the effects of climate change on water resources, given their critical role in supporting ecosystems, agriculture, industry, and human populations. Changes in precipitation patterns, melting glaciers, and altered runoff regimes affect water availability, quality, and distribution, leading to conflicts over water resources and exacerbating water stress in arid and semi-arid regions.

A 2007 IPOC Change-Agenda study mentions several repercussions of climate change generally feared. A closer look at these multifaceted repercussions reveals the gravity of the challenge at hand:

- i. ***Ecosystem Disruption:*** Climate change's cascading effects disrupt ecosystems on a global scale. With the rising temperatures, various species grapple with the daunting task of adapting to these new environmental conditions, causing shifts in their distribution and migration patterns (Akpodiogaga-a & Odjugo, 2010). This, in turn, leads to alterations in biodiversity and imbalances in the delicate web of life on Earth.

- ii. **Food and Water Security:** The stability of food and water supplies is profoundly threatened by climate change. Shifts in precipitation patterns, prolonged droughts, and extreme weather events create a precarious environment for agriculture (Wheeler, & Von Braun, 2013). Scarcer water resources and heightened competition for these vital elements affect food production, leading to scarcity and food crises, particularly in vulnerable regions.
- iii. **Biodiversity Loss:** Climate change accelerates the loss of biodiversity as species struggle to adapt to changing conditions (McNutt, 2013). This not only has ecological repercussions but also directly impacts human communities that depend on diverse ecosystems for their livelihoods and well-being. The consequences are far-reaching, affecting processes such as pollination and pest control.
- iv. **Inequality Exacerbation:** Climate change amplifies existing social and economic inequalities (Tol, 2018). Vulnerable communities, often situated in economically disadvantaged regions, face the harshest consequences, given their limited resources and inadequate infrastructure to adapt to or recover from climate-related disasters. These disparities deepen the chasm between the privileged and marginalized within and between nations.
- v. **Sea-Level Rise:** The melting ice caps and thermal expansion of seawater contribute to the inexorable rise in sea levels (McNutt, 2013). This not only endangers coastal communities but also leaves coastal infrastructure, cities, and ecosystems at the mercy of flooding. Coastal inundation leads to property loss and carries enormous economic and human costs.
- vi. **Extreme Weather Events:** Climate change ushers in a new era of more frequent and severe extreme weather events. Prolonged droughts, intensified hurricanes, record-breaking heatwaves, and devastating wildfires disrupt communities, infrastructure, and economies, leading to both immediate and long-term consequences (Hitz & Smith, 2004).
- vii. **Conflict, Migration, and Resource Scarcity:** Climate change acts as a catalyst for conflict, migration, and resource scarcity (Tol et al., 2004). As changing conditions strain essential resources like water and arable land, competition and conflict over these limited resources can escalate. Populations are forced to migrate due to the loss of their homes or livelihoods, resulting in conflict over these resources and further destabilizing regions.

Overall, the effects and impacts of climate change are complex and interconnected, posing profound challenges to societies, economies, and ecosystems worldwide. Addressing these challenges requires urgent and coordinated action at local, national, and global levels to mitigate greenhouse gas emissions, build resilience, and adapt to the changing climate.

2.2.5 Climate Change in Ghana

Analysing rainfall patterns and temperatures serves as critical evidence in substantiating the reality of climate change. Shifts in these climatic variables provide tangible indicators of the Earth's changing climate dynamics, reflecting the influence of anthropogenic activities on global ecosystems. Through meticulous examination of historical data and contemporary trends, scientists can discern patterns of variation and identify long-term changes in rainfall distribution and temperature regimes. Understanding how these climatic parameters evolve over time is paramount for comprehensively assessing the impacts of climate change and formulating effective mitigation and adaptation strategies to safeguard communities and ecosystems worldwide.

Temperature:

Analysing temperature records in Ghana provides compelling evidence of climate change's impact on the country's climate system. Over the past few decades, temperature data collected from weather stations across Ghana have revealed a clear warming trend, reflecting broader global patterns (Asare-Nuamah & Botchway, 2019). These records demonstrate that Ghana, like many other regions, is experiencing rising temperatures, with both daytime and nighttime temperatures showing an upward trajectory. This warming trend is particularly concerning as it exacerbates existing challenges faced by Ghana's agricultural sector, water resources, and public health systems.

The temperature records in Ghana also highlight the variability and unpredictability of the country's climate, with fluctuations in seasonal temperatures becoming more pronounced (see figure 1 below). Shifts in rainfall patterns and increasing frequency of extreme weather events further compound the impacts of rising temperatures (Asante & Amuakwa-Mensah, 2014). For instance, prolonged heatwaves and droughts can adversely affect crop yields and water availability, posing significant threats to food security and livelihoods, especially in rural areas where agriculture serves as the primary source of income for many Ghanaians. Conversely, heavy rainfall and flooding events can lead to infrastructure damage, loss of property, and displacement of communities, underscoring the urgent need for climate resilience measures.

Moreover, temperature records offer insights into the localized impacts of climate change within specific regions of Ghana, such as the Greater Accra Region (Bessah et al., 2018). As urbanization and industrialization accelerate in this region, temperature records reflect the urban heat island effect, where urban areas experience higher temperatures compared to surrounding rural areas due to human activities and infrastructure (Klutse, Owusu & Boafo, 2020). Addressing climate change in Ghana requires concerted efforts to mitigate greenhouse gas emissions, implement sustainable land use practices, and enhance adaptive capacity to cope with its impacts effectively. By leveraging temperature records and other climate data, policymakers and stakeholders can develop evidence-based strategies to build resilience and foster sustainable development in the face of a changing climate. Figure 1 shows the average annual temperatures in Ghana which has been inconsistent and vary year-in-year-out.

Figure 1: Trend of Temperature in Ghana's Ecological Zones

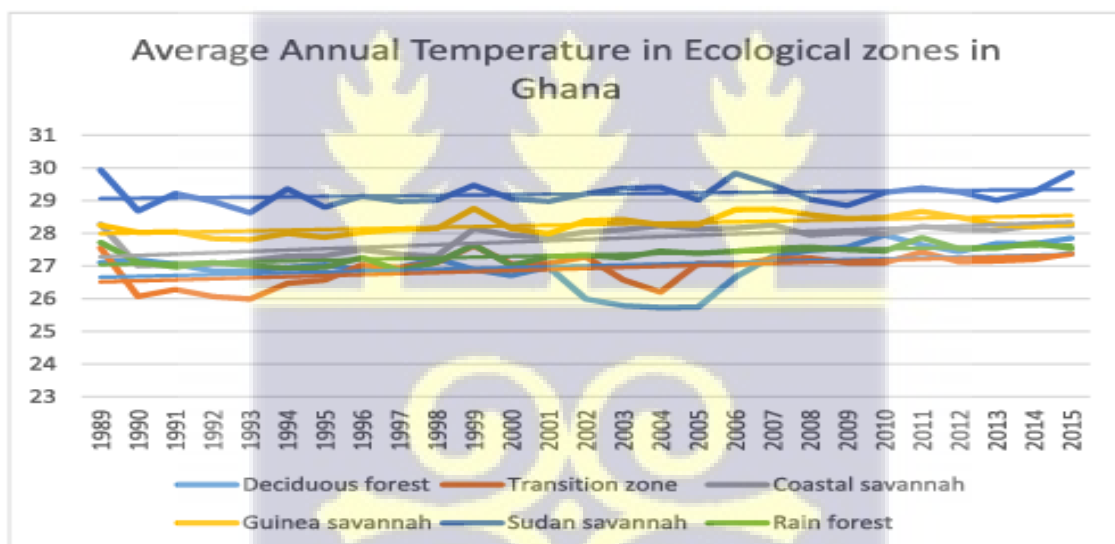


Fig. 9. Trend of temperature in ecological zones.

Source; Asare-Nuamah and Botchway, (2019).

Rainfall:

Climate change is profoundly impacting rainfall patterns in Ghana, presenting challenges to agriculture, water resources, and ecosystems across the country. Historical rainfall data reveals significant shifts in precipitation patterns, with changes in both the timing and distribution of rainfall events (Issahaku, Champion & Edziyie, 2016). In recent years, Ghana has experienced erratic rainfall patterns, characterized by prolonged dry spells interspersed with intense rainfall events (see figure 2). These shifts disrupt agricultural activities, affecting crop yields and exacerbating food insecurity, particularly in rural areas where subsistence farming is prevalent.

The variability in rainfall patterns also heightens the risk of extreme weather events such as floods and droughts, which have become more frequent and severe in many regions of Ghana (Abbam et al., 2018). Floods, often triggered by heavy rainfall, inundate communities, damage infrastructure, and cause loss of lives and livelihoods (Abbam et al., 2018). Conversely, prolonged droughts lead to water scarcity, affecting access to clean water for drinking, sanitation, and irrigation purposes. These climatic extremes underscore the vulnerability of Ghana's population to the impacts of climate change and highlight the urgent need for adaptation strategies to build resilience and mitigate risks.

Furthermore, changes in rainfall patterns have far-reaching implications for Ghana's ecosystems and biodiversity (Klutse, Owusu & Boafo, 2020). Shifts in precipitation regimes disrupt habitats, alter vegetation dynamics, and threaten the survival of plant and animal species. In particular, Ghana's forests, wetlands, and coastal ecosystems are vulnerable to the impacts of altered rainfall patterns, jeopardizing their ecological integrity and the services they provide to local communities. Addressing climate change in Ghana requires holistic approaches that integrate sustainable land management practices, water resource management strategies, and community-based adaptation initiatives to mitigate the adverse effects of changing rainfall patterns and foster climate resilience. Figure 2 shows how unpredictable rainfall patterns are in Ghana.

Figure 2: Trend of Rainfall in Ghana's Ecological Zones

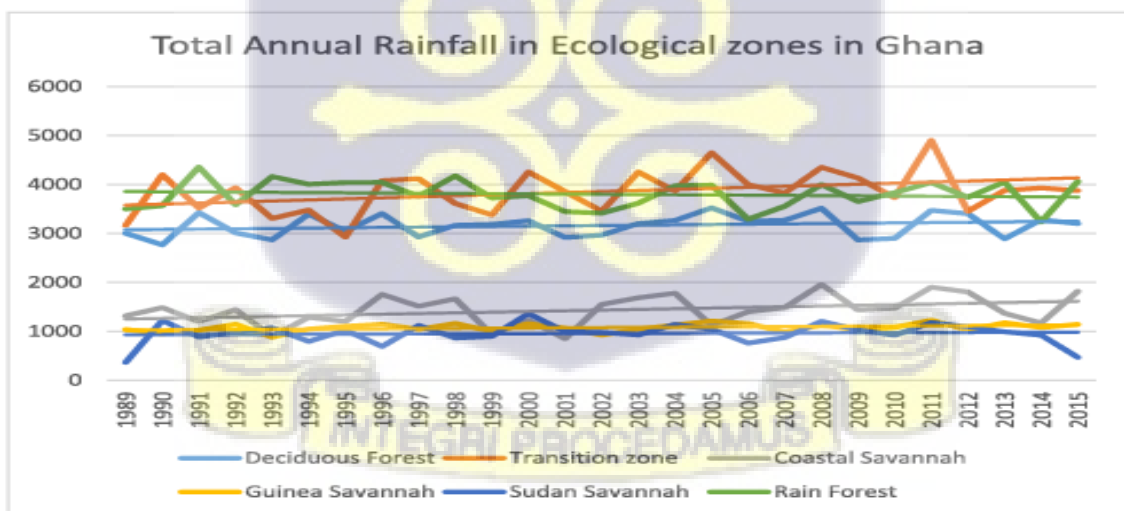


Fig. 8. Trend of rainfall in ecological zones.

Source; Asare-Nuamah and Botchway, (2019).

Thus, the analysis of rainfall patterns and temperatures offers compelling evidence of climate change's tangible impacts on the Earth's climate system. Through historical records, satellite observations, and advanced modelling techniques, scientists can discern discernible trends indicating a warming planet and altered precipitation regimes. These changes have profound implications for ecosystems, agriculture, water resources, and human societies, underscoring the urgent need for concerted global action to address climate change. By leveraging scientific insights derived from the analysis of rainfall and temperature data, policymakers, stakeholders, and communities can develop informed strategies to mitigate greenhouse gas emissions, enhance resilience, and foster sustainable development in the face of a rapidly changing climate.

2.2.6 Climate Change Response: Uniting Against Climate Change

Acknowledging the climate change challenge, nations worldwide have joined forces in an unprecedented effort to formulate strategies and solutions aimed at averting the most devastating effects of this global crisis (Ziervogel et al., 2014). At the heart of this collective endeavour lies the Paris Agreement, a monumental milestone in the quest to combat climate change, adopted in 2015. Its overarching goal, to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with a preferable target of 1.5 degrees Celsius, symbolizes a united and resolute front against the escalating threat of climate change. The Paris Agreement, however, does not stand alone; it is part of a comprehensive framework of international agreements and initiatives designed to galvanize climate action at the global, national, and local levels (Seo, 2017).

The urgency to address climate change cannot be overstated. While mitigation efforts aim to curb greenhouse gas emissions to prevent further warming, adaptation strategies are designed to enhance resilience to the impacts that are already in motion (Segger, 2016). These impacts include the rise in sea levels, the growing frequency and severity of heatwaves, altered patterns of precipitation, and disruptions to the intricate balance of ecosystems. The consequences of inaction are dire and far-reaching, with the potential to undo the hard-won progress achieved in various critical domains, such as health, education, poverty reduction, and social stability (Klutse, Owusu & Boafo, 2020).

The Paris Agreement, as a flagship of international cooperation, embodies the world's shared commitment to addressing the climate crisis head-on. It underscores the belief that by working collectively, nations can marshal the resources and expertise needed to forge a path toward a

more sustainable and resilient future (Seo, 2017). By setting ambitious targets for limiting global warming, the agreement calls for immediate, drastic reductions in greenhouse gas emissions, urging the world to depart from its fossil fuel-driven past and embrace the transition to cleaner, more sustainable energy sources.

Yet, the Paris Agreement is only one component of a broader web of international agreements and initiatives designed to address climate change on multiple fronts. It serves as a foundation upon which nations can build a comprehensive approach, reinforcing their commitments through domestic policies, innovation, and the collaboration of governments, industries, and civil society. The imperative for a coordinated response to climate change cannot be emphasized enough. The challenges we face are so interconnected and interdependent that no single nation or entity can tackle them in isolation. A unified global effort is essential, as the impacts of climate change reach across borders, affecting ecosystems, economies, and societies worldwide (Wuebbles, 2018).

Mitigation efforts, focusing on reducing greenhouse gas emissions, are vital to curbing the progression of climate change. However, they must be complemented by adaptation strategies that enable communities to withstand and adapt to the impacts already underway (VijayaVenkataRaman, Iniyar, & Goic, 2012). These impacts encompass not only environmental shifts but also social, economic, and health-related challenges. Sea-level rise threatens coastal communities, more frequent and severe heatwaves endanger lives, and alterations in precipitation patterns disrupt agriculture and water resources. These changes have the potential to unravel the progress made in areas like healthcare, education, poverty reduction, and social stability, further underscoring the urgent need for coordinated action (Chen, Suzuki, & Lackner, 2017).

Thus, the imperative for a coordinated response to climate change is an irrefutable call to action. The Paris Agreement serves as a beacon of hope, highlighting the potential for global unity in the face of this monumental challenge. By collectively embracing the targets and principles of this agreement, nations can not only mitigate the dire impacts of climate change but also foster a more sustainable and resilient world for current and future generations. This unified response is essential to safeguard the well-being of our planet and all its inhabitants.

2.2.6.1 Mitigation Efforts: Addressing the Root Causes of Climate Change

Mitigation efforts are pivotal strategies aimed at addressing the core causes of climate change by systematically reducing the emission of greenhouse gases into the Earth's atmosphere. These

gases, chiefly carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), are the byproducts of human activities that include burning fossil fuels for energy, deforestation, and various industrial processes (Chen, Suzuki, & Lackner, 2017). The primary goal of mitigation is to curb these emissions through a range of comprehensive strategies that not only mitigate climate change but also usher in a more sustainable and environmentally responsible way of living. Some mitigation actions include transition to renewable energy, energy efficiency, reforestation and afforestation, carbon capture and sequestration and transition to sustainable agriculture (VijayaVenkataRaman, Iniyan, & Goic, 2012; Chen, Suzuki, & Lackner, 2017).

- i. **Transition to Renewable Energy:** A cornerstone of mitigation strategies is the transition from fossil fuels to renewable energy sources like solar, wind, and hydropower (Chen, Suzuki, & Lackner, 2017). This shift is revolutionary in reducing the carbon footprint associated with energy generation and effectively lowering greenhouse gas emissions. By harnessing these clean, sustainable sources of energy, societies can significantly diminish their reliance on fossil fuels and the carbon emissions they produce.
- ii. **Energy Efficiency:** Another key aspect of mitigation involves enhancing energy efficiency across industrial, residential, and commercial sectors (VijayaVenkataRaman, Iniyan, & Goic, 2012). By reducing energy consumption, we can effectively cut down on the associated greenhouse gas emissions. This can be achieved through various means, such as upgrading building insulation to reduce heat loss, optimizing industrial processes to minimize energy waste, and encouraging the use of fuel-efficient modes of transportation.
- iii. **Reforestation and Afforestation:** Trees play a vital role in mitigating climate change by acting as carbon sinks, capturing and storing carbon dioxide from the atmosphere (Ingham, Ma & Ulph, 2007). Reforestation, the process of replanting trees in deforested areas, and afforestation, the practice of planting trees in regions that were not previously forested, are essential techniques for sequestering carbon and mitigating climate change. These actions help rebuild and expand forested areas, restoring a crucial natural mechanism for carbon absorption.
- iv. **Carbon Capture and Storage (CCS):** CCS technologies are designed to capture carbon dioxide emissions generated by industrial processes and power plants (Ussiri & Lal, 2017; Locatelli et al., 2015). Once captured, these emissions are stored underground, preventing their release into the atmosphere. CCS is a critical strategy for addressing

emissions from sectors that are difficult to decarbonize rapidly, helping to reduce the overall carbon footprint of various industries.

- v. ***Shift to Sustainable Agriculture:*** The agricultural sector is another significant contributor to greenhouse gas emissions, particularly from activities like tilling and livestock farming (Laukkonen et al., 2009). Sustainable agricultural practices, such as no-till farming and precision agriculture, emphasize reduced emissions, improved soil health, and enhanced resource efficiency. These practices not only lower emissions from agriculture but also promote food security and environmental sustainability.

Mitigation efforts represent a multifaceted approach to addressing climate change at its source, focusing on reducing greenhouse gas emissions that drive global warming. By combining these strategies and adopting them on a global scale, we can work toward a more sustainable, climate-resilient future, while also mitigating the most detrimental effects of climate change. Mitigation is not only a way to combat the root causes of climate change but also to lay the foundation for a more environmentally conscious and sustainable way of life.

2.2.6.2 Adaptation Strategies: Strengthening Resilience in a Changing Climate

As climate change's impacts become increasingly evident and its effects more pronounced, adaptation strategies play a pivotal role in addressing the challenges that are already underway (VijayaVenkataRaman, Iniyar, & Goic, 2012). These strategies are a proactive response to the reality that climate change is happening now, and we must prepare ourselves, our communities, and our environments to withstand and respond to these changes. Adaptation encompasses a diverse array of actions and initiatives designed to protect communities, ecosystems, and infrastructure in the face of an evolving climate (Ingham, Ma & Ulph, 2007).

- i. ***Climate-Resilient Infrastructure:*** One cornerstone of adaptation is the construction of climate-resilient infrastructure. This involves building and retrofitting structures capable of withstanding the impacts of climate change, including rising sea levels, extreme weather events, and heightened temperatures. Measures such as constructing flood defences, implementing stricter building codes, and designing transportation systems that can withstand flooding and extreme weather conditions are essential components of building climate resilience (Solecki et al., 2015).
- ii. ***Ecosystem-Based Adaptation:*** Preserving and restoring critical ecosystems like wetlands, mangroves, and forests constitutes a natural defence against climate change impacts. These ecosystems serve as invaluable shields, providing protection against

flooding, erosion, and habitat disruptions. By safeguarding and enhancing these natural assets, communities can bolster their resilience to climate change and reduce vulnerability to its effects.

- iii. ***Water Resource Management:*** Sustainable water resource management practices are paramount for ensuring reliable access to water resources, even amidst shifting precipitation patterns and an increased frequency of droughts (Sharifi, 2020). Developing strategies to optimize water storage, distribution, and conservation can help maintain a stable and secure water supply in a changing climate, a vital necessity for both human communities and ecosystems.
- iv. ***Agricultural Adaptation:*** The agricultural sector, heavily influenced by climate conditions, is central to adaptation efforts. Climate-smart agricultural practices, such as crop diversification, the development of drought-resistant crop varieties, and improved soil management, are crucial for maintaining food security under changing climate conditions (Sharifi, 2020). These measures allow farmers to adapt to shifting growing seasons and emerging challenges.
- v. ***Community Engagement:*** Successful adaptation strategies often centre on community engagement, recognizing that local communities possess unique knowledge and needs. Involving these communities in the planning and implementation of adaptation initiatives can lead to more effective and sustainable outcomes. Local knowledge and practices, along with community input, are invaluable in tailoring adaptation strategies to the specific needs and vulnerabilities of the people affected (Halsnæs & Verhagen, 2007).

Adaptation strategies are a fundamental component of a comprehensive response to climate change. By focusing on building resilience, these strategies help protect communities, ecosystems, and infrastructure from the inevitable impacts of climate change. They represent a forward-looking approach, acknowledging that climate change is not just a future threat but a present reality. Combining adaptation strategies with mitigation measures allows us to tackle climate change from both ends: by reducing its causes and by strengthening our ability to cope with its effects.

As the challenges of climate change continue to unfold, it is imperative that societies, governments, and organizations adopt these adaptation strategies alongside mitigation efforts. Together, they form a holistic and robust response to the complexities of a changing climate, safeguarding our well-being, the environment, and the prosperity of future generations.

2.2.7 The Role of Financial Resources in Climate Action

In the complex landscape of climate action, the availability and allocation of financial resources play a pivotal role in determining the success of both mitigation and adaptation efforts. Climate-related projects, require funding across various stages, including research, development, deployment, and long-term maintenance (Giglio, Kelly, & Stroebel, 2021). The United Nations Framework Convention on Climate Change (UNFCCC) formally defines climate finance as "local, national, or transnational financing drawn from public, private, and alternative sources of finance that seeks to support mitigation and adaptation actions that will address climate change." In essence, climate finance represents the financial backbone of our climate action efforts, a resource to fund projects and policies that are vital for combatting climate change (Hong, Karolyi & Scheinkman, 2020).

Climate finance, encompassing both public and private investments aimed at mitigating and adapting to climate change, plays a pivotal role in addressing the impacts of global warming and fostering sustainable development. Several studies have examined the effects and impacts of climate finance from various perspectives, shedding light on its multifaceted contributions to climate action and resilience-building efforts.

One significant effect of climate finance is its contribution to reducing greenhouse gas emissions and promoting the transition to low-carbon technologies and practices. Carfora, Ronghi, and Scandurra (2017) employ a quantile regression approach to assess the effect of climate finance on greenhouse gas emissions, revealing nuanced impacts across different segments of the emissions distribution. Additionally, Islam (2022) explores distributive justice in global climate finance, examining how funds are allocated based on recipients' climate vulnerability and the implications for equity and fairness in climate action.

Furthermore, climate finance plays a crucial role in enhancing resilience to the impacts of climate change, particularly in vulnerable communities and regions. Investments in climate adaptation measures such as early warning systems, resilient infrastructure, and nature-based solutions help communities prepare for and respond to climate-related hazards. Studies by Scandurra et al. (2020) and Hussain and Ahmad (2019) empirically investigate the effectiveness of climate finance in reducing vulnerability in Small Island Developing States (SIDS) and managing climate-related risks in Bangladesh's southwestern coast, respectively.

Moreover, climate finance has broader socio-economic impacts, including job creation, poverty reduction, and fostering sustainable development. Investments in renewable energy and energy efficiency projects create employment opportunities in green industries, while initiatives such as sustainable agriculture and forestry contribute to rural development and poverty alleviation. Lee et al. (2022) provides new evidence on the contribution of climate finance to environmental sustainability, highlighting its effectiveness in driving positive environmental outcomes.

However, realizing the full potential of climate finance requires concerted efforts to strengthen governance mechanisms, build institutional capacity, and ensure the equitable distribution of resources. Colenbrander et al. (2018) discussed the politics and practice of channelling resources to the local level, emphasizing the importance of using climate finance to advance climate justice and support local communities. Additionally, Kotchen and Costello (2018) explore strategies for maximizing the impact of climate finance, weighing the merits of funding large-scale projects versus smaller pilot initiatives.

Thus, climate finance plays a critical role in addressing the impacts of climate change and advancing sustainable development goals. By facilitating investments in mitigation and adaptation measures, climate finance contributes to reducing emissions, enhancing resilience, and promoting inclusive and sustainable development. However, ensuring the effectiveness and equity of climate finance requires transparent, accountable, and inclusive processes, as well as strategic coordination between public and private actors.

2.2.8 Public Climate Finance: Nurturing Climate Action through Government Support

Public climate finance initiatives play a pivotal role in addressing the challenges posed by climate change through both mitigation and adaptation projects. One notable example is the development of renewable energy infrastructure in countries like India, where initiatives such as the National Solar Mission and the Wind Energy Program receive funding from public climate finance sources (Laukkonen et al., 2009; Mandal & SIVAPRADHA, 2019). These projects aim to reduce greenhouse gas emissions by increasing the share of renewable energy in the country's energy mix, contributing significantly to mitigation efforts.

In addition to mitigation projects, public climate finance also supports adaptation initiatives, particularly in vulnerable regions. For instance, Bangladesh has received funding for rural climate resilience programs aimed at improving water management systems, promoting climate-smart agricultural practices, and enhancing early warning systems for natural disasters (Halsnæs & Verhagen, 2007; Odhong' et al., 2019). These projects help build resilience among

rural communities that rely heavily on agriculture for their livelihoods, thereby reducing their vulnerability to climate change impacts.

Forest conservation and restoration projects are another area where public climate finance plays a crucial role. Countries like Brazil and Indonesia have received funding for initiatives to reduce deforestation rates and restore degraded forest areas (Ussiri & Lal, 2017). These projects not only contribute to climate change mitigation by sequestering carbon but also provide additional benefits such as biodiversity conservation and watershed protection.

Moreover, public climate finance supports upgrades to urban infrastructure to enhance resilience to climate change impacts, particularly in cities prone to flooding and extreme heat events (Sharifi, 2020). Projects such as stormwater management systems, green infrastructure development, and urban heat island mitigation measures receive funding to reduce vulnerability to climate-related hazards and improve the sustainability of urban areas (Solecki et al., 2015).

Furthermore, public climate finance facilitates the establishment and improvement of climate information and early warning systems, particularly in vulnerable regions such as sub-Saharan Africa (Jachnik et al., 2015). These projects aim to strengthen meteorological services, develop drought monitoring systems, and enhance community resilience to climate variability and extreme weather events, ultimately reducing the impacts of climate change on vulnerable populations.

These examples illustrate the diverse range of public climate finance initiatives aimed at both mitigating greenhouse gas emissions and enhancing resilience to climate change impacts. By mobilizing financial resources and supporting innovative projects, public climate finance plays a critical role in advancing global efforts to address climate change and its associated challenges.

2.2.8.1 Types/Categories of Public Climate Finance:

Public climate finance encompasses various types or categories of financial instruments and mechanisms that are funded or facilitated by governments, multilateral institutions, and other public entities. These funds are dedicated to addressing climate change mitigation and adaptation efforts, as well as supporting sustainable development initiatives. The types/categories of public climate finance can be broadly categorized as follows:

- i. **Grants:** Grants are non-repayable financial transfers provided by governments or international institutions to support climate-related projects and programs. These funds are typically allocated to projects that promote renewable energy deployment, climate-resilient infrastructure, capacity building, and adaptation measures in vulnerable communities. Grants are particularly valuable for projects in low-income countries and communities where repayment may be challenging (Barnard et al., 2014).
- ii. **Concessional Loans:** Concessional loans are provided by governments or development finance institutions at below-market interest rates or with flexible repayment terms to support climate-related projects and initiatives. These loans are often targeted at projects that may not be viable under standard commercial lending conditions, such as renewable energy projects in emerging economies or adaptation projects in vulnerable regions. Concessional loans can help leverage additional private sector investment and catalyse sustainable development (Stender et al., 2020).
- iii. **Equity Investments:** Equity investments involve the purchase of shares or ownership stakes in climate-related projects or companies by public entities. These investments provide capital to support the development and scaling-up of renewable energy, clean technology, and climate resilience initiatives. Equity investments can generate financial returns for governments or public institutions while also advancing climate goals and stimulating innovation in the private sector (Leal et al., 2023).
- iv. **Subsidies and Tax Incentives:** Subsidies and tax incentives are financial incentives provided by governments to encourage investment in climate-friendly activities and technologies. These incentives may include direct subsidies for renewable energy generation, tax credits for energy efficiency improvements, or exemptions from carbon taxes or import duties on clean technologies. Subsidies and tax incentives can help level the playing field for sustainable investments and accelerate the transition to a low-carbon economy (Bracking, 2015).
- v. **Climate Funds and Facilities:** Climate funds and facilities are financial mechanisms established by governments or international organizations to pool and channel climate finance resources to priority areas and projects. Examples include the Green Climate Fund (GCF), the Adaptation Fund, and national climate finance facilities. These funds provide a platform for coordinating and mobilizing public and private sector resources,

as well as for ensuring transparency, accountability, and effectiveness in climate finance allocation (Kotchen & Costello, 2018).

2.2.8.2 Characteristics of public climate finance include:

- **Public Accountability:** Public climate finance is subject to public scrutiny and accountability, with governments and public institutions responsible for ensuring that funds are used effectively, efficiently, and transparently to achieve climate and development objectives (Barnard et al., 2014).
- **Additionality:** Public climate finance is expected to be additional to existing development assistance and domestic resources, providing funding where private investment may be insufficient or unavailable to address climate-related challenges (Jakob et al., 2015).
- **Long-term Orientation:** Public climate finance often has a long-term orientation, recognizing the need for sustained investment in climate mitigation and adaptation efforts to achieve lasting impacts and resilience-building outcomes (Lee et al., 2022).
- **Adaptability:** Public climate finance mechanisms and instruments are designed to be flexible and adaptable to evolving climate risks, priorities, and opportunities, allowing for timely and targeted responses to emerging challenges (Colenbrander et al., 2018).
- **Catalytic Effect:** Public climate finance aims to catalyse additional private sector investment in climate-friendly projects and initiatives by providing seed funding, de-risking investments, and creating enabling environments for private sector engagement (Kotchen & Costello, 2018).

Overall, public climate finance plays a critical role in mobilizing resources, driving investment, and catalysing action to address climate change and advance sustainable development goals at the national, regional, and global levels.

2.2.9 Private Climate Finance: The Power of Market-Driven Solutions

Private climate finance initiatives have emerged as key players in addressing climate change challenges through both mitigation and adaptation projects. One prominent example of private climate finance in mitigation efforts is the investment in renewable energy projects. Companies and investors globally have been financing large-scale solar and wind energy installations,

contributing significantly to the reduction of greenhouse gas emissions (Ryan Hogarth, 2012). These projects not only facilitate the transition to clean energy but also offer attractive returns on investment, driving further interest from the private sector.

In addition to renewable energy, private climate finance also supports energy efficiency projects aimed at reducing carbon emissions. Initiatives such as building retrofits, industrial process optimization, and the adoption of energy-efficient technologies receive funding from private investors seeking to minimize environmental impact while improving operational efficiency and reducing costs (Haščič et al., 2015). These projects demonstrate the potential for private finance to drive innovation and technological advancements in the pursuit of climate goals.

Furthermore, private climate finance plays a crucial role in supporting climate resilience and adaptation initiatives, particularly in vulnerable regions. Insurance companies, for example, are increasingly investing in climate resilience projects such as resilient infrastructure, early warning systems, and disaster risk reduction measures (Stadelmann et al., 2013). These investments help communities and businesses better prepare for and respond to the impacts of climate change, reducing the associated economic losses and enhancing long-term sustainability.

Moreover, private finance is facilitating the development of nature-based solutions for climate adaptation. Investments in projects such as reforestation, afforestation, and ecosystem restoration not only sequester carbon but also enhance ecosystem services, such as water purification, soil stabilization, and biodiversity conservation (Torvanger et al., 2016). These projects offer multiple co-benefits, making them attractive to private investors seeking both financial returns and positive environmental impacts.

Additionally, private climate finance supports the integration of climate considerations into business operations and supply chains. Companies are investing in sustainable agriculture practices, water management systems, and supply chain resilience measures to mitigate climate risks and ensure long-term viability (Savvidou et al., 2021). These investments contribute to building adaptive capacity and reducing vulnerability to climate-related disruptions across various sectors.

Overall, private climate finance initiatives are driving innovation, promoting sustainability, and catalysing action on climate change mitigation and adaptation. By leveraging capital, expertise,

and technology, the private sector plays a crucial role in complementing public efforts and advancing global climate goals.

2.2.9.1 Types/Categories of Private Climate Finance:

- i. **Direct Investments:** Direct investments entail the allocation of capital by private investors into climate-friendly projects and initiatives. These investments may include equity stakes in renewable energy projects, climate-resilient infrastructure, sustainable agriculture, and carbon offset projects (Leal et al., 2023).
- ii. **Green Bonds:** Green bonds, as discussed by Bracking (2015), are debt instruments issued by private sector entities to fund environmentally sustainable projects. Proceeds from green bonds are earmarked for projects that promote climate mitigation, adaptation, energy efficiency, and renewable energy development.
- iii. **Climate Funds and Venture Capital:** Climate funds and venture capital funds pool capital from private investors to finance climate-related projects and initiatives. These funds may focus on specific sectors such as renewable energy, clean technology, sustainable agriculture, or climate resilience (Jakob et al., 2015).
- iv. **Impact Investing:** Impact investing, as described by Kotchen and Costello (2018), involves deploying capital with the intention of generating positive social and environmental impacts alongside financial returns. Private investors engage in impact investing by funding projects and businesses that address climate change and promote environmental sustainability.
- v. **Corporate Climate Finance:** Corporations contribute significantly to private climate finance through investments in renewable energy projects, energy efficiency improvements, carbon offsetting initiatives, and sustainability initiatives within their operations and supply chains. Corporate climate finance encompasses a range of activities, including corporate social responsibility (CSR) initiatives, green procurement, and sustainability reporting (Bracking, 2015).

2.2.9.2 Characteristics of private climate finance include:

- **Profit Orientation:** Private climate finance seeks to generate financial returns for investors while contributing to climate mitigation, adaptation, and sustainable

development objectives. Private investors prioritize investments that offer attractive risk-adjusted returns and align with their financial goals (Jakob et al., 2015).

- ***Innovation and Efficiency:*** Private sector entities bring innovation, expertise, and efficiency to climate finance by leveraging market mechanisms, technology, and entrepreneurship to identify and scale climate solutions. Private climate finance encourages competition, innovation, and cost-effectiveness in addressing climate challenges (Leal et al., 2023).
- ***Risk Appetite:*** Private investors have varying risk appetites and investment preferences, leading to diverse strategies and approaches in climate finance. Some investors may prioritize low-risk, proven technologies and projects, while others may be willing to take on higher risks in pursuit of greater impact or returns (Kotchen & Costello, 2018).
- ***Market Integration:*** Private climate finance operates within the broader financial markets, integrating climate considerations into investment decision-making processes, risk assessments, and valuation frameworks. Private investors influence market dynamics and asset allocation decisions, shaping the flow of capital toward climate-friendly investments (Bracking, 2015).

Private climate finance, by harnessing the power of private sector capital, expertise, and innovation, plays a critical role in accelerating the transition to a low-carbon, resilient, and sustainable future, as highlighted by various studies.

2.2.10 Public Sector Versus Private Sector Projects

Project design is a crucial phase in the implementation of climate change mitigation and adaptation initiatives, encompassing the planning, structuring, and conceptualization of strategies to address the challenges posed by climate change. Comparing public sector projects to private sector projects involves assessing various aspects such as management, funding, objectives, accountability, and efficiency.

i. Management and Governance:

- ***Public Sector:*** Public sector projects are typically managed by government agencies or public institutions. Decision-making processes in the public sector often

involve bureaucratic procedures, stakeholder consultations, and regulatory compliance (Sagalyn, 2007).

- **Private Sector:** Private sector projects are managed by corporations, businesses, or private entities. Decision-making in the private sector is often streamlined, with a focus on profitability, efficiency, and shareholder value (Ferreira et al., 2014).

ii. **Funding and Financing:**

- **Public Sector:** Funding for public sector projects primarily comes from government budgets, taxes, grants, and public borrowing (Jacobson & Ok Choi, 2008). Public sector projects may also involve public-private partnerships (PPPs) where private capital is leveraged alongside public funds.
- **Private Sector:** Private sector projects are financed through equity investments, debt financing, venture capital, and corporate funding (Gatti, 2023). Private sector projects rely on market mechanisms to attract investment and generate returns for investors.

iii. **Objectives and Goals:**

- **Public Sector:** Public sector projects often prioritize public welfare, social equity, and the provision of essential services such as infrastructure, healthcare, education, and utilities (Mayshar, 1977). The primary goal is to serve the public interest and address societal needs.
- **Private Sector:** Private sector projects are driven by profit motives, market demand, and business objectives. Private projects aim to generate financial returns, create value for shareholders, and achieve competitive advantage in the marketplace (Ferreira et al., 2014).

iv. **Accountability and Transparency:**

- **Public Sector:** Public sector projects are subject to government oversight, accountability mechanisms, and public scrutiny. Transparency, accountability, and compliance with regulations are essential in the public sector to ensure taxpayer confidence and prevent corruption (Sagalyn, 2007).
- **Private Sector:** Private sector projects are accountable to shareholders, investors, and regulatory bodies. While private companies may prioritize confidentiality and

proprietary information, they are still subject to regulations, financial reporting requirements, and corporate governance standards (Jurisch et al., 2013).

v. **Efficiency and Innovation:**

- **Public Sector:** Public sector projects may face challenges related to bureaucracy, inefficiency, and red tape, which can impact project delivery timelines and costs (Van Marrewijk et al., 2008). However, public sector projects can also foster innovation through public-private collaborations and research partnerships.
- **Private Sector:** Private sector projects are often characterized by efficiency, agility, and innovation. Private companies are incentivized to optimize processes, minimize costs, and adopt innovative technologies to remain competitive and maximize profits (Gatti, 2023).

In summary, while both public and private sector projects aim to achieve specific objectives, they differ in terms of management approaches, funding sources, objectives, accountability mechanisms, and efficiency. Understanding these differences is crucial for policymakers, investors, and project managers to effectively plan, execute, and evaluate projects in both sectors.

2.2.10.1 Intervention Design and Resource Allocation

Intervention design and resource allocation are crucial aspects of effective climate finance. This involves identifying and designing interventions that are most likely to succeed, allocating resources efficiently, and managing a pipeline of projects capable of absorbing funds (Cohen & Uphoff, 1977). However, numerous challenges exist at both national and international levels in this regard.

Allocation procedures employed by national and international sources of climate finance encompass various criteria reflecting strategic objectives influencing project outcomes (Ellis, Caruso & Ockenden, 2013). These criteria include parameters such as target countries, activity types, and project sizes (Ellis, Caruso & Ockenden, 2013). For instance, the Ghanaian government has outlined primary and secondary priorities for both mitigation and adaptation expenditures under initiatives like the Ghana Nationally Determined Contributions (NDCs) and Ghana Shared Growth and Development Agenda (GSGHA). Ellis, et al. (2013) adds that

certain funds impose limits on total flows to specific activities, while others may have explicit allocation criteria between countries.

Various tools theoretically support strategy development and ex-ante assessments of intervention effectiveness, including marginal abatement cost curve analysis, options analysis, impact assessments, cost-benefit analysis, and multi-criteria analysis (Ellis, et al., 2013; Farquhar et al., 1985). However, information and data constraints often hinder their application, particularly due to limited evidence and knowledge for appraising projects and identifying market failures and barriers (Brooks, Waylen & Borgerhoff Mulder, 2012). Despite these challenges, providers and supporters of climate finance are working on methodologies to measure benefits and trade-offs among different dimensions of intervention impacts (Ellis, et al., 2013).

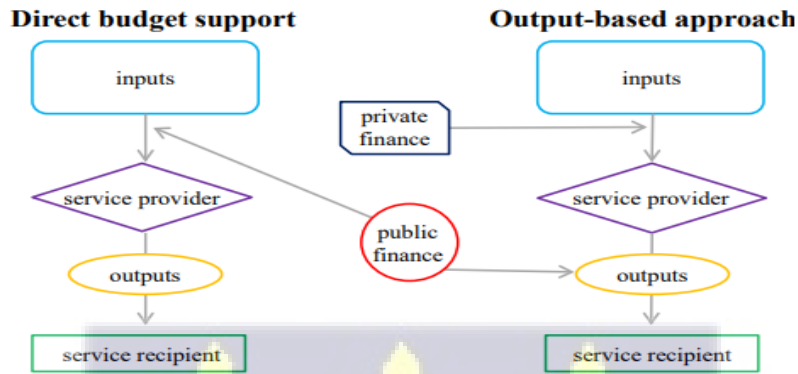
Methodologies such as the UK's Department for International Development (DFID)/ Department of Energy and Climate Change (DECC) Greenhouse Gas Appraisal Guidance and the World Bank Source Book aid in directing future climate finance allocation to projects with the highest overall results (Ellis, et al., 2013). Project design may involve developing a results framework against which effectiveness is assessed, with some projects explicitly tied to achieving key results, as seen in results-based finance models or investment criteria for funds such as the Climate Investment Funds Criteria for the Clean Technology Fund. (see Box 3 – adopted from Ellis, et al., 2013).

Figure 3: Result-Based Finance



With increasing focus on demonstrating verified results from climate projects, results-based finance (RBF) has received significant attention in the climate finance community. Results-based finance is an umbrella term that includes a number of different financing mechanisms that seek to tie the provision of financial resources to specific and measurable results (Caruso and Ellis, 2013). These range from Advanced Market Commitments and Output Based Aid that focus on “outputs” to Conditional Cash Transfers or Cash on Delivery Aid that can be linked to behavioural triggers more oriented towards “outcomes” (GPOBA, 2012).

As depicted in the figure below, payments under an RBF arrangement are only disbursed after independently verified results have been demonstrated. Depending on project types, the results chosen to trigger payments can vary widely after consultation with donors, implementing entities, and partner countries. Drawing from a number of existing or proposed RBF programmes relevant to climate change, these triggers can include the number of natural gas connections made or solar-home systems installed (GPOBA, 2013), the number of technical assistance sessions held (IFC, 2012a), or the amount of fugitive methane emissions abated (MFSG, 2013).



Source: Adapted from Brook and Petrie (2001)

In the context of assessing the effectiveness of climate finance projects, RBF arrangements are relevant in two ways. The first relates to the requirement of demonstrating verified results up-front. With an ex-ante assessment of mutually agreed outputs or outcomes, donors can more easily account for results to both taxpayers at home and development partners abroad. The second is how RBF approaches transfer risk from donors to service providers, thus creating a direct incentive to achieve the result more efficiently and effectively (World Bank, 2013a). However, RBF may not be appropriate in all situations, and will need to be explored further in order to understand how it best fits with the principles in the Paris Declaration and objectives of the UNFCCC.

Source; Ellis, et al. (2013)

2.2.10.2 Project Performance Evaluation

When evaluating the performance of projects general performance criteria such as relevance, effectiveness, efficiency, sustainability, and impact can be utilized in the assessment. By using a combination of these metrics, stakeholders can comprehensively evaluate the performance of projects, understand their strengths and weaknesses, and make informed decisions to enhance their effectiveness and sustainability in achieving set objectives.

- i. **Relevance:** Relevance measures the alignment of a climate initiative with the priorities, needs, and circumstances of the target stakeholders and beneficiaries. It evaluates

whether the initiative addresses pressing climate challenges, responds to local contexts, and contributes to broader development goals (DeCotiis & Dyer, 1979).

- ii. **Effectiveness:** Effectiveness assesses the extent to which a climate initiative achieves its intended objectives and outcomes. It considers the degree of goal attainment, implementation success, and the ability to produce desired changes in behaviour, practices, or conditions related to climate change (Anantatmula, 2015).
- iii. **Efficiency:** Efficiency evaluates the relationship between the inputs (resources, time, and effort) invested in a climate initiative and the outputs or outcomes achieved. It measures how effectively resources are utilized to produce results, aiming to minimize wastage and maximize productivity (Takim & Akintoye, 2002).
- iv. **Sustainability:** Sustainability metrics assess the long-term viability and durability of climate initiatives, considering their environmental, social, and economic impacts over time. This includes the ability to maintain benefits beyond the project lifecycle, foster community ownership, and ensure equitable distribution of costs and benefits (Rockel & Geyer, 2008).
- v. **Impact:** Impact measures the broader effects and consequences of a climate initiative on stakeholders, ecosystems, and society as a whole. It encompasses both intended and unintended outcomes, evaluating the magnitude of positive changes in climate resilience, livelihoods, well-being, and environmental quality (Refsgaard et al., 2014).

2.2.10.3 Monitoring and Evaluating the Results of Interventions

Monitoring and evaluating the results of interventions in climate finance entails distinguishing between creating an enabling environment for achieving results and demonstrating that interventions have indeed achieved those results (Islam, 2022). While enabling environments are crucial, they might not suffice to showcase the climate impacts of specific interventions. Monitoring and evaluating climate finance interventions serve several purposes. It aids in transparency for both donors and recipients, demonstrates project feasibility and success for attracting private finance, and enables a comprehensive assessment of the environmental, economic, and development impacts of climate finance (Ellis, et al., 2013).

Assessing effectiveness encompasses not only demonstrating results but also building an evidence base to inform better policies and interventions in the future (Christensen et al., 2007). The choice of time horizon and scale for monitoring results significantly influences the

assessment of intervention effectiveness. For instance, assessing the effectiveness of an intervention aimed at enhancing infrastructure's climate resilience may require a considerable time lag to determine its impact. Similarly, there might be a delay between capacity-building interventions and their effects. While a pilot project for a new technology may run efficiently on a small scale, its effectiveness may diminish when attempting to replicate it on a large scale.

At the early stages of intervention implementation, identifying and allocating inputs are essential (Ellis, et al., 2013; Gleckler, Taylor & Doutriaux, 2008). These inputs, whether financial, human, or material goods, contribute to achieving intervention objectives. Decisions regarding inputs depend on strategic objectives and local contexts (DeCotiis & Dyer, 1979). Inputs yield different types of results: outputs, outcomes, and impacts. Outputs represent the tangible products delivered by an intervention in the short term, demonstrating progress. Outcomes, occurring in the short or medium term, result from outputs and may include improvements such as enhanced resilience to climatic conditions. Impacts, intended or unintended, emerge over time and span various sectors. They can only be assessed based on an intervention's objectives and may include climate-specific and broader development-related indicators.

The issue of scale is crucial in monitoring and assessing effectiveness across local, national, and global levels. Indicators should reflect progress at different scales to comprehend effectiveness fully. Employing a mix of top-down and bottom-up systems and indicators allows policymakers to contextualize interventions within transformational climate goals. However, different types of interventions may vary in their suitability for evaluation across spatial scales and time horizons. For instance, assessing the impacts of low-carbon infrastructure projects may be more straightforward than evaluating community resilience-building activities. In the latter case, measuring results at the output or outcome level may be more practical.

2.2.10.4 Monitoring Climate-Specific Results

Monitoring climate-specific results is fundamental for assessing the effectiveness of mitigation and adaptation interventions, setting climate finance apart from broader development finance. Mitigation efforts primarily aim to directly or indirectly reduce greenhouse gas (GHG) emissions, while adaptation projects focus on enhancing resilience to climate impacts through various means such as awareness programs, institutional reforms, or infrastructure projects. Despite being addressed separately, there is often significant overlap between mitigation and

adaptation activities in practice, with around 21% of climate-related Official Development Assistance (ODA) flows targeting both aspects (Ellis, et al.,2013).

i. Mitigation activities:

In assessing the climate impact of mitigation activities, a key factor is the intervention's effect on the Earth's climate system. Various indicators are utilized globally and nationally to monitor mitigation activities. These indicators range from measuring emissions intensity and the ratio of renewables to fossil fuels at the macro level to specific intervention-level indicators like installed renewable energy capacity or hectares of deforestation avoided.

Many efforts concentrate on evaluating GHG emissions at the project or portfolio level, typically converted into CO₂-equivalents by assessing climate initiative success in reducing greenhouse gas emissions, such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) (Christensen et al., 2007). International financial institutions (IFIs) have collaborated on harmonizing approaches for accounting GHG impacts, enabling organizations like the Agence Française de Développement (AFD) to assess projects' climate impacts. Additionally, institutions consider broader indicators like renewable energy capacity or policy implementation, recognizing that these activities contribute indirectly to GHG reduction by enhancing technical knowledge and capacity (Ellis, Caruso and Ockenden, (2013).

However, the complexity of climate change and the potential for emissions displacement necessitate a broader understanding of emissions trends beyond project or portfolio levels. Some institutions adopt a top-down approach, assessing effectiveness at sectoral, national, or global scales. Developing countries like South Africa, the Philippines, Bangladesh, and Mozambique are establishing monitoring and evaluation systems for in-country mitigation activities to better understand the effectiveness of international financial commitments (Ellis, Caruso & Ockenden, 2013).

At both national and global levels, various initiatives track climate-related impacts of interventions over different spatial scales and time horizons. For instance, the Climate Investment Funds (CIF) and the International Energy Agency (IEA) monitor indicators like GHG intensity per unit of GDP or energy supplied. Such initiatives provide valuable tools for stakeholders to understand the expected climate impacts of interventions (Ellis, Caruso & Ockenden, 2013). Nonetheless, attributing outcomes or

impacts to specific interventions becomes more challenging at larger scales and longer time horizons, emphasizing the importance of ongoing evaluation to inform future interventions effectively.

ii. *Adaptation Interventions*

Adaptation interventions encompass a variety of forms, including infrastructure projects, research and development, technical assistance, capacity building, and policy or institutional measures. Unlike mitigation, the ultimate impacts of adaptation interventions, such as increased adaptive capacity and resilience, are challenging to model beforehand or directly measure (Ellis, Caruso and Ockenden, (2013). While broader developmental impacts are often considered co-benefits in mitigation contexts, they become core indicators for assessing adaptation effectiveness. Consequently, a diverse array of indicators are monitored to gauge the effectiveness of adaptation interventions, focusing specifically on vulnerability or resilience.

Assessing resilience and adaptive capacity is complex, leading adaptation monitoring efforts to prioritize institutional and procedural output indicators over outcomes and impacts. For instance, an analysis of adaptation projects by six bilateral development agencies found that monitoring activities primarily focused on policy management, education, research, and coordination rather than risk reduction (Ellis, et al., 2013). The multifaceted nature of building resilience and adaptive capacity often requires interventions across various sectors like health, water, energy, agriculture, and economics. Clear links between cause and effect in adaptation activities are often lacking, necessitating the use of both top-down (e.g., number of people vulnerable to climate change) and bottom-up indicators (e.g., number of climate vulnerability assessments conducted).

Climate resilience metrics assess the ability of communities, ecosystems, and infrastructure to withstand and recover from climate-related impacts such as extreme weather events, sea-level rise, and temperature fluctuations. Indicators may include the implementation of adaptation measures, enhancement of natural buffers, and improvement in disaster preparedness and response (Luedeling et al., 2014).

The Adaptation Fund employs various indicators to evaluate results at different stages, depending on project goals. For instance, indicators for education and awareness projects may include the number and type of risk reduction actions introduced at the

local level or the coverage of the topic in local media. To assess projects' effectiveness in reducing longer-term vulnerability, indicators like the number of people with reduced risk to extreme weather events are tracked. Given that climate-financing interventions often pursue multiple objectives, labelling projects solely as "adaptation projects" can oversimplify their scope. Hence, adaptation interventions typically employ results frameworks containing indicators relevant to broader development objectives.

2.2.10.5 Monitoring Broader Development Benefits

The source of climate finance, whether public or private, significantly influences the design of climate change interventions, subsequently impacting project performance and the realization of broader development benefits, including Sustainable Development Goals (SDGs) (Barnard et al., 2014). When climate finance comes from public sources, such as government budgets or international aid, interventions often prioritize broader societal objectives and public interests (Heuson et al., 2015). These projects tend to have more extensive stakeholder consultations, regulatory compliance, and adherence to government policies and priorities (Scandurra et al., 2020). Additionally, public finance may enable the implementation of large-scale infrastructure projects and capacity-building initiatives that contribute to long-term resilience and sustainability (Steckel et al., 2017). On the other hand, climate finance from private sources, such as corporate investments or philanthropic funds, may prioritize profitability and risk mitigation (Zhao et al., 2022). Private interventions often emphasize innovation, efficiency, and market-driven solutions tailored to specific business objectives or investment criteria (Kotchen & Costello, 2018). Consequently, private projects may exhibit more flexibility, agility, and responsiveness to market dynamics (Lou et al., 2022). However, they may also face challenges related to accountability, transparency, and inclusivity, particularly concerning marginalized communities and vulnerable populations (Colenbrander et al., 2018).

The design of climate change interventions, influenced by the source of climate finance, ultimately shapes project performance across various metrics, including relevance, effectiveness, efficiency, sustainability, and impact (Stender et al., 2020). Publicly funded interventions tend to prioritize broader societal benefits and public goods, aiming for relevance to government policies and objectives (Islam, 2022). These projects often demonstrate effectiveness in achieving stated goals and objectives, supported by robust planning, stakeholder engagement, and institutional support (Jakob et al., 2015). However, they may face challenges related to bureaucratic processes, budget constraints, and political considerations,

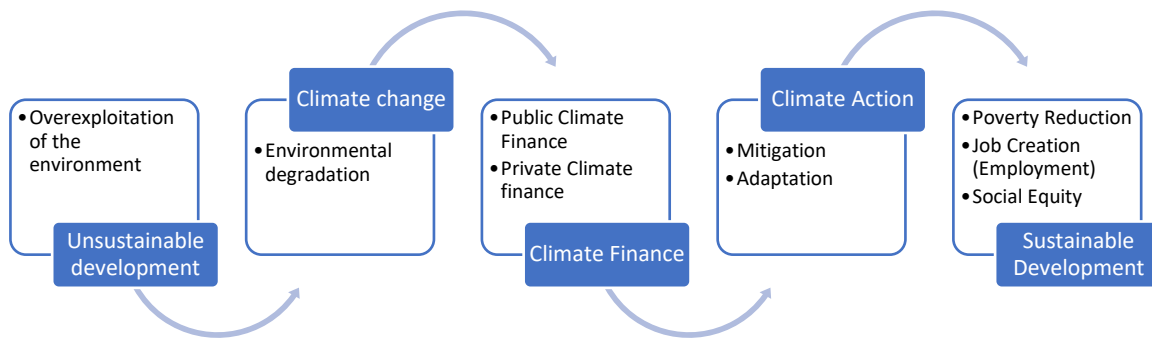
which can impact efficiency and timeliness (Hussain & Ahmad, 2019). Conversely, privately funded interventions may prioritize efficiency and profitability, aiming to maximize returns on investment while minimizing costs and risks (Lee et al., 2022). These projects often demonstrate agility and innovation, leveraging market dynamics and technology advancements to achieve desired outcomes (Carfora et al., 2017). However, they may face challenges related to scalability, equity, and long-term sustainability, particularly in ensuring inclusivity and addressing social and environmental concerns (Leal et al., 2023).

The performance of climate change interventions, influenced by their design and financing sources, ultimately determines their impact on broader development benefits, including SDGs (Stender et al., 2020). Publicly funded interventions, with their emphasis on societal objectives and public interests, may have a more direct and measurable impact on SDGs, particularly those related to environmental sustainability, poverty alleviation, and social equity (Stender et al., 2020). These projects often contribute to multiple SDGs by addressing interconnected challenges and promoting inclusive and sustainable development (Steckel et al., 2017). However, their impact may be constrained by resource limitations, institutional capacity, and political dynamics (Barnard et al., 2014). Privately funded interventions, while potentially innovative and efficient, may have a more indirect or limited impact on SDGs, focusing primarily on profitability and market-driven outcomes (Stender et al., 2020). Nonetheless, they can complement public efforts and catalyse private sector engagement in addressing climate change challenges and achieving sustainable development goals (Jakob et al., 2015). Overall, a combination of public and private finance, coupled with effective governance, stakeholder engagement, and monitoring mechanisms, is essential for maximizing the impact of climate change interventions on broader development benefits and advancing sustainable development goals.

2.3 Conceptual Framework

Conceptual frameworks help clarify the key concepts and relationships underlying the effects of the source of climate finance on climate action and sustainable development. Figure 4 shows the linkages and chain of thoughts between the concepts discussed in this study.

Figure 4: Conceptual Framework



Source; Author, 2024

Unsustainable development practices have been a significant driver of **climate change**, exacerbating environmental degradation, biodiversity loss, and resource depletion. The reliance on fossil fuels for energy generation, deforestation for agricultural expansion, and intensive industrial activities have contributed to the accumulation of greenhouse gases in the atmosphere, leading to global warming and climate instability. Moreover, unsustainable land-use practices, such as urban sprawl and monoculture farming, disrupt ecosystems, degrade soil fertility, and increase vulnerability to climate-related disasters. The unsustainable consumption and production patterns prevalent in many sectors further intensify climate change impacts, posing significant challenges to achieving sustainable development goals.

Climate finance, both from public and private sources, plays a crucial role in addressing the root causes of climate change and promoting sustainable development. **Mitigation projects**, funded through climate finance, focus on reducing greenhouse gas emissions across various sectors, including energy, transportation, and industry. Public climate finance provides essential support for initiatives such as renewable energy deployment, energy efficiency improvements, and sustainable land management practices. By investing in low-carbon technologies and promoting sustainable practices, mitigation projects contribute to decarbonizing economies, mitigating climate change impacts, and fostering long-term environmental sustainability.

Private climate finance complements public efforts by mobilizing capital and expertise to scale up mitigation actions and drive innovation. Private sector investments in renewable energy, clean technologies, and sustainable infrastructure contribute to reducing emissions and transitioning to a more sustainable energy system. Furthermore, private finance supports market-driven initiatives, such as carbon offset projects and emission reduction programs, which incentivize businesses to adopt more sustainable practices and invest in climate-friendly solutions. By leveraging market mechanisms and promoting sustainable investments, private climate finance accelerates the transition to a low-carbon economy and facilitates the adoption of environmentally sound practices.

In addition to mitigation efforts, climate finance also supports *adaptation projects* aimed at enhancing resilience and reducing vulnerability to climate change impacts. Public climate finance plays a critical role in financing adaptation initiatives, particularly in developing countries and vulnerable communities. Investments in climate-resilient infrastructure, disaster risk reduction measures, and ecosystem restoration projects help build adaptive capacity and enhance the resilience of communities facing climate risks. Private climate finance complements public funding by supporting innovative adaptation solutions, such as climate risk insurance, early warning systems, and resilient agricultural practices. By providing financial resources and risk-sharing mechanisms, private finance strengthens the adaptive capacity of communities and businesses, reducing the social and economic costs of climate-related disasters.

Overall, climate finance, whether from public or private sources, is essential for driving climate action and ensuring sustainable development. By investing in mitigation and adaptation projects, climate finance contributes to addressing the root causes of climate change, reducing emissions, and building resilience to climate impacts. Public finance provides stability and support for large-scale initiatives, while private finance mobilizes capital, drives innovation, and promotes sustainable investments. By working together, public and private climate finance can catalyse transformative change, promote sustainable development, and create a more resilient and prosperous future for all.

2.4 Theoretical Review

Theoretical underpinnings of comparing public and private projects lie in contrasting principles of social welfare economics and private enterprise. Public projects, guided by social welfare

economics, prioritize equitable access, long-term societal benefits, and government intervention to address market failures (Jacobson, & Ok Choi, 2008). In contrast, private projects operate under the principles of private enterprise and market efficiency, focusing on profit maximization, innovation, and competition-driven resource allocation (Mayshar, 1977). Comparing these theoretical frameworks illuminates the divergent objectives, funding mechanisms, and accountability structures inherent in public and private sector initiatives (Van Marrewijk, Clegg, Pitsis, & Veenswijk, 2008).

When comparing public climate change projects (both mitigation and adaptation) with private initiatives, notable distinctions emerge. Public climate change projects, informed by principles of social welfare economics, prioritize the collective interest, equitable distribution of benefits, and long-term sustainability. These projects often involve governmental intervention, robust regulatory frameworks, and public financing mechanisms to address systemic challenges (McHenry, 2011). In contrast, private climate change projects, grounded in principles of private enterprise, emphasize innovation, cost-effectiveness, and market-driven solutions (Tompkins, & Eakin, 2012). While driven by profit motives, private initiatives have the ability to respond quickly to market demands, leverage technological advancements, and explore novel approaches to climate change mitigation and adaptation (Zhang, & Maruyama, 2001). However, they may face challenges in ensuring equitable access, addressing externalities, and aligning business objectives with broader societal goals. Comparing these approaches sheds light on the potential synergies and trade-offs between public and private sector contributions to climate action.

Overall, various theoretical perspectives including government failure, property rights theory, principal-agent models, and public choice perspectives, have shaped arguments for or against privatization and are thus relevant in public versus private climate finance. For this study however, sustainable development theory provides a suitable framework for understanding how the source of climate finance influences climate action and sustainable development in Ghana and other developing countries. By examining how climate actions, driven by the allocation of finance, may influence broader development goals such as poverty reduction, health improvements, and enhanced access to education, theoretical models and scenarios offer insights into optimizing the impact of financial resources for climate-related initiatives, ensuring coherence between climate action and sustainable development agendas.

2.5.1 Sustainable Development Theory:

Sustainable development theory is a multidisciplinary concept that has evolved over time with contributions from various thinkers, policymakers, and scholars. While it lacks a single set of exclusive proponents, key figures have significantly shaped the concept, including Gro Harlem Brundtland, whose "Our Common Future" report defined sustainable development; Rachel Carson, whose "Silent Spring" raised early environmental awareness; and authors like Meadows and Sen who explored the limits of growth and capability-based development. Elinor Ostrom's work on common-pool resources, Herman Daly's steady-state economics, and various United Nations initiatives have further advanced the understanding and promotion of sustainable development, which seeks to harmonize environmental preservation, social equity, and economic progress for the benefit of present and future generations. The adoption of the United Nations Sustainable Development Goals (SDGs), have played a central role in promoting and operationalizing sustainable development at the global level.

Sustainable Development Theory is a foundational framework that underpins climate finance and guides efforts to address climate change while promoting broader societal and environmental well-being. Sustainable development theory emphasizes the interconnectedness of environmental, social, and economic dimensions of development. It provides a foundation for evaluating the alignment of climate projects with broader sustainable development goals. The theory suggests that climate finance should not only mitigate environmental risks but also enhance social equity and economic prosperity. Climate actions funded by public or private sources should be assessed in terms of their contributions to poverty reduction, job creation, health, education, and environmental preservation. Sustainable development theory underscores the importance of projects that offer multiple co-benefits beyond emissions reduction. Key aspects of this theory include:

- i. **Interconnected Goals:** Sustainable Development Theory emphasizes the interconnectedness of economic, environmental, and social goals. It posits that climate finance should not be seen in isolation but should be integrated into broader development strategies. In this context, climate action is seen as one dimension of sustainable development.
- ii. **Environmental Stewardship:** The theory underscores the need for environmental stewardship and responsible resource management. Climate finance interventions should prioritize projects and initiatives that contribute to the preservation of natural resources and ecosystems, aligning with goals such as life on land (SDG 15) and life below water (SDG 14).

- iii. ***Inclusivity and Equity:*** Sustainable Development Theory places a strong emphasis on inclusivity and equity. Climate finance should be distributed in a way that benefits marginalized communities and reduces inequalities. It aligns with objectives related to no poverty (SDG 1), reduced inequalities (SDG 10), and gender equality (SDG 5).
- iv. ***Long-Term Vision:*** This theory encourages a long-term perspective. Climate finance should support initiatives that not only yield immediate climate benefits but also contribute to the long-term resilience of communities and ecosystems. It is aligned with goals such as clean water and sanitation (SDG 6) and sustainable cities and communities (SDG 11).
- v. ***Multi-Stakeholder Engagement:*** Sustainable Development Theory promotes multi-stakeholder engagement. It encourages the involvement of governments, civil society, businesses, and local communities in climate finance decision-making processes. This participatory approach aligns with principles of partnerships for the goals (SDG 17).
- vi. ***Measuring Progress:*** Sustainable Development Theory advocates for comprehensive metrics to measure progress. Climate finance interventions should be assessed not only in terms of their carbon reduction impact but also in relation to their effects on poverty reduction, employment generation, and other social and economic indicators.

Sustainable development theory holds significant relevance for Ghana and other developing nations, as it addresses the delicate balance between environmental preservation, social equity, and economic progress, a pressing concern in these regions. This framework aligns with the overarching aspiration of attaining sustainable outcomes in both climate action and broader development endeavours. This research therefore employs this theory to assess the impact of climate projects, whether publicly or privately funded, in Ghana and similar developing contexts, evaluating their contributions to multiple facets of sustainability, encompassing poverty alleviation, job creation, enhanced health, education, and environmental conservation, alongside their climate-related objectives. The advantage of sustainable development theory lies in its ability to provide a holistic framework that underscores the interconnectedness of diverse goals and emphasizes the significance of co-benefits extending beyond emissions reduction, which is particularly valuable in settings where achieving a multitude of societal objectives is paramount.

2.5.2 Government Failure:

Government failure is a theoretical perspective that underscores the inefficiencies and shortcomings of government-run projects and services (Buchanan, 1954). This perspective emphasizes the inefficiencies and shortcomings of government-run enterprises. It argues that government agencies may suffer from bureaucratic red tape, lack of incentives, and political influence, leading to poor performance, cost overruns, and misallocation of resources. When applied to the debate over public vs. private climate finance, this perspective raises important considerations for addressing climate change.

In selecting climate projects, Governments may prioritize projects that garner political support or provide short-term economic benefits, rather than those that have the most significant long-term climate impact. Inefficiencies Government-run climate finance initiatives can delay project implementation and hinder the achievement of climate targets. Delays in funding allocation, approval processes, and decision-making can be detrimental in the context of climate change, where rapid action is often crucial. Thus; in favour of private climate finance, supporters of private climate finance argue that private sector efficiency and innovation can drive rapid deployment of clean technologies and green solutions.

But, advocates of public climate finance argue that governments, through public climate finance can focus on long-term, high-impact projects that might not yield immediate profits, addressing market failures and underinvestment in clean technologies. While government failure is a concern, it's essential to recognize that market failures, such as externalities and public goods issues, often necessitate government intervention in climate finance. Public financing can address these market failures by providing incentives for clean energy adoption and supporting projects that might not have immediate profitability.

2.5.3 Public Choice Perspectives:

Buchanan and Tollison (1984) is key in the development of public choice theory, which explores the application of economic reasoning to political decision-making. Public choice theory explores how individuals' self- and the influence of special interest groups shape public policy and decision-making (Buchanan & Tullock, 2018). These perspectives play a crucial role in the public vs. private climate finance debate and the outcomes of climate projects. In favor of public climate finance, public choice theory supports the idea that governments are more likely to represent the broader interests of the public (Buchanan & Musgrave, 1999). Public finance can be less influenced by profit-maximizing incentives, and funding decisions can be made based on societal needs and environmental goals. Critics argue that private entities,

while profit-driven, can respond more quickly to market demands and emerging green technologies, making them well-suited for implementing climate projects efficiently, driving innovation and contributing to the deployment of sustainable technologies and solutions. However, they acknowledge the need for appropriate regulations to prevent market failures.

Public choice perspectives highlight the *influence of special interest groups* on government decision-making. In the context of climate finance, this perspective underscores the need for transparency and accountability to prevent undue influence by interest groups that may prioritize short-term economic interests over long-term environmental and societal goals. Public choice theory recognizes that ***market failures, such as externalities, can necessitate government intervention***. Public climate finance is often required to address market failures that might result in underinvestment in clean technologies and climate projects. Achieving a balance between public and private interests is crucial in climate finance. While private financing can expedite project implementation, it should be appropriately regulated to ensure that climate projects align with sustainability objectives and do not compromise broader societal and environmental interests.

2.5.4 Principal-Agent Models:

George A. Akerlof and Michael Spence both received Nobel Prizes in economics for their contributions to the theory of information asymmetry and principal-agent models (Akerlof, 1990; Spence, 1981,1997; Spence & Zeckhauser, 1978). They helped develop the concept of moral hazard and adverse selection, which are central to these models. Principal-agent theory examines the relationship between a principal (e.g., the funding body) and an agent (e.g. the project implementer) in achieving specific objectives. It delves into the challenges of aligning the interests of both parties. In favour of public climate finance: Advocates argue that public finance can establish clear objectives for climate projects and use regulatory mechanisms to align the interests of public agencies (the principal) with project implementers (the agents). This can enhance accountability and ensure that public goals are met. Supporters of private financing contend that it aligns interests through contracts and incentives. In this case, the government acts as the principal, and private entities execute climate projects, often driven by profit motives. This model can promote cost-efficiency and results-driven performance.

Achieving the alignment of interests is crucial for the success of climate projects, as it ensures that agents work diligently to meet the public goals set by the principal. Principal-agent relationships are often governed by contractual agreements that specify the terms, conditions,

and performance criteria. In climate finance, these contracts are used to define the roles, responsibilities, and performance expectations of implementing entities. Properly structured contracts can help manage risks, ensure accountability, and provide incentives for agents to meet the goals of climate projects. Effective principal-agent models include mechanisms for monitoring and ensuring accountability. Public climate finance often relies on robust monitoring and evaluation systems to track the progress of projects, measure their performance, and ensure that the agents are fulfilling their obligations. Transparency and accountability mechanisms are essential for building trust between principals and agents.

Overall, principal-agent models are highly relevant to SDGs, particularly those related to partnerships and responsible economic growth. Climate projects influenced by these models can align with SDG 17 (Partnerships for the Goals) by fostering collaboration between the public and private sectors, and they can contribute to SDG 8 (Decent Work and Economic Growth) by promoting responsible and sustainable economic activities that address climate challenges.

2.5.5 Property Rights Theory:

Ronald Coase is renowned for his work on property rights and the theory of the firm (Coase, 1910). His research laid the foundation for understanding the role of property rights in resource allocation and market transactions. Property rights theory focuses on well-defined and secure property rights and how they affect resource allocation. It argues that well-defined and secure property rights lead to efficient resource utilization. Proponents in favour of public climate finance argue that public financing ensures collective property rights over environmental resources and can lead to better conservation and sustainable use of these resources. By emphasizing shared ownership and responsible stewardship of common goods like the atmosphere and natural habitats, public financing, when well-structured supports long-term sustainability goals. Supporters of private finance on the other hand emphasize that property rights can be well-defined and secure in private initiatives, allowing for investments in green technologies and projects with clear ownership and revenue models. These secure rights can encourage innovation and provide the private sector with a clear framework for responsible resource management.

Both public and private climate finance approaches, when guided by property rights principles, can significantly contribute to environmental conservation. By securing property rights to natural resources and ecosystems, financing can facilitate responsible usage and protection of

vulnerable ecosystems. Property rights theory aligns well with SDGs that emphasize responsible resource management, such as Goal 12 (Responsible Consumption and Production) and Goal 14 (Life Below Water). It promotes a framework in which ecosystems and resources are conserved for the benefit of present and future generations, supporting the broader objectives of sustainability.

In the debate over public vs. private climate finance, the application of these perspectives varies. Public climate finance is often favoured for large-scale, long-term climate initiatives, while private climate finance may excel in rapidly deploying established green technologies. The optimal approach often involves a combination of both, striking a balance between public oversight and private-sector efficiency to address climate change effectively while ensuring accountability and safeguarding public interests. The specific context and objectives of climate projects play a significant role in determining the appropriate funding source.

2.6 Empirical Literature Review

Privatization as a topic and its impact on comparative efficiency has received significant attention in recent years (Tang, 1997). Despite the common association of privatization, including Public-Private Partnerships (PPPs), with increased technical efficiency, empirical evidence challenges this assumption (Cook & Fabella, 2001). Various studies across different sectors and forms of privatization reveal no inherent superiority of the private sector in terms of technical efficiency (Berg, 1985; Paul, 1985; Kikeri, Nellis & Shirley, 1992; Kikeri, Nellis & Shirley, 1994). Cook & Fabella (2001) note that this holds true for outsourced services, privatizations by sale, and PPPs alike. The debate on privatization thus hinges on the comparative efficiency between the public and private sectors, with significant implications. If the private sector fails to consistently demonstrate substantial technical efficiency gains, the primary rationale for privatization weakens.

In the context of climate change and climate finance, there is the need to examine how the public and private sector affects the effectiveness and efficiency of climate change interventions. As such, just as privatization is often associated with efficiency, private climate finance is expected to be more efficient compared to public climate finance from project initialisation/design to project performance and achieving climate change mitigation and adaptation goals. Climate finance initiatives aim to reduce greenhouse gas emissions and enhance resilience to climate-related risks, particularly in vulnerable communities. Climate

finance effectiveness in terms of reducing emissions and vulnerability is a multifaceted Endeavor that encompasses various strategies, interventions, and considerations. Examining the effectiveness of public and private climate finance involves evaluating its influence on project initialisation/design, project performance as well as meeting sustainable development goals.

2.6.1 Linkages Between Project Design, Performance and SDGs

The source of climate finance, whether public or private, significantly influences the design of climate change interventions, subsequently impacting project performance and the realization of broader development benefits, including Sustainable Development Goals (SDGs) (Barnard et al., 2014). When climate finance comes from public sources, such as government budgets or international aid, interventions often prioritize broader societal objectives and public interests (Heuson et al., 2015). These projects tend to have more extensive stakeholder consultations, regulatory compliance, and adherence to government policies and priorities (Scandurra et al., 2020). Additionally, public finance may enable the implementation of large-scale infrastructure projects and capacity-building initiatives that contribute to long-term resilience and sustainability (Steckel et al., 2017). On the other hand, climate finance from private sources, such as corporate investments or philanthropic funds, may prioritize profitability and risk mitigation (Zhao et al., 2022). Private interventions often emphasize innovation, efficiency, and market-driven solutions tailored to specific business objectives or investment criteria (Kotchen & Costello, 2018). Consequently, private projects may exhibit more flexibility, agility, and responsiveness to market dynamics (Lou et al., 2022). However, they may also face challenges related to accountability, transparency, and inclusivity, particularly concerning marginalized communities and vulnerable populations (Colenbrander et al., 2018).

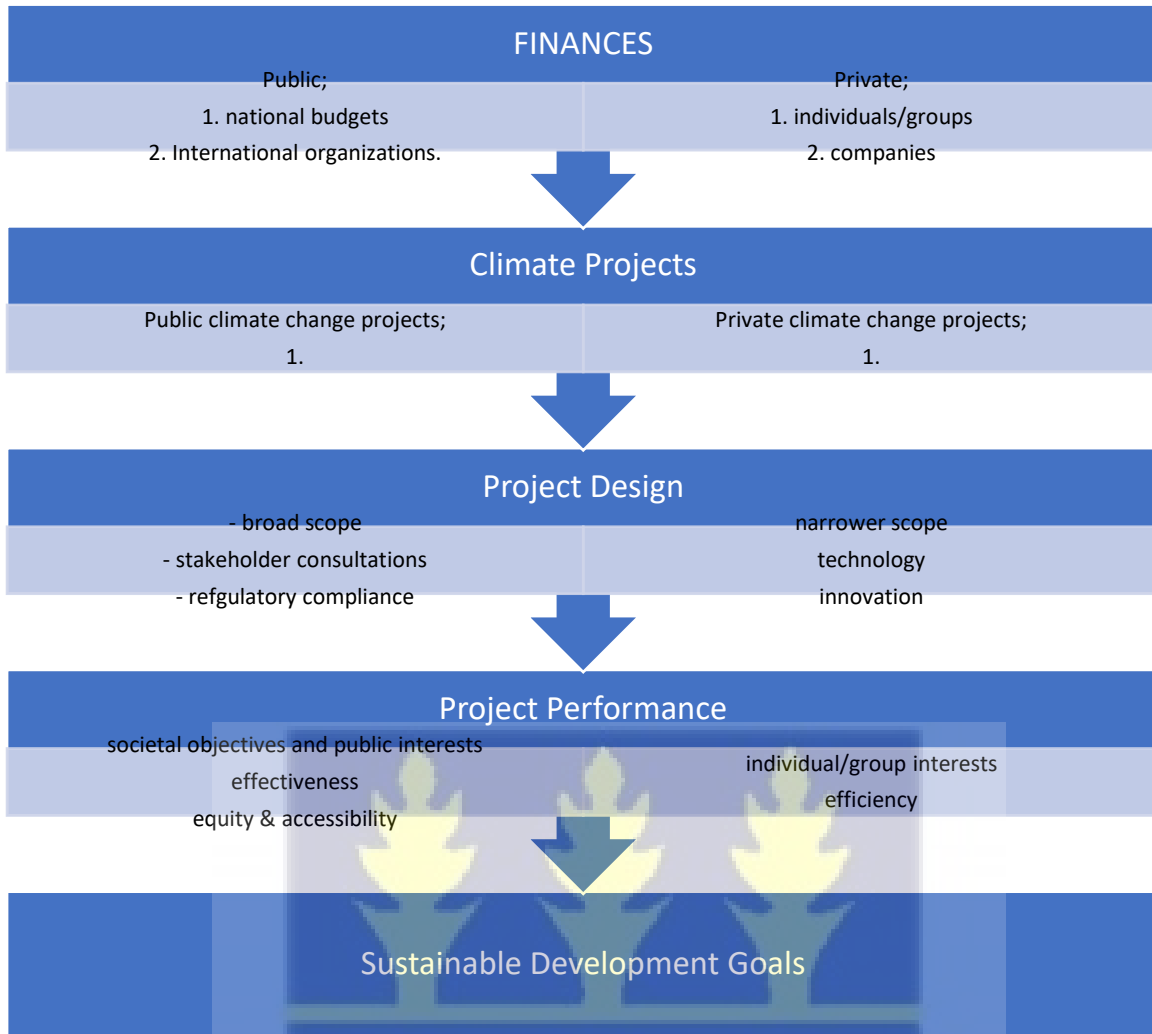
The design of climate change interventions, influenced by the source of climate finance, ultimately shapes project performance across various metrics, including relevance, effectiveness, efficiency, sustainability, and impact (Stender et al., 2020). Publicly funded interventions tend to prioritize broader societal benefits and public goods, aiming for relevance to government policies and objectives (Islam, 2022). These projects often demonstrate effectiveness in achieving stated goals and objectives, supported by robust planning, stakeholder engagement, and institutional support (Jakob et al., 2015). However, they may face challenges related to bureaucratic processes, budget constraints, and political considerations,

which can impact efficiency and timeliness (Hussain & Ahmad, 2019). Conversely, privately funded interventions may prioritize efficiency and profitability, aiming to maximize returns on investment while minimizing costs and risks (Lee et al., 2022). These projects often demonstrate agility and innovation, leveraging market dynamics and technology advancements to achieve desired outcomes (Carfora et al., 2017). However, they may face challenges related to scalability, equity, and long-term sustainability, particularly in ensuring inclusivity and addressing social and environmental concerns (Leal et al., 2023).

The performance of climate change interventions, influenced by their design and financing sources, ultimately determines their impact on broader development benefits, including SDGs (Stender et al., 2020). Publicly funded interventions, with their emphasis on societal objectives and public interests, may have a more direct and measurable impact on SDGs, particularly those related to environmental sustainability, poverty alleviation, and social equity (Stender et al., 2020). These projects often contribute to multiple SDGs by addressing interconnected challenges and promoting inclusive and sustainable development (Steckel et al., 2017). However, their impact may be constrained by resource limitations, institutional capacity, and political dynamics (Barnard et al., 2014). Privately funded interventions, while potentially innovative and efficient, may have a more indirect or limited impact on SDGs, focusing primarily on profitability and market-driven outcomes (Stender et al., 2020). Nonetheless, they can complement public efforts and catalyze private sector engagement in addressing climate change challenges and achieving sustainable development goals (Jakob et al., 2015). Overall, a combination of public and private finance, coupled with effective governance, stakeholder engagement, and monitoring mechanisms, is essential for maximizing the impact of climate change interventions on broader development benefits and advancing sustainable development goals.

Figure 5: Linkages Between Project Design, Performance and SDGs





Source; Author, (2024)

From figure 6 above, the financing of the project (public/private) leads to different ownership (public/private), project designs and performance. But ultimately, both publicly and privately financed climate change projects end up meeting SDGs intended or unintended.

2.6.2 Effects of Public and Private Climate Finance on Project Design

Several studies have looked into project initialisation/designs and how payoffs of allocated resources are structured trying to understand decision making regarding resources used/protected, benefits provided and the beneficiaries. Yellow Brick Consulting, Inc and Guzman (2020) and Berkes (2004) make it clear that a clear plan involving the scope/scale, goals, funding sources, assigning responsibilities, management etc is the first step to a successful project. But decisions on project finance runs through the entire project and affects every aspect of it (Gatti, 2023). Brooks, Waylen and Borgerhoff Mulder (2012) categorized the

aspects of project design into decentralization, access to resource, equity of benefits and investment in human/social capital. Project success is often contingent on local participation and engagement, as emphasized by Ostrom (1993) and Ingram et al. (2010), who advocate for decision-making in the hands of local communities. Furthermore, equitable distribution of benefits, capacity building, and environmental education are identified as key factors affecting project success.

Utilization of climate services/projects has seen mixed outcomes from researchers. Bruner, Gullison, Rice and Da Fonseca (2001) found that Protectionism sometimes brings about success of ecological projects whereas Berkes (2004) indicated that access to resources rather brings about benefits including economic benefits which encourages sustainable resource extraction as well as support and compliance with climate initiatives. There is further evidence that insufficient compensation/protectionism can engender resentment (Lindsay, 1988) leading to biodiversity loss (Caro et al. 1998). In the context of resource utilization, projects that do not lace natural resources off limits are expected to be successful in comparison to projects in Favor of protectionism.

Ferraro (2011) indicated that economic benefits can help reduce environmental exploitation by rewarding sustainable use through the provision of alternative livelihoods (Godoy, 2001)) performance payments (Pretty, 2003). Thus, benefits through direct compensation, development infrastructure, income generating opportunities affect climate projects. Brooks, Waylen and Borgerhoff Mulder (2012) also mention that equitable distribution of benefits among community members affects climate projects success. Providing clear and well directed economic benefits as well as ensuring equitable sharing of benefits affects project success.

In the works of Salafsky et al. (2001) where they look at enterprise-based projects, project designs that involve employing community policing and using/training locals as managers were more successful compared to projects which inculcated economic returns. As such, investments in human and social capital makes positive outcomes more likely as it lowers cost of transaction and strengthens potential of local coordination (Pretty, 2003).

As much as incorporating participation, utility, equity and capacity building into project designs elevates the effectiveness of the projects, the source of funds also has the potential to influence project designs. Given the numerous studies that have looked at project designs, there are no studies on how public and private sectors influence projects. This study thus looks to

bridge this gap by investigating the influence of public and private climate finance on project designs, decision-making, project scale, community participation, innovation and technology.

Christel et al. (2018) study on climate services delineates two primary design challenges: a domain challenge and an informational challenge, emerging during the early stages of research and prioritized through stakeholder engagement. The domain challenge revolves around rendering innovative information and services usable within a complex user landscape, particularly in an as yet undeveloped market, aiming to foster growth in the climate services sector (Buontempo et al., 2014). Effective collaboration with potential users from the outset and a human-centred design approach are deemed essential for developing products and services that meet user needs (Vaughan & Dessai, 2014). The EUPORIAS project exemplifies this challenge, as the development of prototypes faced uncertainties in potential use cases and low awareness among relevant industries regarding Seasonal to Decadal (S2D) climate predictions, presenting obstacles to user engagement (Brunet et al., 2010; Weisheimer & Palmer, 2014).

The informational challenge primarily concerns the probabilistic nature of S2D predictions, posing difficulties in effectively communicating complex scientific information to decision-makers in various sectors, including energy (Dilling & Lemos, 2011). Moreover, entrenched practices in certain sectors and limited accessibility to information further compound these challenges (Landberg et al., 2003; Rodrigo, 2010). Addressing these challenges requires leveraging design and data visualization expertise to enhance the usability and comprehensibility of climate information, particularly in interdisciplinary teams involving actors from outside academia, such as data artists (visualizers), to transcend disciplinary boundaries and tackle the complexity of the problem holistically (Lang et al., 2012; McNerny et al., 2014; Burgin & Hofkirchner, 2017). Ultimately, the design challenge lies in creating and testing user-oriented services based on probabilistic information within this emerging domain.

2.6.3 Effects of Climate Finance on Effective Mitigation (Climate Change and Emissions Reduction)

In addressing emissions reduction, climate finance initiatives encompass a multifaceted approach aimed at catalysing the transition towards low-carbon economies and sustainable energy systems (Nakhouda et al., 2015). This comprehensive strategy involves allocating resources to various sectors and activities designed to mitigate greenhouse gas emissions and

promote environmental sustainability. One key aspect involves investments in renewable energy infrastructure, including but not limited to solar photovoltaic, wind turbines, and hydroelectric power generation. By funding the development and installation of these renewable energy technologies, climate finance facilitates the displacement of fossil fuel-based energy sources, thereby reducing carbon emissions and mitigating climate change. Wind generation is generally promoted by policy makers to reduce national emissions as it does not in itself create any harmful emissions (Denny, Bryans, Gerald & O'Malley 2006; Denny & O'Malley, 2006). In light of this Denny and O'Malley (2006) constructed a dispatch model to assess how large levels of wind generation affects the operation of conventional plants and consequent emissions of carbon dioxide (CO₂), sulphur dioxide (SO₂), and nitrogen oxides (NO_x). Their study focused on a predictive approach that integrates wind generation forecasts into dispatch decisions. Results indicated that while wind generation could mitigate CO₂ emissions, it was insufficient in reducing SO₂ and NO_x emissions on its own.

Furthermore, climate finance initiatives support the deployment of energy-efficient technologies across industries, buildings, and transportation networks. These efforts involve financing the adoption of energy-saving equipment and practices, retrofitting existing infrastructure for improved energy efficiency, and promoting the use of cleaner transportation alternatives such as electric vehicles and public transit systems. By incentivizing the adoption of energy-efficient measures, climate finance contributes to lowering energy consumption and reducing emissions associated with various economic activities. Reducing fossil carbon emissions across various industrial sectors is paramount due to their significant material flows and energy consumption. Inefficient energy use exacerbates carbon emissions, underscoring the importance of aligning economic, energy, and environmental policies with resource efficiency, particularly energy efficiency (Robaina-Alves, Moutinho & Macedo, 2015). Carbon emissions are inherent in all industrial activities, spanning from material extraction to end-of-life product management. Despite rising aggregate carbon emissions, industrial practices lag behind in necessary improvements (Stål, 2015). However, emerging carbon emission reduction technologies offer promise if implemented effectively sector-wide, aiding in mitigating climate change crises (Slowak & Taticchi, 2015). Alongside technical innovation, the strategic design and timing of policy interventions are crucial for overcoming barriers to innovation and enhancing energy efficiency.

Iron and steel production stands as a significant contributor to anthropogenic CO₂ emissions, with efforts to limit global mean temperature increase necessitating potential drastic increases

in CO₂ prices to internalize externalized impacts. Morfeldt et al. (2015) demonstrate that substantial energy efficiency enhancements in current steel production processes, like top gas recycling, can only meet binding climate targets when paired with Carbon Capture and Storage (CCS). Moreover, such targets may induce regional price differentiations, posing challenges for regions such as China, India, and South Korea, reliant on fossil fuels for energy, to meet their steel demand due to high CO₂ prices. Among various pathways of reducing emissions, industrial symbiosis emerges as a crucial approach, fostering win-win synergies between environmental and economic performance through shared energy, materials, and infrastructure among co-located entities. For China's integrated steel mills (ISMs), Yu, Li, Shi and Qian (2015) identified key symbiotic measures for CO₂ abatement, including blast furnace gas and coke oven gas recycling on-site or for sale off-site, along with selling blast furnace slag to cement producers. They also highlighted the significant potential of utilizing gaseous and solid waste/byproducts and emphasized the importance of cleaner production within ISMs for CO₂ abatement compared to symbiotic measures with other enterprises.

Cement is a fundamental and widely used building material, particularly in civil engineering, with its demand surging due to rapid urbanization. However, the cement industry is also a significant contributor to carbon emissions, accounting for about 1.8 gigatons of CO₂ emissions in 2006, representing approximately 7% of global anthropogenic CO₂ emissions (Gao et al., 2015; Chen, Hong & Xu, 2015). Ishak and Hashim (2015) conducted a comprehensive review of CO₂ emissions throughout all stages of cement manufacturing, highlighting that 90% of emissions originate from clinker production, while the remaining 10% stem from raw materials preparation and the finishing stage of cement production. Various strategies to reduce CO₂ emissions in the cement industry have been proposed, including energy efficiency enhancements, waste heat recovery, adoption of renewable energy sources, production of low-carbon cement, and carbon capture and storage (CCS). Moreover, the utilization of supplementary cementitious materials, such as fly ash, silica fume, and ground-granulated blast furnace slag, is advocated to mitigate carbon emissions (Liu et al., 2015; Crossin, 2015; Yang et al., 2015). Gao et al. (2015) demonstrated that replacing carbonate-containing materials with non-carbonate alternatives and adjusting the clinker ratio are primary methods for reducing CO₂ content in raw materials and process emissions. For instance, the adoption of Calcium sulphoaluminate (CSA) cement manufacturing in modern plants can yield CO₂ emissions reductions of up to 35% per unit of cement produced compared to ordinary Portland cement manufacture.

Apart from allocating resources towards renewable energy and energy efficiency projects, climate finance assumes a pivotal role in propelling the development of clean energy innovations and technologies (Huisingsh et al., 2015; Crossin, 2015). Through research and development initiatives funded by climate finance, significant strides are made in advancing technological solutions across various sectors. Specifically, investments aim to drive progress in renewable energy generation, focusing on enhancing the efficiency and scalability of solar, wind, and hydroelectric power systems (Denny & Malley, 2006). Furthermore, funding is directed towards the advancement of energy storage technologies, crucial for overcoming intermittency challenges associated with renewable energy sources. Additionally, climate finance supports research into carbon capture and storage (CCS) technologies, aimed at mitigating emissions from fossil fuel-based energy generation (Huisingsh et al., 2015). By fostering innovation in these key areas, climate finance accelerates the transition towards a more sustainable and low-carbon energy system. This shift towards cleaner energy sources and technologies is integral to achieving emissions reduction goals and combating climate change effectively.

Overall, by channelling financial resources towards these diverse initiatives, climate finance plays a pivotal role in reducing the emission intensity of economic activities and accelerating the decarbonization process. However, there has been no studies on which source of funding or resource allocation (public sector or private sector) will be more effective at emissions reduction interventions. Thus, this study looks to investigate how public and private climate finance affects mitigation projects so as to come out with the best mode of financing climate change mitigation interventions.

2.6.4 Effects of Climate Finance on Effective Adaptation (Sustainable Development and Vulnerability)

Effective climate finance strategies acknowledge the multifaceted challenges posed by vulnerability to climate change impacts, particularly in regions and communities that are disproportionately affected (Gordon, 2018; Schalatek, & Nakhooda, 2015). Recognizing the urgency of addressing vulnerability, climate finance initiatives prioritize investments in adaptation measures aimed at enhancing resilience and adaptive capacity across various sectors and geographies (Wong, 2016; Nakhooda et al., 2011). These adaptation efforts encompass a

broad spectrum of interventions, ranging from enhancing the resilience of critical infrastructure to supporting nature-based solutions and community-based adaptation projects.

One critical aspect of vulnerability mitigation involves strengthening critical infrastructure to withstand climate-related hazards. Climate finance is instrumental in funding projects aimed at fortifying infrastructure such as flood defences, coastal protection systems, and water management infrastructure, thereby reducing the risk of damage and loss from extreme weather events and rising sea levels (Gordon, 2018). By investing in resilient infrastructure, climate finance helps communities adapt to changing climate conditions and minimize the socio-economic impacts of climate-related disasters. In the works of Gordon et al. (2018) for instance, they assessed the multi-sector performance of Green Infrastructure with the premise that Green Infrastructure (GI) offers a promising solution to challenges posed by aging water infrastructure, urbanization, and increasing water demands. However, realizing GI's potential requires overcoming barriers such as funding access and design of financing strategies. Without a scalable model for assessing GI project performance, attracting investment remains challenging. To address this, comprehensive conceptual frameworks and models are proposed to systematically monitor and measure GI performance. A conceptual model integrates evaluation methods, performance metrics, and risk management techniques to enhance funding opportunities. These findings offer insights for both research and practitioners aiming to implement GI projects. Additionally, incorporating ecosystem services into decision-making processes can further bolster the case for GI's importance.

Moreover, climate finance plays a crucial role in supporting nature-based solutions, which leverage the inherent resilience of ecosystems to enhance climate resilience and provide multiple co-benefits. Investments in ecosystem restoration and conservation initiatives help protect biodiversity, enhance carbon sequestration, and improve ecosystem services, such as water regulation and soil stabilization. By promoting nature-based approaches, climate finance not only mitigates climate risks but also contributes to sustainable development goals, including biodiversity conservation, inequality and poverty alleviation. In their respective studies, Schalatek and Nakhooda (2016) and Wong (2016) delve into the gender dynamics of climate finance and its implications on equity. Schalatek and Nakhooda's research, outlined in "Gender and Climate Finance," underscores how women, representing the majority of the world's poorest, face disproportionate climate impacts due to gender norms and discrimination. They advocate for gender-responsive climate financing to ensure the equitable use of public funds, with recent improvements exemplified by the Green Climate Fund's prioritization of

gender integration. Wong (2016), on the other hand, examines how climate finance aids in mobilizing additional development funds for emission reduction and climate adaptation in developing countries. However, concerns arise regarding the increasing implications of climate finance on gender equity. Drawing on an equity framework, Wong's literature review highlights constraints on climate finance effectiveness stemming from gender gaps in access to land and capital, urging policymakers to address structural inequalities to maximize climate finance impact.

Additionally, community-based adaptation projects are essential for building resilience at the local level. These projects empower communities to identify and implement adaptation strategies that are tailored to their specific needs and contexts, often integrating traditional knowledge and local practices. By involving local stakeholders in decision-making processes and capacity-building activities, climate finance enables communities to enhance their adaptive capacity, strengthen social cohesion, and promote sustainable livelihoods. Through these community-driven approaches, climate finance fosters resilience from the ground up, ensuring that vulnerable communities are better prepared to cope with the impacts of climate change now and in the future.

Overall, allocating resources for climate change adaptation projects is essential as it leads to sustainable development by reducing vulnerabilities resulting from climate change and creating resilient communities. Achieving this objective however requires that more studies are done to unearth optimum levels of resource allocation such as whether public sector or private sector is better at rolling out climate change adaptation interventions. There have been no studies within this sphere and this study thereby looks to fill this gap.

2.6.5 Climate Finance and SDGs

Climate finance, sourced from both public and private sectors, stands as a pivotal driver in propelling the Sustainable Development Goals (SDGs) forward. Substantiated by empirical evidence highlighting its impact on climate change mitigation/adaptation, poverty reduction, environmental preservation, and economic growth. Here's a breakdown of how public and private climate finance contribute to achieving the SDGs, supported by concrete research findings:

- I. **SDG 7: Affordable and Clean Energy:** Studies, such as those by Nhemachena et al. (2020) and Luu et al. (2021), underscore the role of climate finance in facilitating the adoption of renewable energy sources like solar, wind, and hydroelectric power. These investments not only enhance energy accessibility but also drive down costs, aligning with SDG 7's aim of ensuring affordable and clean energy access for all.
- II. **SDG 13: Climate Action:** Farzaneh et al. (2021) and Frank et al. (2021) provide empirical evidence supporting the critical role of climate finance in funding climate mitigation and adaptation projects. These initiatives, encompassing renewable energy deployment and climate-resilient infrastructure development, directly contribute to SDG 13 by curbing greenhouse gas emissions and bolstering societal resilience to climate impacts.
- III. **SDG 1: No Poverty:** Gandini, Quesada, Prieto and Garmendia (2021) and Pour et al. (2020) present research demonstrating how climate finance supports poverty alleviation efforts. By promoting sustainable livelihoods and investing in climate-resilient agriculture, both public and private finance channels contribute to SDG 1's objective of eradicating poverty and fostering inclusive economic growth.
- IV. **SDG 3: Good Health and Well-being:** Studies such as those by Satterthwaite et al. (2020) and Nicholls et al. (2020) provide empirical support for the positive health outcomes associated with climate finance interventions. Reduced air pollution and improved access to clean water and sanitation, facilitated by climate finance, directly contribute to SDG 3's goal of ensuring good health and well-being for all.
- V. **SDG 6: Clean Water and Sanitation:** Marando et al. (2022) and Pour et al. (2020) offer empirical evidence highlighting the impact of climate finance on enhancing access to clean water and sanitation services. Through investments in water resource management and wastewater treatment, both public and private finance avenues contribute to realizing SDG 6's objectives.
- VI. **SDG 11: Sustainable Cities and Communities:** Research by Gandini et al. (2021) and Marando et al. (2022) provides empirical support for the role of climate finance in fostering sustainable urban development. Investments in climate-resilient infrastructure and green initiatives contribute to SDG 11's aim of building inclusive, safe, resilient, and sustainable cities.
- VII. **SDG 12: Responsible Consumption and Production:** Pour et al. (2020) and Nicholls et al. (2020) present empirical evidence highlighting how climate finance drives investments in sustainable production processes and promotes responsible consumption

patterns. These initiatives, supported by both public and private finance, align with SDG 12's objective of ensuring sustainable consumption and production patterns.

In conclusion, empirical evidence underscores the critical role of both public and private climate finance in advancing the Sustainable Development Goals. By aligning investments with SDG targets and integrating climate considerations into development strategies, policymakers and stakeholders can maximize the impact of climate finance and accelerate progress towards a sustainable and resilient future for all.

2.7 Conclusion

Assessing the effectiveness of climate finance in these domains requires a comprehensive approach that considers not only the quantity of financial resources mobilized but also the quality and impact of interventions. Key metrics for evaluating emissions reduction effectiveness may include the volume of greenhouse gas emissions avoided or reduced per unit of investment, as well as the contribution of climate finance to the overall trajectory of global emissions. Similarly, vulnerability mitigation effectiveness can be assessed by indicators such as improvements in adaptive capacity, reduced exposure to climate-related risks, and enhanced socio-economic resilience in vulnerable communities.

To ensure accountability and enhance learning, robust monitoring, and evaluation mechanisms are essential. This involves tracking the implementation and outcomes of climate finance projects, conducting rigorous impact assessments, and sharing lessons learned to inform future decision-making and optimize resource allocation. By continuously refining strategies based on evidence-based insights and stakeholder feedback, climate finance can maximize its contribution to emissions reduction and vulnerability mitigation, thereby advancing global efforts towards a more sustainable and resilient future.

2.7.1 Gaps and Methodologies

Within the extensive body of literature on climate finance and its effects on climate projects, several notable gaps warrant further exploration. One key gap is the need for more comprehensive research on the synergies and conflicts between public and private sources of climate finance. While existing studies have shed light on their respective impacts, there is

limited research on how to effectively blend these funding sources to maximize climate project outcomes. Bridging this gap would involve conducting comparative analyses of case studies and assessing the specific conditions under which such blends are most successful.

Another critical gap in the literature pertains to the evaluation of climate project outcomes in terms of their contributions to Sustainable Development Goals (SDGs), particularly those related to poverty reduction, employment generation, and inequality reduction. While there is a growing recognition of the interconnectedness between climate action and SDGs, empirical studies that assess these linkages remain scarce. Researchers can employ methodologies such as impact evaluations, surveys, and case studies to assess the direct and indirect effects of climate projects on poverty alleviation, employment opportunities, and social equity.

Additionally, there is a need for more research on the role of climate finance in specific regions and contexts, with a focus on developing countries and regions vulnerable to climate change impacts. Literature gaps exist in understanding the unique challenges and opportunities these regions face in accessing and utilizing climate finance effectively. Qualitative research methodologies, such as interviews and participatory assessments, can provide insights into the barriers faced by local communities and the potential solutions to enhance their resilience through climate finance.

In view of the gaps revealed in the literature review, this study seeks to investigate and assess the effects of public and private climate finance on the design of climate change initiatives/interventions (mitigation and adaptation projects), the effects of public and private climate finance on the performance and effectiveness of climate change initiatives/interventions (mitigation and adaptation projects) and the effects of public and private climate finance on sustainable development.



CHAPTER THREE

METHODOLOGY

3.1 Introduction

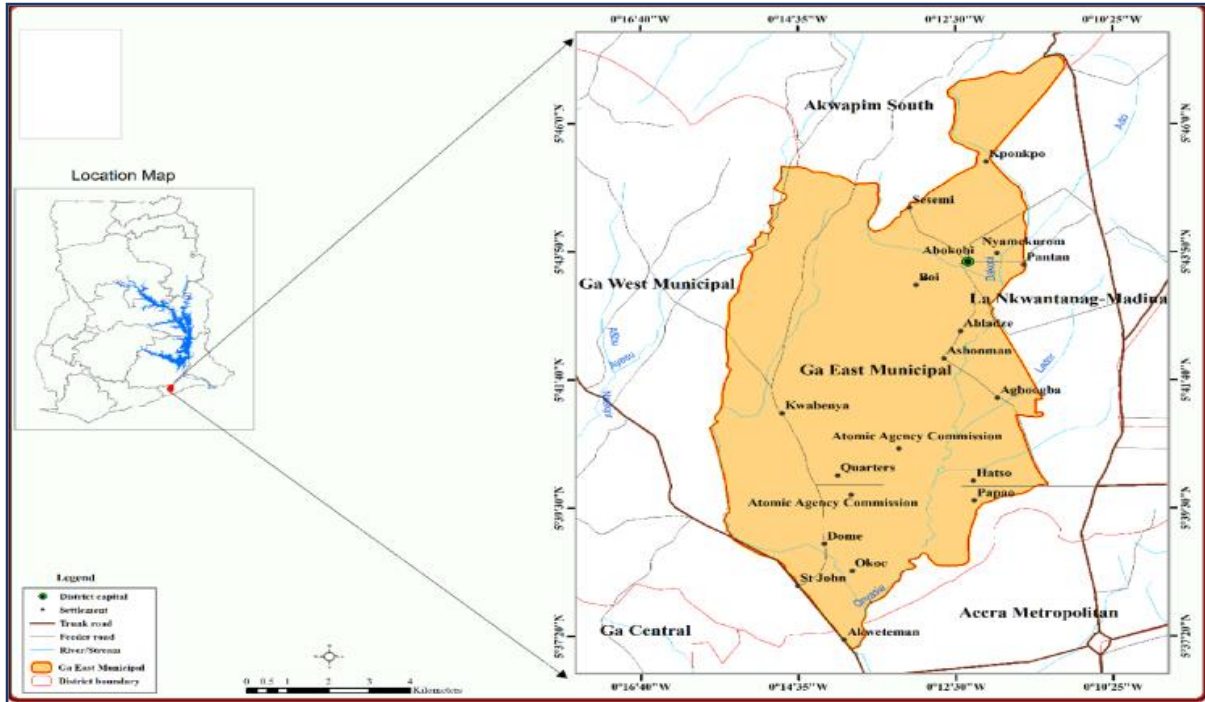
In an effort to explore how different sources of climate finance affect the outcomes of climate change projects in Ga East Municipal, this chapter explains the research methods that were used to achieve the objectives of the study. Themes discussed under this chapter include; study area, case study projects, design of the study, variables of interest, data sources, data collection and analysis.

3.2 Study Area: Ga East Municipal

The Ga East Municipal area, also known as the Ga East Municipality, is a prominent administrative district located in the Greater Accra Region of Ghana. Compared to other districts in Accra, Ga East Municipal Assembly (GEMA) stands out due to its unique geographical location at the base of a mountain, which makes it more prone to landslides, soil erosion, and flooding, especially during heavy rains. While districts like Accra Metropolitan and Tema experience coastal flooding, GEMA faces distinct challenges in water management and drainage due to its terrain. Additionally, GEMA has a mix of urban and rural areas, with rapid urbanization and informal settlements that lack adequate infrastructure, making it especially vulnerable to climate impacts. In contrast, other districts in Accra, such as the more urbanized parts of Accra Central, may have better infrastructure and focus on coastal resilience, but they too face challenges related to flooding and waste management, albeit with less topographical complexity than GEMA.

Geographical Location: Ga East Municipal is situated in the northeast of Accra, the capital city of Ghana, and it shares borders with several other districts, including La-Nkwantanang-Madina Municipal, Kpone-Katamanso District, Tema Metropolitan, and Adentan Municipal. Its strategic location places it within the Greater Accra area, making it an essential part of the region's urban and economic landscape.

Figure 6: Map of Ga East Municipal



Source; GEMA APR (2021)

The Ga East Municipal area serves as an ideal and relevant study area for various reasons, making it a good fit for the research at hand.

- i. **Urban and Environmental Significance:** Ga East Municipal is an urban area located in the Greater Accra Region of Ghana. As part of the Greater Accra Metropolitan Area, it experiences urbanization pressures, including population growth, infrastructure development, and economic activities. This urban context is particularly important in the context of climate change, as urban areas are often more vulnerable to its impacts due to factors like increased heat, flooding, energy demand and infrastructure strain.
- ii. **Climate Vulnerability:** Ga East Municipal faces several climate-related challenges, including unpredictable rainfall patterns, flooding, demand for electricity and increased temperatures. These issues are not unique to this region but reflect broader climate concerns in many urban areas globally. Studying climate finance in Ga East Municipal can provide insights and lessons applicable to other urban settings dealing with similar challenges.
- iii. **Diversity of Climate Finance Needs:** This area presents a diverse set of climate finance needs. It requires mitigation efforts to reduce emissions, such as transitioning to cleaner energy sources, waste management and sustainable transportation systems. Simultaneously, it requires adaptation strategies to cope with the adverse effects of

climate change, like flooding or extreme weather events. In terms of financing these projects, the municipality has residents and businesses capable of privately finance climate change projects and government as well has interests in the municipality thus public climate change projects are expected to be available. The range of climate finance needs can serve as a microcosm of the broader climate finance landscape, allowing researchers to explore various dimensions of funding requirements and solutions.

- iv. ***Community Engagement and Participation:*** Research in Ga East Municipal can involve local communities and stakeholders, ensuring that the study benefits from their insights and addresses their specific concerns. Engaging with the community can lead to more contextually relevant findings and foster greater local ownership of climate finance initiatives.

Thus, Ga East Municipal's urban and climate-related challenges, policy relevance, and potential for diverse climate finance needs make it a compelling study area. The findings from this region have the potential to contribute not only to a deeper understanding of climate finance dynamics at the local level but also to the development of strategies and policies that can be applied to address climate change challenges in urban areas both within and beyond the Greater Accra Region of Ghana.

3.2. Projects Under Study

3.2.1 Climate Change Mitigation Projects; Energy and climate change:

Climate change and energy are closely related. The U.S. energy system is vulnerable to a wide range of climate change impacts such as rising temperatures and heat waves, cold and snow events, severe drought, intense rainfall, sea level rise, hurricanes, and wildfires. Three-quarters of global greenhouse gas emissions come from our current fossil-fuel based energy sector. The Intergovernmental Panel on Climate Change (IPCC) clearly shows us that global emissions need to be reduced to net-zero within the next few decades to avoid a dangerous increase in global temperatures. By using renewable energy sources such as solar and wind power and reducing our energy consumption by using energy-efficient appliances and reducing waste, we can help mitigate the effects of climate change and ensure a sustainable future for generations to come.

a) Public Sector Street Light Project by GEMA (Ga East Municipal Assembly):

The public sector street light project led by GEMA in Ga East exemplifies a proactive approach by governmental bodies to address climate change mitigation. Grounded in principles of social welfare economics, this project aims to enhance public safety, reduce carbon emissions, and promote energy efficiency. GEMA's project involves the installation of energy-efficient LED street lights across Ga East, reducing energy consumption and greenhouse gas emissions compared to traditional lighting systems. By investing in sustainable infrastructure, GEMA demonstrates its commitment to environmental stewardship and long-term resilience against climate change impacts. Moreover, the project aligns with Sustainable Development Goals related to affordable and clean energy (SDG 7) and climate action (SDG 13), contributing to global efforts to combat climate change and build sustainable communities.

b) Private Group Street Light Project in Ga East:

In contrast to the public sector initiative, the private group street light project in Ga East reflects principles of private enterprise and market efficiency in addressing climate change mitigation. Led by a private homeowners' association (a community-based organization), this project seeks to enhance neighbourhood safety, security, and aesthetics through the installation of street lights. The private group may opt for energy-efficient lighting solutions to reduce operational costs and environmental impact. While driven by profit motives and self-interest, the project's outcomes contribute to climate change mitigation by promoting renewable energy adoption and reducing reliance on fossil fuels. Additionally, the project fosters community engagement and social cohesion, as residents collaborate to improve their living environment and address common challenges. By leveraging the innovative capacities and collective action of local stakeholders, the private group street light project demonstrates the potential of bottom-up approaches in advancing climate resilience and sustainable development at the grassroots level.

3.2.2 Climate Change Adaptation Projects: Drainage for floods and climate change

Warmer atmosphere holds more moisture as there is evidence that for every degree of warming the atmosphere can hold around 7% more moisture. More moisture thus means frequent rainfalls in short, intense downpours which increases the risk of flash flooding. Adding to this, increased urbanization adds impermeable surfaces which alters natural drainage systems leading to urban floods. Thus, the *construction of drainage systems within Ga East municipal*

is aimed at managing the effects of flooding and therefore contributes to an adaptation project.

a) *Public Sector Drainage Project by GEMA:*

The public sector drainage project led by GEMA represents a strategic response to climate change adaptation in Ga East. Grounded in principles of social welfare economics, this project aims to mitigate the impacts of flooding and enhance community resilience to climate-related hazards. GEMA's initiative involves the construction of robust drainage systems, designed to effectively manage storm water runoff and reduce the risk of inundation in vulnerable areas. By investing in resilient infrastructure, GEMA prioritizes the protection of public assets, livelihoods, and well-being. The project aligns with Sustainable Development Goals related to sustainable cities and communities (SDG 11) and climate action (SDG 13), contributing to the creation of safer, more liveable urban environments.

b) *Private Group Drainage Project by Homeowners Association:*

In contrast to the public sector endeavour, the private group drainage project led by a homeowners' association reflects principles of private enterprise and community resilience in climate change adaptation. Driven by the desire to protect their properties and enhance neighbourhood safety, the homeowners' association collaborates to implement localized drainage solutions. This project involves the construction of retention ponds, rain gardens, or other nature-based features to manage storm water runoff and reduce flood risk. While motivated by self-interest, the project fosters community cohesion and collective action in addressing common challenges. Additionally, the adoption of sustainable drainage practices contributes to ecosystem health and biodiversity conservation. The private group drainage project exemplifies the potential of decentralized approaches in building climate resilience at the local level, leveraging community resources and expertise to adapt to changing environmental conditions.

3.3 Method of Data Collection and Analysis

3.3.1 Objective 1: To Compare the Designs of Public and Private Climate Change Projects

- i. **Data Type:** Qualitative data is primarily used in this objective. Qualitative data allow for a deeper exploration of the nuances of project design, capturing insights,

perspectives, and considerations that quantitative data may not fully capture (Mazhar et al. 2021).

- *The independent variables* in this objective include the type of project (public vs. private). These variables are crucial as they influence the initial design considerations, strategies, and features of the projects.
 - *The dependent variables* here are the project design features, considerations, plans, and strategies. The main variables of focus here are project features like project objectives, stakeholder involvement, budget allocation, and technical specifications. These variables represent the outcomes of the project design process and are directly influenced by the independent variables.
- ii. **Data Sources:** The main sources of data for this objective are interviews with project managers, government officials, and community representatives, along with document analysis of project reports, proposals, and policy documents. These sources provide firsthand accounts and documentation of the project design process and decisions.
- iii. **Sampling Approach:** Purposive sampling is chosen to select key stakeholders involved in project design. This approach ensures that individuals with relevant knowledge and experience in project design are included in the study, providing rich and insightful data (Kairuz, Crump, & O'Brien, 2007). To ensure proper representation, we categorize climate change projects as either public/private. Then within each public/private projects we select one mitigation project and one adaptation project making a total of four projects. Going further, for each project we purposively choose three stakeholders for the interview - one stakeholder each from the financiers, implementers and beneficiary group.
- iv. **Sample Size:** this study sample will involve three key informant interviews from each project. The sample size for this objective is typically smaller, focusing on key decision-makers and project planners who have direct involvement in the project design process. A smaller sample size allows for in-depth exploration and understanding of project design features. The sample size will increase until point of saturation where respondents start repeating responses (Mazhar et al. 2021). In this objective, the sample size will be 12 interviews from key informants.
- v. **Research Instrument:** Semi-structured interview guides were used to facilitate interviews with 12 key stakeholders, while document analysis templates were used to systematically analyse project documents. These research instruments ensure consistency in data collection and analysis.

- vi. **Data Analysis:** Thematic analysis is employed for interview data to identify patterns, themes, and key insights related to project design features and considerations. Content analysis is used for document analysis to systematically categorize and analyse project design elements documented in project reports, proposals, and policy documents. These analytical approaches help to uncover and interpret the underlying factors influencing project design.

By investigating the project design of both public and private projects, this objective aims to provide insights into how different factors influence the initial planning and strategies of mitigation and adaptation projects, contributing to a comprehensive understanding of their effectiveness and impact.

3.3.2 Objective 2: Investigate the Effects of Public and Private Climate Finance on Project Performance (Relevance, Effectiveness, Efficiency, Sustainability, Impact)

- i. **Data Type:** Both quantitative and qualitative data were used in this objective. Quantitative data provide numerical insights into project performance metrics, while qualitative data offer deeper contextual understanding and insights into stakeholder perspectives.
 - *The independent variables* in this objective include the type of project (public vs. private). These variables influence various aspects of project performance and determine the extent to which the projects achieve their intended objectives.
 - *The dependent variables* in this objective are the project performance metrics, including relevance, effectiveness, efficiency, sustainability, and impact. These variables represent the outcomes of project implementation and are influenced by the independent variables identified above. Other aspects of project design like project implementation strategies, stakeholder engagement, budget utilization, and project duration also influence performance.
- ii. **Data Sources:** Surveys with project stakeholders, interviews with key stakeholders, and document analysis of project reports, evaluations, and performance assessments are the main sources of data for this objective. These sources provide a comprehensive view of project performance from multiple perspectives.
- iii. **Sampling Approach:** The sampling approach involves stratified random sampling and convenience sampling, depending on the availability and accessibility of project

stakeholders. Stratified random sampling ensures representation across different stakeholder groups, while convenience sampling may be used for practical reasons (Jain, 2021). Thus; for the qualitative side, four strata of projects are selected such that we have two mitigation projects and two adaptation projects. For representation's sake, we also have within the mitigation projects one which is financed and implemented by private sector and the other financed by the public sector. The same is done for the adaptation projects (one public funded adaptation project and one private funded adaptation project). For the quantitative side, 30 respondents will be conveniently sampled from each of the four projects and a survey will be conducted.

- iv. **Sample Size:** The sample size should be large enough to ensure the representation of different stakeholder groups and project types, ensuring the generalizability of the findings. Power analysis may be conducted to determine the appropriate sample size. However, this study sample constituted interviews of three key informants from each of the four projects making 12 interviews in all. The survey will include 30 respondents from each of the four projects i.e., 120 respondents from the four projects.
- v. **Research Instrument:** A structured survey questionnaire is used to gather quantitative data on project performance metrics, while semi-structured interview guides are employed to collect qualitative insights from key stakeholders (Alshenqeti, 2014). Document analysis templates are used to systematically analyse project reports, evaluations, and performance assessments.
- vi. **Data Analysis:** Descriptive statistics was used to analyse survey data, providing numerical summaries of project performance metrics (Chizawsky, Estabrooks, & Sales, 2011). Thematic analysis was employed for interview data to identify patterns, themes, and key insights related to project performance. Content analysis was used for document analysis to systematically categorize and analyse project performance indicators and outcomes.

3.3.3 Objective 3: To Compare the Effects of Public and Private Climate Change Projects on Sustainable Development Goals (SDGs) in Ga East Municipal Assembly (GEMA)

- i. **Data Type:** Both quantitative and qualitative data were used in this objective. Quantitative data provide numerical insights into stakeholders' perceptions of the projects' contributions to specific SDGs, while qualitative data offer deeper contextual

understanding and insights into stakeholders' perspectives on the linkages between project activities and SDGs.

- *The independent variables* in this objective include the type of project (public vs. private), project activities, stakeholder engagement, and project outcomes. These variables influence the extent to which the projects contribute to specific SDGs.
 - *The dependent variables* are the contributions of the projects to specific SDGs. These variables represent the outcomes of project activities and are influenced by the independent variables identified above.
- ii. **Data Sources:** Surveys with project stakeholders, interviews with key stakeholders, and document analysis of project reports, evaluations, and SDG alignment assessments are the main sources of data for this objective (Taherdoost, 2021). These sources provide insights into stakeholders' perceptions and understanding of the projects' contributions to specific SDGs.
- iii. **Sampling Approach:** Similar to Objective 2, the sampling approach involved stratified random sampling and convenience sampling to ensure representation across different stakeholder groups and project types. Thus; for the qualitative aspect, four strata of projects are selected such that we have two mitigation projects and two adaptation projects. For representation's sake, we also have within the mitigation projects one which is financed and implemented by private sector and the other financed by the public sector. The same is done for the adaptation projects (one public funded adaptation project and one private funded adaptation project). On the qualitative side, 30 respondents will be conveniently sampled from each of the four projects and a survey was conducted.
- iv. **Sample Size:** The sample size must be large enough to ensure representation across different stakeholder groups and project types, ensuring the generalizability of the findings. Thus, this study sample constituted interviews of three key informants from each of the four projects making 12 interviews in all. The survey included 30 respondents from each of the four projects i.e., 120 respondents from the four each project.
- v. **Research Instrument:** A structured survey questionnaire was used to gather quantitative data on stakeholders' perceptions of the projects' contributions to specific SDGs, while semi-structured interview guides are employed to collect qualitative

insights from key stakeholders. Document analysis templates were used to systematically analyse project reports, evaluations, and SDG alignment assessments.

- vi. **Data Analysis:** Descriptive statistics were used to analyse survey data, providing numerical summaries of stakeholders' perceptions of the projects' contributions to specific SDGs (Chizawsky, Estabrooks, & Sales, 2011). Thematic analysis is employed for interview data to identify patterns, themes, and key insights related to stakeholders' understanding of the linkages between project activities and SDGs. Content analysis was used for document analysis to systematically categorize and analyse references to specific SDGs in project documents.



CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSIONS

4.1 Introduction

Chapter four of this thesis presents the results, analysis, and discussion of the research findings obtained through data collection and statistical analysis. This chapter aims to critically examine the empirical evidence gathered from the research process and to provide insights into the implications of these findings.

4.2 Study Participants

The participants used to gather data for analysis are presented in this section. Table 2 shows the participants for the interviews

Table 1: Qualitative Data Participants

Project	Ownership/Funding	Key informants	Responses
GEMA Streetlight Project	Public	GEMA Development planner, GEMA works department representative, GEMA resident 1	3
GEMA Public Drainage Project	Public	GEMA Development officer, contractor, GEMA resident 1	3
Ga East Homeowners Private Streetlight Project	Private	Association representative, contractor, resident 2	3
Ga East Homeowners Private Drainage Project	Private	Association rep, contractor, resident 2	3
Total			12

Source; Author, 2024

Table 2: Quantitative Data Responses

Project	Ownership/Funding	Responses
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GEMA Public Streetlight Project	Public	30
GEMA Public Drainage Project	Public	30
Ga East Homeowners Private Streetlight Project	Private	30
Ga East Homeowners Private Drainage Project	Private	30
Total		120

Source; Author, 2024

4.3 Demographic Distribution of Respondents

This section presents the demographic information of respondents including respondents' gender, age, education and marital status. As indicated in the methodology, this study involves a sample size of 120 surveys of Ga East Municipal Assembly residents.

Table 3: Demographic Distribution of Respondents

Category	Options	Percentage
SEX		
	Male	46%
	Female	54%
AGE RANGE		
	18 - 30 years	33%
	30-39 years	20%
	40-49 years	17%
	50-59 years	14%
	>60 years	16%
LEVEL OF FORMAL EDUCATION.		
	Graduate Degree (master's or PhD)	26%
	Bachelor	47%
	Diploma/HND	19%
	High School and lower	8%
	No formal Education	0%
MARITAL STATUS		
	single	48%
	Married	28%
	Divorced	14%
	Separated	7%
	Widow/widower	4%
RESIDENCY IN THE DISTRICT		
	< 5 years	15%
	5 - 9 years	19%
	10 - 19 years	30%
	20 - 29 years	23%

30 or more years	13%
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Source; Author, (2024)

4.3.1 Sex

Gender representation is very important in our world today. Owing to this fact, it is necessary that both sexes are represented in the sample. From the table 4 above, majority of the respondents were female which corresponds to Ghana’s population statistics that female population is larger compared to male as well as the fact that majority of traders and entrepreneurs in Ghana are female.

4.3.2 Age

Age is also factored into the level of information/awareness of the history of the municipality with climate change challenges and problems being resolved through the implementation of the projects under study. From table 4 above, majority of the respondents fall within the age range of 18-30 followed by age 30-39 with the least age group representation being 50-59.

4.3.3 Education

Level of education speaks to the quality of the responses gathered for the study given that well educated respondents are likely more well informed with appropriate understanding of the study requirements. Table 4 above show that 45 percent of the respondents hold at least an undergraduate degree, followed by 26% respondents holding a master’s degree. Only 8 percent of the respondents have up to high school level education or less as there were no respondents who did not receive any formal education.

4.3.4 Marital Status

Marriage also signals commitment and responsibility which are important traits when looking at social issues like climate change. At a glance of the table 4 above, majority of the respondents are single representing a whopping 48% of the respondents. However, when you take the married (28%) plus the divorced (14%) together with the separated (7%), we see that they total 49 percent which is greater than the singles (47%).

4.3.5 Residential Status

The residential status speaks to the familiarity of respondents with climate change issues within the municipality. From table 4, majority of the respondents have been residents of the municipality for about 10-19 years with 23 percent of respondents haven been residents for 20-

29 years 19 percent and 15 percent of respondents have lived in the municipality for 5-9 years and 0-5 years respectively. It is good to note that a good 13 percent of respondents have been residents for over 30 years.

4.4 Public Versus Private Sector Climate Change Project Designs

The initial stage of projects involves decisions on the scope and scale of objectives, stakeholder involvement, innovative approaches and technologies and overall management. The objective here is to assess how public sector and private sector design similar projects so as to inform decision making on the most efficient/effective resource allocation. To this end, interviews were conducted with 12 respondents from 4 projects (2 public and 2 private). three stakeholders were interviewed for each project allowing for a comparison and contrast of GEMA streetlight project and Homeowners Association streetlight project as well as Greater Accra Resilient and Integrated Development (GARID) drainage project by GEMA and Homeowners Association drainage project.

4.4.1 Scope and Stakeholder Involvement:

The GEMA mitigation and adaptation projects showcased a comprehensive approach to addressing flooding issues within the municipality. According to the District Planner:

"The scope of the projects was carefully defined through extensive consultations with various stakeholders, including municipal authorities, engineering firms, and community representatives."

This inclusive approach ensured that the projects aligned with broader municipal priorities and regulatory requirements. Furthermore, the Contractor involved in the GEMA projects emphasized the importance of stakeholder engagement, stating,

"We collaborated closely with community leaders and residents to understand their needs and concerns, which informed the design and implementation of drainage systems and flood mitigation measures."

Conversely, the Homeowners' Association mitigation and adaptation projects had a narrower scope, primarily focusing on addressing flooding issues within the neighbourhood. An excerpt from the Association's representative's interview highlights this localized approach:

"Our projects were driven by the specific needs of our community members. We conducted surveys and meetings to identify areas prone to flooding and prioritize solutions that would benefit our neighbourhood."

While this approach allowed for more tailored solutions, it may have limited the involvement of external stakeholders and overlooked broader municipal interests.

4.4.2 Innovative Approaches and Technologies:

The GEMA public projects incorporated advanced engineering techniques and large-scale infrastructure improvements to mitigate flooding and enhance resilience. According to the Contractor,

"We utilized innovative technologies such as permeable pavements, bio-retention basins, and green roofs to manage stormwater runoff and reduce the risk of flooding."

These solutions were carefully integrated into the municipal landscape, showcasing a commitment to sustainable urban development.

In contrast, the Homeowners' Association projects emphasized green infrastructure and low-impact development practices. As stated by the association member,

"We focused on implementing nature-based solutions like rain gardens and bioswales to capture and absorb stormwater runoff."

These smaller-scale interventions were tailored to the needs and preferences of the neighbourhood, promoting a sense of ownership and community involvement.

4.4.3 Adaptability and Collaboration:

The adaptability of project designs to changing conditions was evident in both the GEMA and association projects. The District Department Planner highlighted the flexibility of GEMA projects, stating,

"We designed the drainage systems to be adaptable to future changes in climate patterns and urban development."

Collaboration with external partners and stakeholders, such as government agencies and NGOs, facilitated the integration of diverse perspectives and expertise into project planning and implementation.

Similarly, the homeowners' association projects demonstrated adaptability through localized decision-making and quick response to community needs. According to the Association's representative,

"We were able to implement solutions rapidly and make adjustments based on feedback from residents."

While collaboration beyond the community level was limited, the association's agility allowed for efficient project delivery and responsiveness to neighbourhood concerns.

4.4.4 Long-term Sustainability:

Both the GEMA and association projects prioritized long-term sustainability in project design. The contractor involved in the GEMA projects emphasized the importance of maintenance and monitoring, stating,

"We developed comprehensive plans for ongoing maintenance and conducted regular inspections to ensure the effectiveness of drainage systems."

Institutional support and resources from the municipality facilitated the implementation of sustainable practices and the establishment of community education programs.

Similarly, the Homeowners' Association's projects implemented sustainability plans such as regular maintenance schedules and community outreach programs. The association member highlighted the community's commitment to stewardship, stating,

"We organized workshops and distributed educational materials to promote responsible stormwater management practices among residents."

While resources may have been more limited compared to the GEMA projects, the association's grassroots efforts fostered a sense of shared responsibility and ownership among community members.

4.4.5 Comparison and Contrast

GEMA Streetlight Project Versus. Association Streetlight Project

The GEMA streetlight project, led by the Ga East Municipal Assembly, emphasized standardized approaches and broader municipal relevance. According to The District Department Planner,

"The scope of the GEMA streetlight project was carefully defined through extensive consultations with various stakeholders, ensuring alignment with municipal objectives and regulatory requirements."

Similarly, the contractor involved in the project highlighted,

"We collaborated closely with community leaders and residents to understand their needs and concerns, which informed the design and implementation of street lighting solutions."

Conversely, the streetlight project led by the Ga East Homeowners Association focused on addressing localized needs within the neighbourhood. The Association's representative noted,

"Our streetlight project was driven by the specific needs of our community members. We conducted surveys and meetings to identify areas requiring lighting improvements and prioritize solutions that would benefit our neighbourhood."

Additionally, a beneficiary of the Association project stated, "We appreciated the flexibility of the Association project, as it allowed us to have input into the design and placement of streetlights in our neighbourhood."

GEMA Drainage Project Versus. Association Drainage Project

The GEMA drainage project aimed to mitigate flooding and improve drainage infrastructure across the municipality. According to the district department planner,

"The GEMA drainage project involved comprehensive planning and collaboration with various stakeholders, including municipal authorities, engineers, and external partners."

One contractor involved in the project emphasized,

"We utilized data analytics as well as other innovative technologies and engineering solutions to design and implement drainage systems that effectively address flooding issues within the municipality."

In contrast, the drainage project led by the Ga East Homeowners Association focused on localized flooding issues within the neighbourhood. One Association member highlighted,

"Our drainage project was tailored to the specific needs and preferences of our neighbourhood, allowing for flexibility and customization in design and implementation."

Similarly, a resident interviewed noted,

"We appreciated the community-driven approach of the association project, as it allowed us to collaborate closely with neighbours and association members to address flooding challenges in our area."

Thus, public projects, such as the GEMA streetlight and drainage projects, prioritize standardized approaches, broader municipal relevance, and larger-scale infrastructure improvements. These projects benefit from significant budget allocations and institutional support, ensuring efficiency and effectiveness in implementation. However, they lack flexibility and customization to address localized needs and preferences. Conversely, private association projects, such as the association streetlight and drainage projects, emphasize community-driven solutions, grassroots involvement, and localized customization. While these

projects foster a sense of ownership and pride among residents, they may operate within limited budgets and face challenges in ensuring consistency and long-term sustainability. Overall, both public and private projects play important roles in addressing community needs, with each approach offering unique strengths and considerations.

4.4.6 Discussions on Objective One: Linkages to Literature

The findings from objective one, which examines the design of public and private climate change interventions, align closely with empirical literature in several key aspects. Research indicates that public interventions, typically led by government entities, prioritize broader societal objectives and public interests, emphasizing stakeholder engagement, regulatory compliance, and alignment with government policies and priorities (Jakob et al., 2015). Similarly, the study's findings highlight the systematic and consultative approach adopted by public projects, such as those led by GEMA, which involve extensive stakeholder consultations and adherence to regulatory requirements. This echoes the literature's emphasis on the importance of stakeholder engagement and regulatory compliance in designing effective climate change interventions.

Furthermore, empirical studies suggest that private interventions, driven by market dynamics and profit motives, tend to prioritize localized solutions and community-driven efforts, leveraging grassroots engagement to address climate change challenges (Colenbrander et al., 2018). This is consistent with the findings of the study regarding private projects undertaken by Homeowners' Associations, which prioritize community engagement and responsiveness to local needs. However, while empirical literature highlights the potential for innovation and flexibility in private interventions, it also raises concerns about accountability, transparency, and inclusivity, particularly concerning marginalized communities (Heuson et al., 2015). Similarly, the study's findings indicate that while private interventions demonstrate agility and responsiveness to community needs, they may face challenges related to scalability, equity, and long-term sustainability.

Overall, the findings from objective one are largely consistent with empirical literature, highlighting the distinct design approaches of public and private climate change interventions and their respective strengths and weaknesses. By aligning with existing research, the study provides valuable insights into the factors shaping the design of climate change interventions and underscores the importance of considering both public and private sector perspectives in addressing climate change challenges effectively.

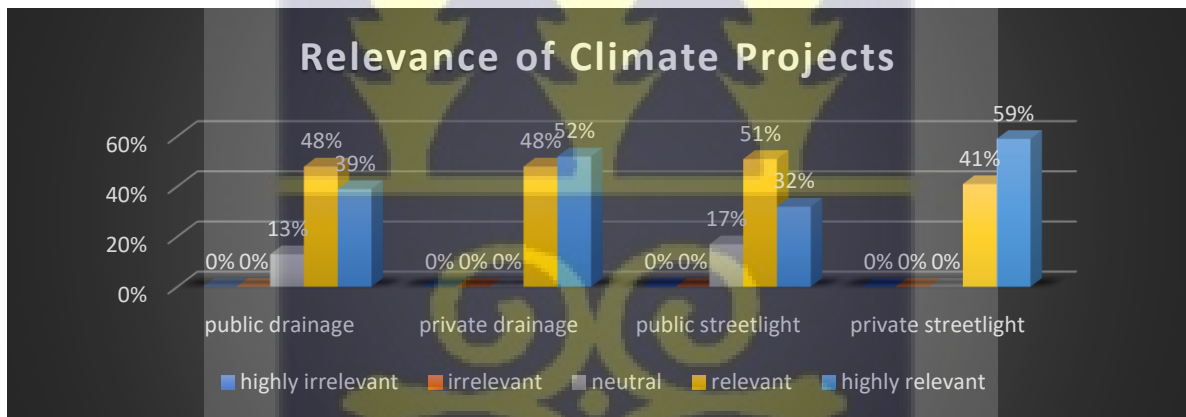
4.5 Public Versus Private Sector Climate Change Project Performance

Here, the aim of the study was to assess and compare the performance of both government (GEMA) and private (Homeowners Association) projects across five key metrics: relevance, effectiveness, efficiency, sustainability and impact. To achieve this objective, interviews and surveys were conducted with various stakeholders of four climate change projects within Ga East Municipal Assembly (GEMA). The results are presented and discussed as follows;

4.5.1 Relevance of Climate Projects

As an evaluation metric, relevance helps ensure that decisions, actions, or information are significant and directly applicable to specific situations, goals or contexts. Relevance helps filter out unnecessary elements saving time and resources to promote efficiency and effectiveness.

Figure 7: Relevance of Climate Projects:



Source: Author, 2024

From figure 7 above, respondents were asked to rate the projects relevance out of five (5). The results suggest the projects were all relevant since they got relevance ratings higher than 50 percent. Comparing the public and private projects however, we see that in both the drainage and streetlight projects, the private projects receive higher 5-star ratings compared to the public projects. This could be as a result of private projects being more personalised and tailored to individual or group needs.

The survey responses from figure 7 above indicate that the GEMA (public) projects demonstrated high relevance to municipal priorities and community needs. On a scale of 1-5: 5 representing high relevance, we can see that for the drainage project, 48 percent and 39

percent of respondents rated the GEMA drainage project 4/5 and 5/5 respectively. The GEMA streetlight project receives a similar sterling rating with 51 percent and 32 percent respondents rating the project 4/5 and 5/5 respectively. This is backed by interview response from the district department planner who emphasized that the projects were carefully aligned with municipal objectives and regulatory requirements. Additionally, stakeholder involvement ensured that project designs effectively addressed flooding issues and drainage deficiencies within the municipality. Similarly, the homeowners' association (private) projects were highly relevant to the needs and preferences of the neighbourhood. The Association representative highlighted that the projects were driven by community concerns and priorities, focusing on localized solutions to address flooding issues within residential areas. While the scope was narrower compared to GEMA projects, the association's initiatives directly addressed neighbourhood-specific challenges.

The District Department Planner from GEMA stated,

"The projects were carefully aligned with municipal objectives, addressing critical flooding issues within the municipality."

Similarly, the Association Representative mentioned,

"Our projects were driven by community concerns, focusing on addressing flooding challenges within our neighbourhood."

In contrast, the Contractor involved in GEMA projects emphasized,

"Extensive consultations with various stakeholders, including municipal authorities and community representatives, ensured that the projects were aligned with broader municipal priorities."

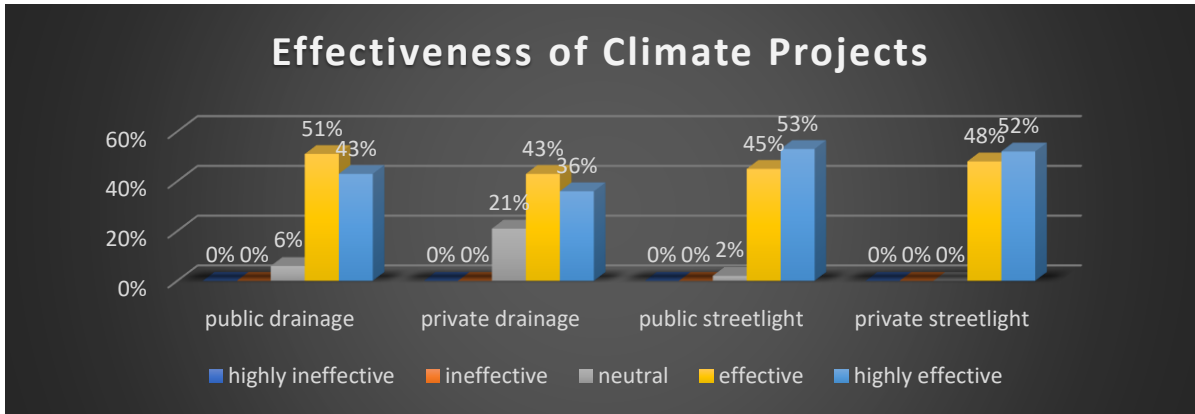
This contrasts with Association Projects, where the Association Representative noted,

"Our projects were more localized, tailored to the specific needs and preferences of our neighbourhood."

4.5.2 Effectiveness of Climate Projects

Respondents were required to rate the effectiveness of projects on a 5-point scale. Figure 8 below show that majority of respondents rated all four projects as either effective or highly effective.

Figure 8: Effectiveness of Climate Projects:



Source; Author, 2024

From the survey data presented in figure 8 above, all the projects were effective in achieving their objectives. This is corroborated by the interview responses indicating the GEMA projects demonstrated effectiveness in achieving their objectives of reducing flood risks and improving drainage infrastructure as well as providing streetlights. According to the District Planner, the projects successfully mitigated flooding and enhanced community resilience, resulting in tangible benefits for residents and businesses. Similarly, the Homeowners' Association's projects were effective in addressing flooding issues as well as providing streetlights within the neighbourhoods. The Association Representative noted that the projects successfully enhanced safety and quality of life for residents by implementing localized mitigation measures. A Beneficiary of the project interviewed shared a similar view adding that now people are free to get home late without any fears. While the scale of impact may have been smaller compared to GEMA projects, the Association's initiatives directly benefited neighbourhood residents.

A resident/Beneficiary indicated,

“The private drainage project reduced flooding within their neighbourhoods but all the water pools in parts they did not cover”

“Since the assembly drains were installed however, we have not experienced any severe flooding municipal-wide even after heavy rains”

The contractor from GEMA projects highlighted,

"The implementation of comprehensive flood mitigation measures resulted in tangible benefits, significantly reducing instances of flooding and property damage."

The Contractor involved in association projects also stated,

"Our projects were successful in mitigating flooding risks within the neighbourhood, enhancing safety and quality of life for residents."

However, the scale of effectiveness differed. The District Planner noted,

"GEMA projects had a broader impact, addressing municipal-level flooding issues."

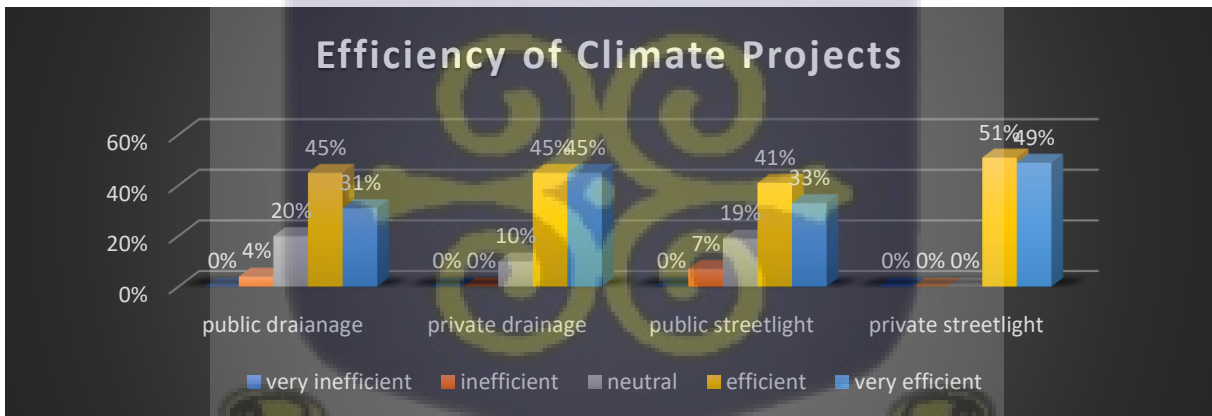
In corroboration, The Association Representative mentioned,

"While effective within the neighbourhood, our projects had a smaller scale of impact."

4.5.3 Efficiency of Climate Projects

Respondents were required to rate the efficiency of projects on a scale of 1-5 on how efficient the project is. From the figure below, the projects can be seen to have received ratings which suggest that they were efficient with significant ratings of efficient and very efficient. We can also note that in comparing the public projects to the private projects, the private projects were generally more efficient owing to the fact that public drainage projects for instance has a total of 86 percent respondents saying the project is efficient whereas the private drainage has a total of 90 percent indicating the project is efficient. The same scenario plays in the public and private streetlight projects as the public project obtained 84 percent efficiency ratings while the private projects got 100 percent efficiency assessment by respondents.

Figure 9: Efficiency of Climate Projects:



Source; Author, 2024

The interview results are similar that efficiency in resource utilization was evident in GEMA projects, with efficient coordination among stakeholders and timely completion of project activities. The contractor emphasized the utilization of skilled labour and innovative technologies to maximize project efficiency and minimize waste. The Homeowners' Association projects also exhibited resourcefulness in leveraging volunteer labour and

community contributions to supplement limited funding. While this grassroots approach enabled cost savings and community involvement, it may have posed challenges in maintaining consistent project timelines and ensuring quality control.

Efficient resource utilization was highlighted in both projects. The Contractor from GEMA projects emphasized,

"We maximized resources and employed advanced technologies to ensure efficient project implementation."

Similarly, the Association member interviewed stated,

"We utilized volunteer labour and community contributions efficiently to execute project activities."

Yet, the methods of resource utilization differed. The Contractor from GEMA projects highlighted,

"Efficient coordination among stakeholders and utilization of institutional resources facilitated timely completion."

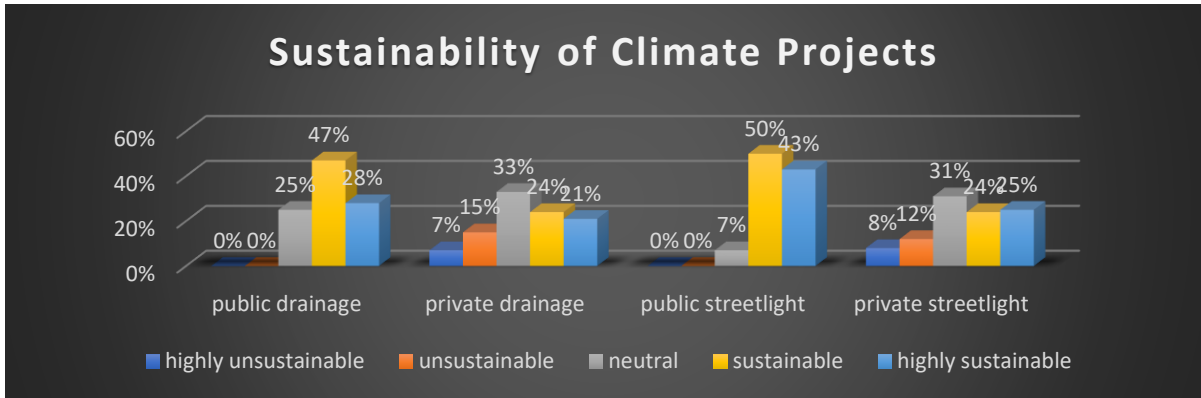
However, the Association representative noted,

"While we made the most of limited financial resources, reliance on volunteer labour posed challenges in maintaining consistent project timelines."

4.5.4 Sustainability of Climate Projects

In the survey, respondents were required to rate the sustainability of the projects on a 5-point scale based on perceptions of how sustainable the project is. From figure 9, the public drainage and streetlight projects can be seen to have better ratings compared to the private drainage and streetlight projects. Over 80 percent of respondents indicated that both public projects are sustainable compared to private projects which were less than 50 percent in both cases. Overall, the sustainability ratings for the projects are; 75 percent public drainage, 45 percent for private drainage, 93 percent for public streetlight, and 49 percent for private streetlight project. This can be linked to the fact that government projects follow protocol and are therefore expected to at least have some funds put aside for maintenance over a certain period unlike private projects.

Figure 10: Sustainability of Climate Projects:



Source; Author, 2024

The interviews revealed that the GEMA projects prioritized long-term sustainability through comprehensive maintenance plans and community education programs. The district department planner highlighted the establishment of sustainability measures to ensure the resilience of public infrastructure over time. Similarly, the homeowners' association projects implemented sustainability plans such as regular maintenance schedules and community outreach programs. The association member emphasized the community's commitment to stewardship and responsible stormwater management practices.

Both projects prioritized long-term sustainability. The District Department Planner mentioned,

"GEMA projects established comprehensive maintenance plans and community education programs to ensure the resilience of public infrastructure over time."

Similarly, the Association member stated,

"We implemented sustainability plans and community outreach programs to promote responsible stormwater management practices."

However, the level of institutional support differed. The District Department Planner noted,

"GEMA projects had institutional support and resources for sustainability efforts."

In contrast, a GEMA Resident/Beneficiary emphasized,

"While community-driven stewardship was pivotal, long-term maintenance may pose challenges because not everyone contributes the money."

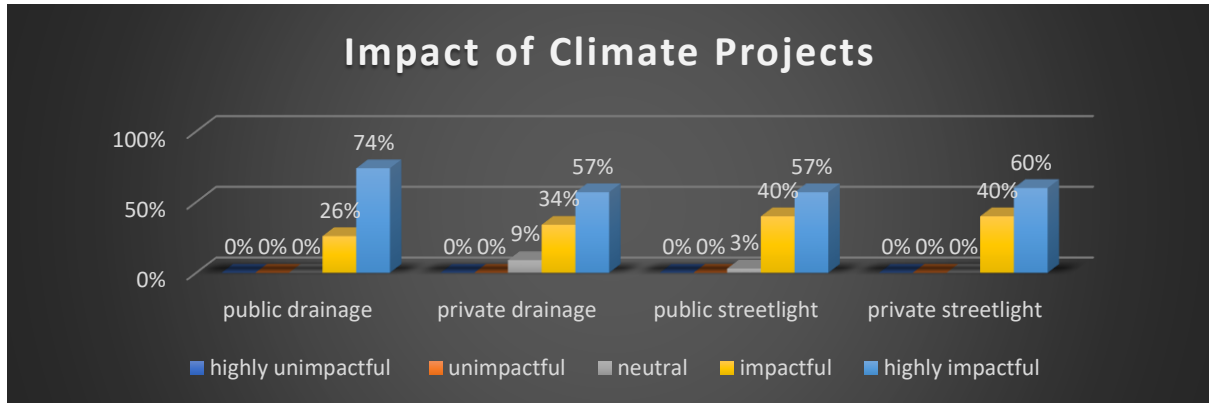
"The projects are effective now, but without proper maintenance, the drains might get clogged and stop working and the streetlights will definitely get faulty over time"

4.5.5 Impact of Climate Projects

Survey respondents were required to rate the projects' impact on a 5-point scale showing how impactful the project was. From the results in the figure below, the projects were generally

impactful as all the projects received significant ratings of 4/5 and 5/5 i.e, impactful and highly impactful.

Figure 11: Impact of Climate Projects:



Source; Author, 2024

The GEMA projects had a broader impact, addressing municipal-level flooding issues and enhancing community resilience. According to stakeholders, the projects significantly reduced instances of flooding and property damage within the municipality, resulting in tangible benefits for residents and businesses. Document review of the GEMA Annual Progress Reports (APR) showed zero instance of flooding within the municipality in 2023 compared to 2 floods recorded in both 2022 and 2021. The Homeowners' Association projects focused on localized objectives tailored to the needs of the neighbourhood. While the scale of impact may have been smaller compared to GEMA projects, the association's initiatives directly benefited neighbourhood residents and fostered a sense of community ownership and pride.

Both projects had tangible benefits for residents and businesses. The Contractor from GEMA projects mentioned,

"Significant reduction of flooding instances and property damage were observed within the municipality."

Similarly, the Association Representative stated,

"Our projects directly benefited neighbourhood residents, enhancing safety and quality of life."

The GARID project by GEMA aimed at resolving the municipal-wide flood risk leading to several contracts being awarded to various contractors to construct various strategic infrastructures that collectively resolve the flood risk. Yet, the scale of impact varied. The District Planner noted,

"GEMA projects had a broader impact at a municipal level, enhancing community resilience."

Conversely, the Association Representative mentioned,

"Our projects had a smaller scale of impact but directly addressed neighbourhood-specific challenges."

This is because the drainages and streetlight by the Homeowners association targeted vulnerable streets and neighbourhoods to light up dark streets and prevent crime as well as prevent floods within a neighbourhood.

In conclusion, while both GEMA and Home Owners' Association projects were effective in mitigating flooding risks, they differed in scale, stakeholder involvement, and resource utilization. GEMA projects demonstrated broader relevance and impact at a municipal level, supported by institutional resources and stakeholder collaboration. In contrast, Association projects excelled in responsiveness to community needs and preferences i.e. community-driven solutions and sustainability at the neighbourhood level. Collaborative efforts between public and private sectors can harness the strengths of both approaches, leading to more comprehensive and sustainable solutions for addressing societal challenges.

4.5.6 Discussions on Objective Two: Linkages to Literature

The findings from objective two, which assesses the performance of public and private climate change interventions, echo trends identified in empirical literature while also offering nuanced insights into specific project contexts. Empirical studies suggest that public interventions, often funded and led by government entities, benefit from institutional support, comprehensive planning, and stakeholder collaboration, leading to significant impacts on resilience and sustainability (Steckel et al., 2017). Similarly, the study's findings highlight the effectiveness of public projects, such as those led by GEMA, in addressing climate change challenges at a broader municipal level (Carfora et al., 2017). This alignment underscores the importance of institutional support and stakeholder collaboration in enhancing the performance of public interventions, as emphasized in existing research.

On the other hand, empirical literature also points to the agility and responsiveness of private interventions, driven by market dynamics and profit motives, in addressing localized climate change challenges (Zhao et al., 2022). This is reflected in the study's findings regarding private projects undertaken by Homeowners' Associations, which excel in community engagement and responsiveness to local needs (Barnard et al., 2014). However, while private interventions

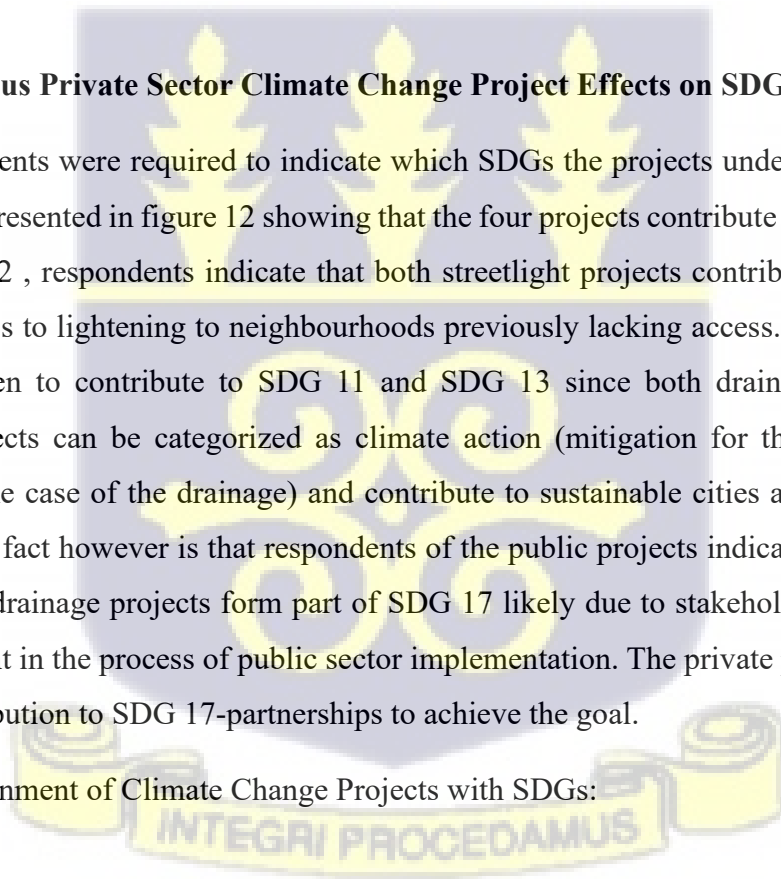
demonstrate efficiency in resource utilization and foster a sense of ownership among community members, they may lack the scale and institutional support of public projects, potentially limiting their long-term sustainability and resilience (Kotchen & Costello, 2018). These nuances highlight the trade-offs associated with public and private climate change interventions, as discussed in empirical literature.

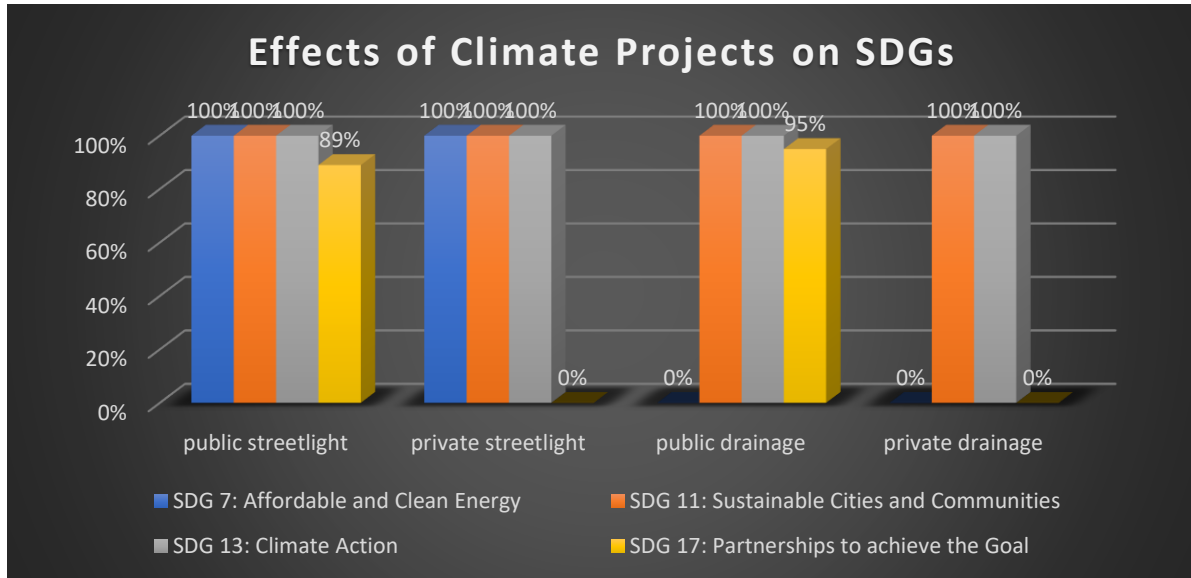
Overall, the findings from objective two offer valuable insights into the performance of public and private climate change interventions, aligning with existing research while also providing context-specific observations. By corroborating trends identified in empirical literature and offering nuanced insights into specific project contexts, the study contributes to a deeper understanding of the factors shaping the performance of climate change interventions. This underscores the importance of considering both public and private sector perspectives in designing and implementing effective climate change strategies.

4.6 Public Versus Private Sector Climate Change Project Effects on SDGs

Survey respondents were required to indicate which SDGs the projects under study meet and the results are presented in figure 12 showing that the four projects contribute to various SDGs. As per figure 12 , respondents indicate that both streetlight projects contribute to SDG 7 by extending access to lightening to neighbourhoods previously lacking access. All four projects can also be seen to contribute to SDG 11 and SDG 13 since both drainage projects and streetlight projects can be categorized as climate action (mitigation for the streetlight and adaptation in the case of the drainage) and contribute to sustainable cities and communities. One interesting fact however is that respondents of the public projects indicate that the public streetlight and drainage projects form part of SDG 17 likely due to stakeholder consultations and involvement in the process of public sector implementation. The private projects however make no contribution to SDG 17-partnerships to achieve the goal.

Figure 12: Alignment of Climate Change Projects with SDGs:





Source: Author, (2024)

4.5.1 SDG 11 - Sustainable Cities and Communities

Both the GEMA streetlight project and the homeowners' association streetlight project play integral roles in advancing SDG 11 (Sustainable Cities and Communities). The GEMA Development Planner emphasized the project's aim to enhance urban safety and inclusivity, directly aligning with SDG 11's objective of creating resilient and sustainable cities. Additionally, the GEMA works department representative highlighted the importance of well-lit public spaces in fostering community well-being and social cohesion, contributing to SDG 11's goals. Similarly, the homeowners' association representative underscored the project's role in promoting safety and enhancing quality of life within the neighbourhood, aligning with SDG 11's focus on creating inclusive and safe urban environments. Furthermore, the beneficiary of the Homeowners' Association project noted the positive impact of improved street lighting on community safety and accessibility, indicating a significant contribution to SDG 11's targets.

The GEMA drainage project and the homeowners' association project both significantly impact SDG 11 (Sustainable Cities and Communities). According to the GEMA development planner, the drainage project aims to create more resilient communities by mitigating the impacts of climate change, directly aligning with SDG 11's objective of making cities inclusive, safe, resilient, and sustainable. The contractor emphasized the implementation of green infrastructure and sustainable drainage systems, further contributing to SDG 11's goals. Similarly, the homeowners' association representative highlighted their project's focus on promoting environmental sustainability and resilience within the neighbourhood, directly

supporting the objectives of SDG 11. Moreover, the beneficiary of the homeowners' association project noted the tangible improvements in the safety and quality of life within the community, indicating a positive impact on SDG 11's targets.

4.6.2 SDG 13 - Climate Action and SDG 17 - Partnerships for the Goals

SDG 13 - Climate Action

The streetlight projects are tagged as climate change mitigation projects whereas the drainage projects are tagged as climate change adaptation projects. Both the GEMA streetlight project and the homeowners' association streetlight project contribute significantly to SDG 13 (Climate Action), specifically in climate change mitigation efforts. The GEMA Development Planner highlighted the importance of energy-efficient street lighting in reducing carbon emissions and promoting sustainability, aligning with SDG 13's objective of taking urgent action to combat climate change. Similarly, the GEMA Works Department representative emphasized the implementation of eco-friendly lighting technologies to minimize environmental impact, further supporting SDG 13's goals. An interview with a GEMA employee from the works department revealed that the GEMA streetlight project also contributes to emissions reduction by utilising LED lights which consume less electricity and last longer thereby saving energy and attracting lower maintenance cost. as the respondents mentioned. Additionally, the Homeowners' Association representative underscored the project's role in promoting energy efficiency and reducing greenhouse gas emissions within the neighbourhood, aligning with SDG 13's focus on enhancing climate resilience and reducing vulnerabilities. Furthermore, the beneficiary of the Homeowners' Association project noted the positive impact of energy-efficient street lighting on environmental sustainability and climate mitigation efforts, indicating a significant contribution to SDG 13's targets.

Both the GEMA drainage project and the Homeowners' Association drainage project play crucial roles in advancing SDG 13 (Climate Action), specifically in climate change adaptation efforts. The GEMA development planner emphasized the projects' objective of mitigating flooding risks and enhancing resilience to extreme weather events, directly aligning with SDG 13's goal of building climate-resilient communities. Dredging of earth channels, desilting storm drains etc ensures that when there is heavy rains water is able to run off rather than choking/standing still and flooding. Furthermore, the GEMA contractor highlighted the implementation of sustainable drainage systems to manage stormwater effectively, further contributing to SDG 13's objectives. Similarly, the homeowners' association representative

underscored the project's role in reducing flood risks and enhancing community resilience within the neighbourhood, aligning with SDG 13's focus on enhancing climate resilience and reducing vulnerabilities. Additionally, the beneficiary of the homeowners' association project noted the positive impact of improved drainage systems on reducing flood-related damages and increasing community resilience to climate change impacts, indicating a significant contribution to SDG 13's targets. The contractor of the Homeowners' association interviewed also indicated that the main aim of the projects was to prevent flooding within the neighbourhood. According to the interviewee whether the flooding is caused by poor planning in the district or heavy rains, the flooding had to be stopped post construction and that was his job.

SDG 17 - Partnerships for the Goals

Public streetlight and drainage projects contribute to SDG 17 (Partnerships for the Goals) by fostering collaboration and cooperation among various stakeholders, including government agencies, local communities, and international organizations. These projects typically involve partnerships between public entities, private contractors, and community groups, aligning with SDG 17's objective of strengthening global partnerships to support sustainable development. The involvement of multiple stakeholders ensures the pooling of resources, expertise, and knowledge to address complex challenges such as infrastructure development and climate resilience. In contrast, private streetlight and drainage projects lack the extensive partnerships and collaborative frameworks characteristic of public projects, limiting their potential to contribute significantly to SDG 17's goals of fostering inclusive and sustainable development through effective partnerships.

Overall, both GEMA and the Homeowners' Association climate change projects demonstrate alignment with Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 7 (Affordable and Clean Energy). These projects contribute to creating sustainable and resilient communities, mitigating climate risks, and promoting the use of renewable energy sources, thus advancing the global agenda for sustainable development. Such alignment underscores the importance of local initiatives in achieving broader sustainability objectives outlined by the United Nations.

4.6.3 SDG 7 - Affordable and Clean Energy

Both the GEMA streetlight project and the homeowners' association streetlight project contribute significantly to SDG 7 (Affordable and Clean Energy). The GEMA development

planner emphasized the importance of energy-efficient street lighting in promoting sustainability and reducing energy consumption, aligning with SDG 7's objective of ensuring access to affordable, reliable, sustainable, and modern energy for all. Although the project did not make use of solar energy like other projects, the use of the LED lights contributes towards affordable energy i.e. SDG 7. Additionally, the GEMA Works Department representative highlighted the implementation of renewable energy sources for street lighting to minimize environmental impact and promote clean energy adoption, further supporting SDG 7's goals. Similarly, the homeowners' association representative underscored the project's role in promoting energy efficiency and reducing reliance on traditional energy sources within the neighbourhood, aligning with SDG 7's focus on expanding access to clean and affordable energy. However, he mentioned that they just wanted to light up the street and did not really consider energy savings in their plans. The main priority was to light up the street with their budget. According to the contractor of the project, he just had to get the job done with the budget given him as long as it was quality/standard. Furthermore, the beneficiary of the homeowners' association project noted the positive impact of energy-efficient street lighting on reducing energy costs and promoting environmental sustainability, indicating a significant contribution to SDG 7's targets.

4.6.4 Discussions on Objective Three: Linkages to Literature

The findings from objective three, which explores the alignment of public and private climate change interventions with Sustainable Development Goals (SDGs), resonate with trends identified in empirical literature while also providing context-specific insights into the impact of these interventions. Empirical studies suggest that both public and private interventions contribute to advancing SDGs, albeit through different mechanisms and with varying degrees of impact (Islam, 2022). Public climate change projects, typically funded and led by government entities, demonstrate a stronger alignment with broader societal objectives and public interests, leading to more direct and measurable impacts on SDGs (Carfora et al., 2017). Similarly, the study's findings highlight the significant contributions of public projects, such as those led by GEMA, to SDGs related to environmental sustainability, poverty alleviation, and social equity, underscoring the importance of institutional support and stakeholder engagement in achieving sustainable development goals.

On the other hand, empirical literature also acknowledges the role of private interventions in advancing SDGs, particularly through innovation, efficiency, and private sector engagement

(Zhao et al., 2022). This is reflected in the study's findings regarding private projects undertaken by homeowners' associations, which may have a more indirect or limited impact on SDGs but play a complementary role in advancing sustainable development goals (Steckel et al., 2017). While private interventions may prioritize individual goals and group-driven outcomes, they contribute to broader societal objectives by fostering innovation and efficiency in addressing climate change challenges (Lee et al., 2022). These nuances underscore the importance of considering both public and private sector perspectives in achieving sustainable development goals, as emphasized in empirical literature.

Overall, the findings from objective three provide valuable insights into the alignment of public and private climate change interventions with SDGs, corroborating trends identified in empirical literature while also offering context-specific observations (Barnard et al., 2014). By highlighting the contributions of both public and private interventions to advancing sustainable development goals, the study underscores the importance of collaborative efforts and synergies between different stakeholders in addressing global sustainability challenges (Scandurra et al., 2020). This aligns with existing research on the role of public-private partnerships in achieving sustainable development goals and emphasizes the need for coordinated action to address the complex challenges posed by climate change.



CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Being the final chapter of the study, chapter five summarizes the study's findings, concludes based on the findings and makes recommendations for practitioners, policymakers and academia.

5.2 Summary of Findings

On how public and private climate interventions are designed, the interviews with informants from both the GEMA streetlight and drainage projects, as well as the homeowners' association streetlight and drainage projects, revealed notable differences in the design of public and private climate change interventions. Public projects led by GEMA demonstrated a systematic approach to project design, involving extensive consultations with various stakeholders and adherence to municipal objectives and regulatory requirements. These projects often incorporated innovative technologies and green infrastructure to enhance sustainability and resilience at a broader municipal level. In contrast, private projects undertaken by homeowners' associations were more community-driven, focusing on localized solutions tailored to the specific needs and preferences of the neighbourhood. While both approaches aimed to address climate change challenges, public projects emphasized institutional support and collaboration, whereas private projects prioritized community engagement and grassroots efforts in their design processes.

On the performance of public and private climate change interventions in terms of relevance, effectiveness, efficiency, sustainability and impact; The interviews with informants from both the GEMA streetlight and drainage projects, as well as the homeowner's association streetlight and drainage projects, shed light on the performance of public and private climate change interventions across five key metrics;

- In terms of relevance, both public and private projects were deemed relevant to addressing climate change challenges, with GEMA projects aligning closely with municipal objectives and regulatory requirements, while the Homeowners' Association projects were tailored to the specific needs of the neighbourhood.

- Both public and private projects demonstrated effectiveness in mitigating climate change risks, with GEMA projects showcasing broader impact at a municipal level, while homeowners' association projects directly benefited neighbourhood residents.
- Efficiency was evident in resource utilization for both types of projects, with GEMA projects demonstrating efficient coordination among stakeholders and utilization of institutional resources, whereas the Homeowners' Association projects leveraged community contributions and volunteer labour.
- Sustainability efforts were prioritized in both public and private projects but more intentional in the public projects, with GEMA projects implementing comprehensive maintenance plans and community education programs, the Homeowners' Association projects did not have maintenance plan/budget but rather emphasized community-driven stewardship.
- Finally, both public and private projects had tangible impacts on climate resilience and community well-being, though GEMA projects had a broader scale of impact at a municipal level, while homeowners' association projects fostered community ownership and pride at the neighbourhood level.

On the alignment of public and private climate change interventions with SDGs, the interviews with informants from the GEMA streetlight and drainage projects, as well as the Homeowners' Association streetlight and drainage projects, provided insights into how public and private climate change interventions affect various Sustainable Development Goals (SDGs), particularly SDGs 7, 11, 13, and 17. Both public and private streetlight projects contributed to SDG 7 (Affordable and Clean Energy) by promoting energy efficiency and reducing reliance on traditional energy sources. However, the public streetlight project was more intentional about energy efficiency due to implemented systems whereas the private streetlight project opted for lightening systems within their budget. Additionally, they aligned with SDG 11 (Sustainable Cities and Communities) by enhancing safety, inclusivity, and resilience within urban areas. Moreover, the adoption of renewable energy sources in public streetlight projects further supported SDG 13 (Climate Action) by reducing greenhouse gas emissions and promoting sustainability. The involvement of multiple stakeholders in public projects also fostered partnerships and collaboration, contributing to SDG 17 (Partnerships for the Goals). Similarly, drainage projects, both public and private, contributed to SDG 11 by mitigating flood risks and enhancing resilience to climate change impacts within communities. Additionally, they supported SDG 13 by promoting climate resilience and reducing vulnerabilities to extreme

weather events. Overall, both public and private climate change interventions demonstrated alignment with multiple SDGs, highlighting the importance of collaborative efforts in addressing global sustainability challenges.

5.3 Conclusions

On the first objective of the study which looks at design of public and private climate change interventions, the study concludes based on the findings of the interviews that public and private climate change interventions differ significantly in their design approaches. Public interventions, exemplified by projects led by GEMA, are characterized by a systematic and consultative process that involves extensive stakeholder engagement, adherence to regulatory requirements, and alignment with municipal objectives. These projects often incorporate innovative technologies and green infrastructure to enhance sustainability and resilience at a broader municipal/country-wide level. In contrast, private interventions undertaken by the Homeowners' Association are more community-driven and tailored to the specific needs and preferences of the neighbourhood. They prioritize localized solutions and grassroots efforts, leveraging community engagement to address climate change challenges. While both approaches aim to mitigate climate change risks, public interventions emphasize institutional support and collaboration, whereas private interventions prioritize community involvement and ownership in their design processes. Ultimately, the diversity in design approaches underscores the importance of flexibility and adaptability in addressing climate change challenges, with opportunities for collaboration between public and private sectors to leverage the strengths of both approaches.

In addressing the second objective of the study based on the findings from the interviews and surveys, it can be concluded that both public and private climate change interventions exhibit strengths and weaknesses in their performance. Public interventions, such as those led by GEMA, demonstrate effectiveness in addressing climate change challenges at a broader municipal level. These projects benefit from institutional support, comprehensive planning, and stakeholder collaboration, leading to significant impacts on resilience and sustainability. However, they may face challenges related to bureaucratic processes and resource allocation. On the other hand, private interventions undertaken by homeowners' associations excel in community engagement and responsiveness to local needs, leading to tangible benefits for neighbourhood residents. These projects often demonstrate efficiency in resource utilization and foster a sense of ownership among community members. Nonetheless, they may lack the

scale and institutional support of public projects, which could limit their long-term sustainability and resilience. Overall, both public and private interventions play crucial roles in addressing climate change challenges, highlighting the importance of collaboration and synergies between different stakeholders to achieve sustainable outcomes.

Based on the findings of objective three, which investigates the effects of public and private climate change projects on Sustainable Development Goals (SDGs), it can be concluded that both types of interventions contribute to advancing SDGs, although through different mechanisms and with varying degrees of impact. Public climate change projects, typically funded and led by government entities, demonstrate a stronger alignment with broader societal objectives and public interests, leading to more direct and measurable impacts on SDGs, particularly those related to environmental sustainability, poverty alleviation, and social equity. These projects often prioritize the needs of marginalized communities and vulnerable populations, promoting inclusive and sustainable development. On the other hand, private climate change projects, often driven by market dynamics and profit motives (private group needs/interests), have a more indirect or limited impact on SDGs, focusing primarily on individual goals and group-driven outcomes. Nonetheless, they play a complementary role in advancing sustainable development goals by leveraging innovation, efficiency, and private sector engagement. Overall, a combination of public and private climate change interventions, supported by effective governance, stakeholder engagement, and monitoring mechanisms, is essential for achieving meaningful progress towards SDGs and addressing the complex challenges posed by climate change.

5.4 Recommendations

To enhance the design of climate change interventions, public projects should prioritize systematic and consultative approaches that include stakeholder engagement, regulatory compliance, and innovative technologies for sustainability. Private interventions should focus on localized, community-driven solutions while collaborating with public entities to leverage institutional support for greater impact. A balanced and flexible approach between public and private sectors is key to addressing climate change effectively.

In terms of performance, public interventions must address challenges such as bureaucratic inefficiencies and resource limitations while continuing to deliver broad societal benefits. Private interventions should expand their focus beyond localized impacts to ensure long-term

sustainability and equity. Strengthened collaboration and resource-sharing between stakeholders can enhance the efficiency and reach of both public and private efforts.

To advance Sustainable Development Goals (SDGs), public interventions should maintain their focus on inclusivity and social equity, while private interventions should integrate sustainability principles to broaden their contributions. Effective governance, stakeholder engagement, and transparent monitoring mechanisms are critical to aligning the strengths of both sectors, fostering innovation, and achieving meaningful progress towards climate resilience and sustainability.



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APPENDIX

Table 4 Methodology Summary

Aspect	Scenario 1	Scenario 2	Scenario 3
Research Objective	To compare the design of public and private climate finance in Ga East district	To compare the performance of public and private climate finance in Ga East district	Examine the effects of public and private sources of climate finance on SDGs in Ga East district of Accra
Project Categories	two Mitigation (one public finance, one private finance) two Adaptation (one public finance, one private finance) projects	two Mitigation (one public finance, one private finance) two Adaptation (one public finance, one private finance) projects	two Mitigation (one public finance, one private finance) two Adaptation (one public finance, one private finance) projects
Research Design	Qualitative	Mixed-Methods	Mixed-Methods
Independent Variable	<i>Source of climate finance:</i> - public and - private climate finance	<i>Source of climate finance:</i> - public and - private climate finance	<i>Source of climate finance:</i> - public and - private climate finance
Dependent Variables	<i>Project design;</i> -Scale/scope of objectives -Technology -Community participation and - innovation	<i>Project performance;</i> - Relevance - Efficiency - Effectiveness - sustainability - impact	<i>Project outcomes (SDGs);</i>
Data Type	Qualitative Data	Quantitative and Qualitative Data	Quantitative and Qualitative Data

Data Sources	- Primary data (interviews)	- Primary data (interviews) - Secondary data (surveys, reports, literature)	- Primary data (interviews) - Secondary data (surveys, reports, literature)
Research Approach	Qualitative	Quantitative and Qualitative	Quantitative and Qualitative
Data Collection: Sampling Approach	Purposive sampling	Purposive sampling	Purposive sampling
Sample Size	12 respondents (interviewees)	12 interviews; 120 surveys	12 interviews; 120 surveys
Research Instruments	Interviews, Document analysis	Surveys, Interviews, Document analysis	Surveys, Interviews, Document analysis
Data Analysis	- Qualitative Analysis: Thematic analysis	- Quantitative Analysis: Descriptive statistics - Qualitative Analysis: Thematic analysis - Integration of findings	- Quantitative Analysis: Descriptive statistics - Qualitative Analysis: Thematic analysis - Integration of findings

RESEARCH INSTRUMENTS

Semi-Structured Interview Guide for Comparing Public and Private Climate Change Projects:

Introduction: Thank you for agreeing to participate in our study on the effects of public and private climate change projects on project design, project performance, and Sustainable Development Goals (SDGs). The purpose of this interview is to gather in-depth insights into your perceptions and experiences regarding climate change projects in your community. Your input is invaluable to our research. Please feel free to elaborate on your responses and share any additional insights you may have.

Researcher: Moses Buobalang (0241756406) mbuobalang@st.ug.edu.gh

Project Information:

1. Project Name:
2. Description of Project:

SECTION A: Project Design:

1. How well-defined is the scope of the project in addressing its objectives?
2. Could you describe the process of project design for the projects you have been involved in?
3. How were stakeholders involved in the design phase of the project?
4. What innovative approaches or technologies were incorporated into the project design?
5. How were potential risks and uncertainties identified and addressed in the project design?
6. How well-integrated are different components or elements within the project design?
7. How adaptable is the project design to changing conditions or evolving needs?
8. Did the project design involve collaboration with external partners or stakeholders?
9. Were there any budget constraints or considerations during the project design phase?

SECTION B: Project Performance

Cost-Effectiveness:

1. What was the total budget allocated for the project?
2. Did the project stay within its allocated budget? (Yes/No)
3. Please provide details if the project exceeded the budget:

Impact:

1. What were the primary objectives of the project?
2. To what extent were the intended outcomes achieved? (Scale: 1-10)
3. Were there any unintended positive or negative outcomes? Please describe:

Efficiency:

1. How would you rate the project's timeline adherence? (Scale: 1-10)
2. Were resources (financial, human, time) utilized efficiently? (Yes/No)
3. Please provide examples of efficient resource utilization or inefficiencies:

Relevance:

1. How closely does the project align with the organization's goals and priorities? (Scale: 1-10)
2. Did the project address identified needs or challenges? (Yes/No)
3. Please describe the relevance of the project to stakeholders:

Sustainability:

1. How does the project promote sustainability and resilience?
2. Are there plans in place to ensure the project's benefits are sustained over the long term? (Yes/No)
3. Please provide details on sustainability plans or challenges:

SECTION C: SDGs (Sustainable Development Goals):

1. To what extent does the project contribute to achieving the SDGs?
2. Which specific SDGs does the project address, and how?

Overall Assessment:

1. On a scale of 1 to 10, how would you rate the overall success of the project?
2. What aspects of the project do you consider particularly successful or areas for improvement?

Additional Information:

1. Stakeholder Name (Optional):
2. Role/Position:
3. Contact Information (Optional):

Conclusion: Thank you for sharing your insights. Your perspectives are invaluable in helping us understand the effects of climate change projects on project design, performance, and SDGs. If you have any additional comments or insights, please feel free to share them.



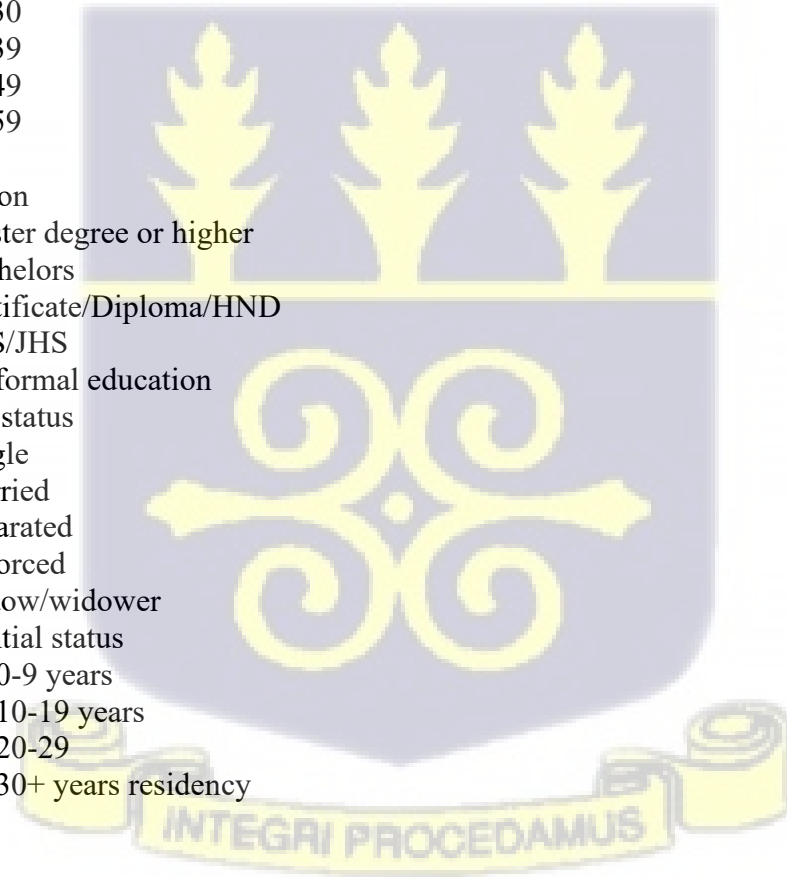
Structured Survey Questionnaire

Introduction: Thank you for participating in our study on the effects of public and private climate change finance on project design, project performance, and Sustainable Development Goals (SDGs). Your insights are invaluable to our research. This survey aims to gather information on your perceptions and experiences regarding climate change projects in your community. Please answer the following questions to the best of your ability.

Researcher: Moses Buobalang (0241756406) mbuobalang@st.ug.edu.gh

Please indicate the project

- a. GEMA drainage project
 - b. GEMA streetlight project
 - c. Homeowners' association drainage project
 - d. Homeowners' association streetlight project
1. On a scale of 1-5, how familiar are you with the project?
 2. Sex
 - a. Male
 - b. female
 3. Age range
 - a. 18-30
 - b. 30-39
 - c. 40-49
 - d. 50-59
 - e. 60+
 4. Education
 - a. Master degree or higher
 - b. Bachelors
 - c. Certificate/Diploma/HND
 - d. SHS/JHS
 - e. No formal education
 5. Marital status
 - a. Single
 - b. Married
 - c. Separated
 - d. Divorced
 - e. Widow/widower
 6. Residential status
 - a. 0-9 years
 - b. 10-19 years
 - c. 20-29
 - d. 30+ years residency



Objective 2: Investigate the Effects of the 4 Projects on Project Performance

1. How relevant do you believe the project is to addressing climate change challenges in your community? (Scale: 1-5, with 1 being not relevant at all and 5 being highly relevant)

2. In your opinion, how effective has the project been in achieving its intended objectives? (Scale: 1-5, with 1 being not effective at all and 5 being highly effective)
3. How would you rate the efficiency of project implementation in terms of resource utilization? (Scale: 1-5, with 1 being not efficient at all and 5 being highly efficient)
4. How would you rate the sustainability of the project in the long term? (Scale: 1-5, with 1 being not sustainable at all and 5 being highly sustainable)
5. How impactful do you believe the project has had on your community? (Scale: 1-5, with 1 being not impactful at all and 5 being highly impactful)

Objective 3: Investigate the Effects of the 4 Projects on Sustainable Development Goals (SDGs)

12. Which SDGs do you think the project contributes to? (Multiple choice). Indicate on a Scale: 1-5, with 1 being no contribution at all and 5 being maximum contribution.

SDG 1: No Poverty

SDG 2: Zero Hunger

SDG 3: Good Health and Well-being

SDG 4: Quality Education

SDG 5: Gender Equality

SDG 6: Clean Water and Sanitation

SDG 7: Affordable and Clean Energy

SDG 8: Decent Work and Economic Growth

SDG 9: Industry, Innovation, and Infrastructure

SDG 10: Reduced Inequality

SDG 11: Sustainable Cities and Communities

SDG 12: Responsible Consumption and Production

SDG 13: Climate Action

SDG 14: Life Below Water

SDG 15: Life on Land

SDG 16: Peace and Justice Strong Institutions

SDG 17: Partnerships to achieve the Goals

Conclusion: Thank you for completing the survey. Your responses will help us better understand the effects of climate change projects on project design, performance, and SDGs. If you have any additional comments or insights, please feel free to share them below.

