

Sustainable Energy Access and Climate Action Plan (SEACAP) for Sekondi- Takoradi Metropolis

Document Version Control			
Version	Date	Authors	Status
1.0	26 th September 2024		Submission 1

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List of Acronyms

Acronym \ Abbreviation	Meaning
AC	Air Condition
AECID	Agencia Española de Cooperación Internacional para el Desarrollo
AFOLU	Agriculture, forestry, and other land use
AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
BEI	Baseline Emission Inventory
BMZ	German Ministry of Economic Cooperation and Development
CCRA	Climate Change Risk Assessment
CFL	Compact Fluorescent Light
CH4	Methane
CO2	Carbon Dioxide
CO2e	Carbon Dioxide equivalent
CoM SSA	Covenant of Mayors for Sub-Saharan Africa
CRA	Climate Risk Assessment
CRVA	Climate Risk and Vulnerability Assessment
CSO	Civil Society Organisation
DVLA	Driver and Vehicle Licensing Authority
EPA	Environmental Protection Agency
GCF	Green Climate Fund

Gg	Gigagram
GPC	Global Protocol for Community-Scale
GHC	Ghana Cedis
GHGs	GreenHouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
kWh	Kilowatt-hours
LED	Light Emitting Diode
LDC	Least Developing Country
LI	Legislative Instrument
LPG	Liquified Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
MCA	Multi-Criteria Analysis
MESTI	Ministry of Environment, Science, Technology, and Innovation
MoFAD	Ministry of Fisheries and Aquaculture Development
NAP	National Adaptation Plan
N ₂ O	Nitrous oxide
NDCs	Nationally Determined Contributions

NIR5	Ghana's Fifth National Inventory Report
NPA	National Petroleum Authority
PFCs	Perfluorocarbons
PHC	Population and Housing Census
RVA	Risk and Vulnerability Assessment
SAEMA	Shama Ahanta East Metropolitan Assembly
SDGs	Sustainable Development Goals
SEA	Sustainable Energy Access
SEACAP	Sustainable Energy Access and Climate Action Plan
SF6	Sulfur Hexafluoride
SLCPs	Short-Lived Climate Pollutants
SHS	Senior High School
STEM	Science, Technology Engineering and Mathematics
STMA	Sekondi-Takoradi Metropolitan Assembly
TaMA	Tamale Metropolitan Assembly
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation

1. Introduction

African cities have emerged as some of the most vulnerable in the world to the impacts of climate change, necessitating immediate and decisive action (Oluwase, 2024). The continent is already experiencing the profound effects of climate change, including increased flooding, prolonged droughts, and erratic weather patterns, which are severely disrupting socio-economic activities, agriculture, infrastructure, and livelihoods. In many parts of Africa, the persistent droughts have led to an alarming scarcity of water resources, posing a critical threat to urban water supplies. Simultaneously, rising sea levels are wreaking havoc on coastal communities, causing extensive damage to infrastructure and threatening the very existence of these communities.

Despite contributing only about 4% to global greenhouse gas emissions, Africa is disproportionately bearing the brunt of climate change, with the continent poised to pay a heavy price for the rapid and relentless progression of these global changes (AFDB, 2022). Without urgent and sustained intervention, the advances in development that have taken decades to achieve could be swiftly undone by the accelerating impacts of climate change.

Against this backdrop, Ghana's commitment to the Paris Agreement underscores its dedication to limiting global warming and advancing nationally determined contributions (NDCs). Recognising the pivotal role of local governance, initiatives such as the Covenant of Mayors for Sub-Saharan Africa (CoM SSA) support entities like the Sekondi Takoradi Metropolitan Assembly (STMA) in fostering sustainable urban development and climate action. Through collaborative efforts and strategic planning, CoM SSA empowers local governments to transition from planning to implementation, facilitating access to climate finance and bolstering resilient infrastructure.

The Covenant of Mayors in Sub-Saharan Africa (CoM SSA), initiated in 2015, is a significant driver of local climate action in the region, with over 350 local governments committed. As the regional chapter of the Global Covenant of Mayors for Climate and Energy, CoM SSA collaborates with city networks, development agencies, and funding institutions. This partnership helps cities tackle the dual challenges of climate change and access to sustainable energy, striving for a low-emission, climate-resilient, and sustainable energy future.

Since January 2019, CoM SSA is co-funded by the European Union, the German Ministry of Economic Cooperation and Development (BMZ), and the Agencia Española de Cooperación Internacional para el Desarrollo (AECID). It is jointly implemented by four European Member State Organizations namely GIZ, AECID, AFD and Expertise France: A Team Europe Green Deal initiative supporting BMZ's Agenda 2030 (protecting the planet) and Vision 100, as well as the African Union Agenda 2063.

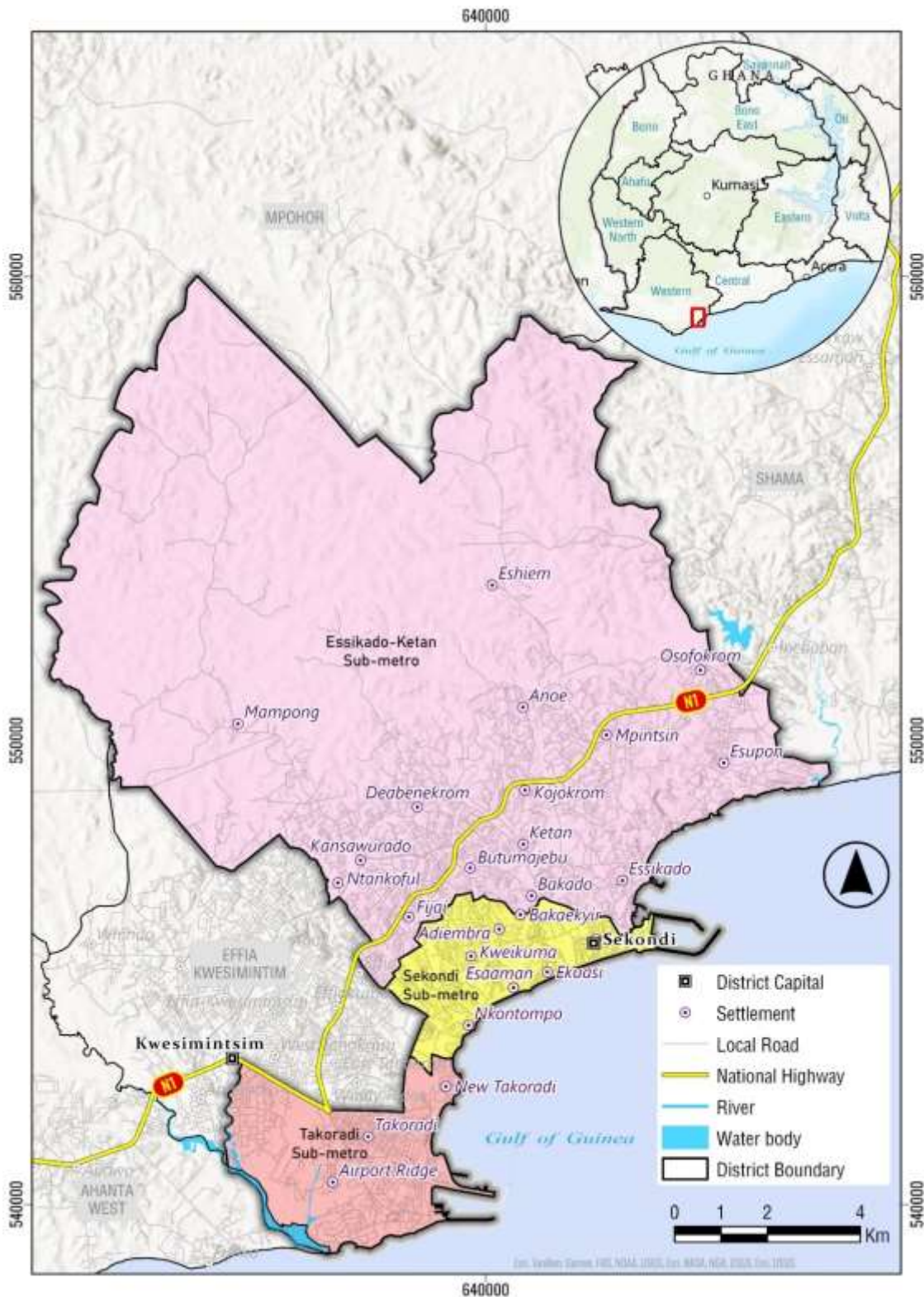
In this context, the development of a Sustainable Energy Access and Climate Action Plan (SEACAP) by STMA emerges as a strategic blueprint for tangible action across climate mitigation, adaptation, and sustainable energy access. This plan, guided by rigorous analysis and stakeholder engagement, aims to translate long-term sustainability goals into actionable steps with defined timelines and responsibilities. Collaborating with GIZ as the operational implementer in Ghana, STMA is poised to leverage the expertise of PSS Urbania to realise the vision of mainstreaming SEACAP into Ghana's planning framework.

1.1 Objectives

The SEACAP aims to develop an action-oriented blueprint on climate change and sustainable energy, to guide the development actions of STMA transitioning it into a smart and resilient city in the future. The SEACAP was co-created through a participatory and comprehensive process through grassroots mobilisation and engagement of state and non-state actors. It involved an analysis of the baseline conditions, targets and actions setting for seamless integration into STMA development plans and ultimately into the national development planning framework.

1.2 Profile of STMA

Figure 1. 1: Map of Sekondi-Takoradi showing Sub Metros



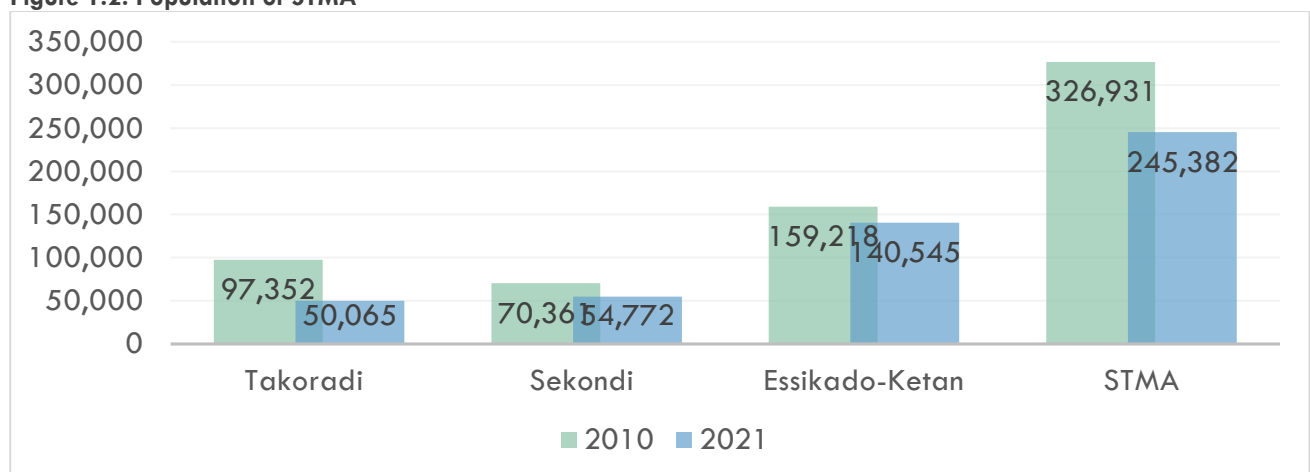
The Sekondi-Takoradi Metropolitan Assembly has undergone significant changes since its inception. In 1930, the Sekondi Town Council was established under Town Council Ordinance No. 26 to oversee the area's development. In 1946, the Takoradi area was incorporated into the Sekondi Town Council, forming a single administrative entity. By June 1962, the combined Sekondi-Takoradi Town Council was elevated to a Metropolitan Assembly. In 1994, the name was changed to Shama Ahanta East Metropolitan Assembly (SAEMA) through Legislative Instrument (LI) 1613. However, in 2008, following the fragmentation and elevation of Shama to a separate district status, the name of the remaining part reverted to Sekondi-Takoradi Metropolitan Assembly (STMA) via LI 1928. In 2017, after further fragmentation and the creation of the Effia-Kwesimintsim Municipal Assembly, the LI establishing STMA was amended to LI 2262. STMA is divided into three sub-metropolitan councils for effective management and development of the metropolitan area. They are Sekondi Sub-Metropolitan District Council, Takoradi Sub-Metropolitan District Council and Essikado/Ketan Sub-Metropolitan District Council.

The STMA is strategically located in the southern part of the Western Region of Ghana, with Sekondi serving as the administrative capital. It lies approximately 250 kilometres from Accra and 130 kilometres from La Côte d'Ivoire. The metropolis is bordered by Mpohor District to the north, Shama District to the east, Effia-Kwesimintsim Municipal to the west, and the Gulf of Guinea to the south. Covering a total land area of 66.44 square kilometres, it is the smallest in terms of land size in the Western Region but the most urbanised and densely populated.

The vision of STMA is to become a world-class city with modern infrastructure, social services, best governance, attractive businesses, and a living environment. The vision is aligned with the mission which seeks to improve the living conditions of the metropolis through the provision of sustainable socio-economic development and good governance that is responsive to the needs of the people.

According to the 2021 Population and Housing Census (PHC) Report, Sekondi-Takoradi has a population of 245,382. This marks a drastic reduction from the 2010 census report, which recorded a population of 559,548 for the metropolis. The decrease in population is attributable to the separation of the Effia-Kwesimintsim Sub-Metro Council. Males in the metropolis account for 49% of the population, while females comprise 51%. The population density of STMA is 3797.4 per sq km and the average household size is 3.2. Figure 1.2 presents the population of STMA per the 2021 Population and Housing Census.

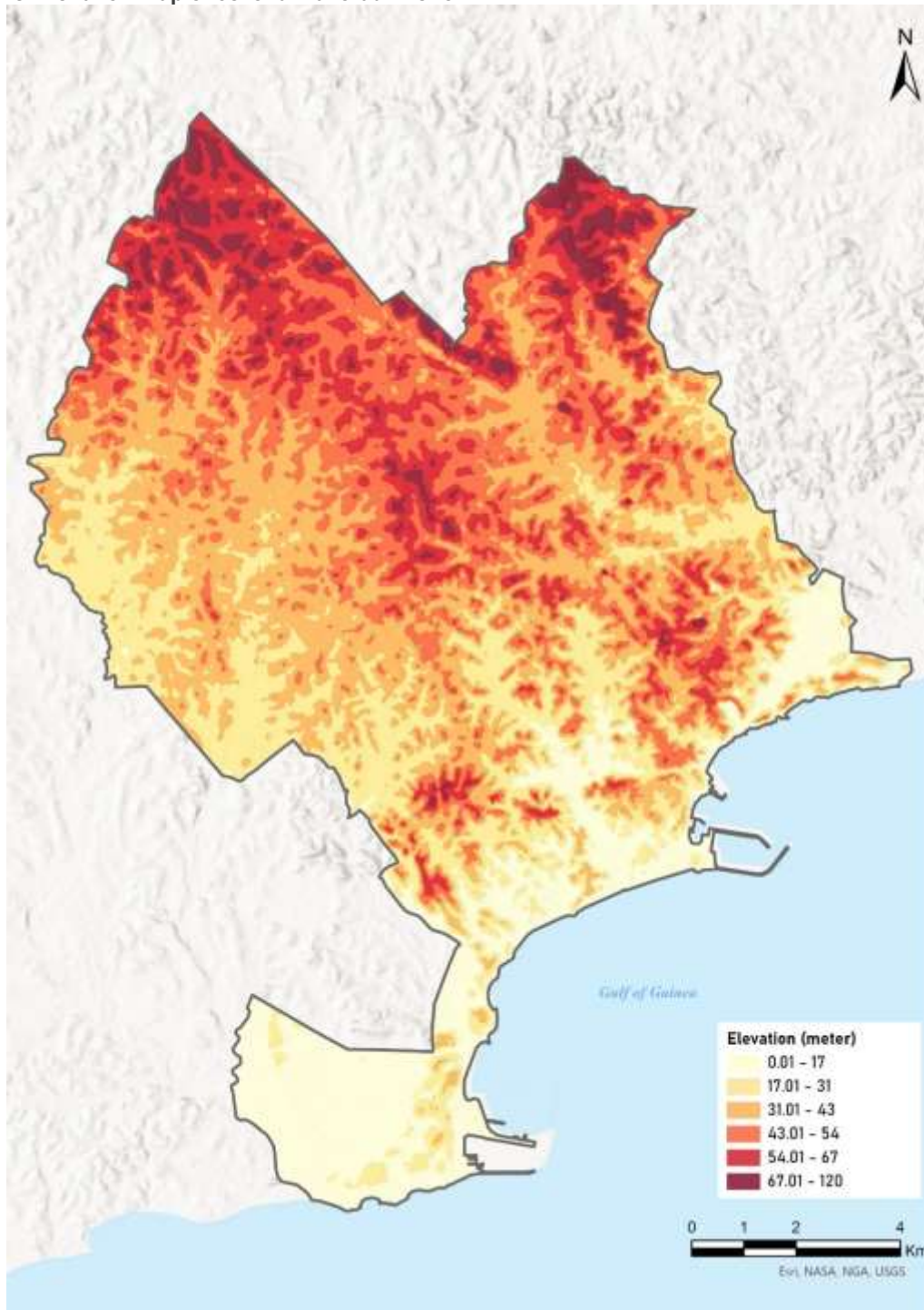
Figure 1.2: Population of STMA



Source: Ghana Statistical Service (2021)

The central area of the STMA is low-lying, with an altitude of approximately 6 metres above sea level, interspersed with ridges and hills ranging from 30 to 60 metres high. The major drainage basins in the metropolis include Kansawura, Buwen, Anankwari, and Whin.

Figure 1:3: Elevation Map of Sekondi Takoradi Metro



Sekondi-Takoradi experiences a wet and dry season. The dry season spans from November to March while a major wet season is between April and July and a minor rainy season is between September and October. This climate data in Table 1.2 shows the average monthly maximum temperature, average monthly minimum temperature, monthly average temperature and average monthly rainfall for the period 1991-2023. It indicates the long-term yearly averages for these parameters. From the table the hottest month is March with an average maximum temperature of 31.98⁰C and the coolest month is August with an average minimum temperature of 22.42⁰C. June is the wettest month with an average rainfall of 286mm and January recorded the least amount of rainfall (20mm). Yearly average temperature is at 27.08⁰C

Table 1.1: Climate data for Sekondi-Takoradi

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average monthly maximum °C	31.46	31.96	31.98	31.83	31.13	29.43	28.23	27.72	28.38	29.80	31.14	31.53	30.38
Monthly average °C	27.43	28.24	28.32	28.27	27.78	26.60	25.61	25.07	25.72	26.66	27.52	27.70	27.08
Average monthly minimum °C	23.40	23.51	24.65	24.71	24.43	23.78	22.98	22.42	23.07	23.53	23.89	23.87	23.77
Average rainfall mm	20	30	57	118	216	286	102	44	59	144	70	46	1,171

Source: PSS Urbania based on GMET, 2024

2. Review of Policies and Methodology

2.1 Relevant Policies

Climate Change is on top of Ghana's development agenda and policies, plans and strategies have been formulated in response to this global threat. A number of these documents have been reviewed as seen in Table 2.1 which provide a solid backing for the SEACAP.

Table 2.1 Relevant Policies

No	Policy, Plan or Strategy	Description
1	Updated Nationally Determined Contribution (NDC) under the Paris Agreement 2020- 2030 (September 2021)	<p>Ghana's updated NDC, submitted in 2021, outlines the country's enhanced climate ambitions, building on the commitments made in the 2016 NDC. Ghana aims to achieve an absolute greenhouse gas (GHG) emission reduction of 64 MtCO₂e by 2030, contributing to global efforts in combating climate change. The 2021 NDC sets two tiers of commitments: unconditional and conditional targets. Ghana pledges to implement nine unconditional mitigation programmes of action that would result in an 8.5 MtCO₂e GHG reduction by 2025 and a further 24.6 MtCO₂e reduction by 2030, relative to a baseline scenario and seven adaptation measures.</p> <p>With adequate financial support from international and private sectors, Ghana aims to adopt an additional 25 conditional mitigation programmes, potentially achieving a further 16.7 MtCO₂e reduction by 2025 and 39.4 MtCO₂e by 2030 and six adaptation measures. The policy document also includes a National GHG Inventory and served as a reference for comparing national emissions and mitigation strategies with those of the Sekondi-Takoradi Metropolitan Assembly (STMA).</p>
2	Ghana's Fifth National Inventory Report (NIR5) to the United Nations Climate (May 2022)	<p>This document presents the baseline National data. The methodology for Ghana's greenhouse gas (GHG) inventory follows the 2006 IPCC guidelines and covers emissions from four key economic sectors: Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry, and Other Land Use (AFOLU); and Waste. Ghana's total GHG emissions in 2019 were 59.8 million tonnes of CO₂-equivalent (MtCO₂e), a 16.3% increase from 2016 and 139.2% higher than 1990 levels. Excluding emissions from land use, land-use change, and forestry (LULUCF), the total drops to 45.3 MtCO₂e. National data was downscaled to undertake the STMA inventory and the corresponding mitigation measures for GHG emissions.</p>
3	National Adaptation Plan (NAP) Framework, (October 2018)	<p>Ghana's National Adaptation Plan (NAP) guides the country's medium- and long-term adaptation efforts through a coordinated and coherent approach. The government's long-term vision is to integrate climate adaptation into district-level medium-term development plans. This involves conducting vulnerability assessments across key sectors such as agriculture, water, health, energy, and forestry, using downscaled climate risk and vulnerability scenarios, and socio-economic modelling for various climate zones. The NAP outlines Ghana's adaptation vision, objectives, and principles, detailing the roles of national stakeholders and prioritising key adaptation actions. It serves as a comprehensive framework for aligning sectoral and sub-national adaptation planning with existing policies and strategies and provides a foundation for</p>

No	Policy, Plan or Strategy	Description
		stakeholder engagement. This guided the development of the STMA adaptation pillar.
4	Ghana National Climate Change Policy, 2013	The policy seeks to provide strategic directions and coordinate issues of climate change in Ghana, bearing in mind its linkages with development. It is intended to ensure the mainstreaming of the climate-proofing agenda into national development processes. The policy emphasised the need for mutually reinforcing and integrating the climate change issues into the national planning and budgeting processes and ensuring the involvement and participation of all relevant stakeholders, including the private sector, NGOs and civil society organisations. It also provides the policy direction for mainstreaming the climate change agenda into national development processes including planning and budgeting. The three policy objectives for adaptation, social development and mitigation, will facilitate the development and integration of climate change adaptation and mitigation into the STMA development planning processes.
5	National Climate Change Adaptation Strategy (NCCAS)	The preparation of the adaptation strategy was principally influenced by; (1) Ghana's commitments under the UNFCCC to ensure that climate change issues are adequately considered in national development planning, (2) the country's responsiveness to the Hyogo Framework for Action (HFA) 2005– 2015 (comprehensive and action-oriented response to international concern about the growing impact of disaster on individuals, communities and national development, which aims to reduce substantially loss of life as well as the social, economic and environmental losses caused to communities), (3) the extent of added vulnerability to the Ghanaian economy attributed to the current and expected impacts of climate change on the entire society. This guided the development of local adaptation strategies to ensure alignment.
6	Ghana National Climate Change Master Plan Action Programmes for Implementation: 2015– 2020	The master plan focuses on ten key programme areas to address climate change, including developing climate-resilient agriculture and food security systems, building resilient infrastructure, and increasing the resilience of vulnerable communities to climate-related risks. It also aims to increase carbon sinks and improve the management of terrestrial, aquatic, and marine ecosystems. Additional focus areas relevant to the SEACAP include addressing the impacts of climate change on human health, gender issues, and migration, as well as minimising greenhouse gas emissions and ensuring access to water and sanitation. The goal of mainstreaming climate change adaptation is to mitigate the adverse effects of climate change on national development processes while achieving the added benefit of reducing greenhouse gas emissions. This requires a participatory approach that allows stakeholders to actively contribute to policy planning and cost estimation for various programmes.
7	Ghana Energy Transition and Investment Plan	The Energy Transition and Investment Plan offers a consolidated strategy for the energy sector, encapsulating an all-encompassing approach that outlines the financial layout necessary for its fruition. It maps out the immediate journey and lays the groundwork for formulating energy-specific objectives to be integrated into upcoming policy and regulatory frameworks. Core decarbonization technologies are pinpointed within this plan to facilitate a seamless transition. These technologies encompass renewable energy, energy efficiency, hydrogen, e-mobility, energy storage, and sustainable cooking solutions. Furthermore, the plan is geared towards project identification that can trigger funding from

No	Policy, Plan or Strategy	Description
		state-driven and private avenues. The SEACAP adopted renewable energy technologies, improved energy efficiency, and promoted sustainable cooking solutions, and will potentially rely on both state and international donor funding.
8	Ghana's Adaptation Communication to the United Nations Framework Convention on Climate Change (November 2021)	The first adaptation communication (ADCOM) is in line with Article 7, paragraphs 10 and 11, of the Paris Agreement and also draws on the results of Ghana's National Adaptation Planning (NAP) process, which aims to fully integrate adaptation into economic, environmental and social decision making. It highlights national overall efforts towards adaptation to climate change. The three pillars of the SEACAP: mitigation, adaptation and energy access align positively with the ADCOM.
9	EPA Policy Brief No: 6 covers issues pertaining to impacts of climate change on energy sector, in Ghana	Climate change poses a significant risk to energy infrastructure, with severe storms and floods potentially damaging offshore oil platforms, oil and gas pipelines, and national electricity grids. It is crucial to incorporate climate change impacts and adaptation strategies into the planning, design, costing, and management of such infrastructure to mitigate these risks. The SEACAP aimed to address the impact of climate change on energy infrastructure, severe storms, and floods through a combination of adaptation and mitigation measures.
10	Third Biennial Update Report (BUR3) to the United Nations Framework Convention on Climate Change (UNFCCC) (August 2021)	The BUR3 contains the output of the two years of gathering information on GHG emissions sources, estimation of GHG emissions levels and trends, assessment of mitigation actions and their effects in the context of sustainable development, and tracking of climate support. This aligned with the SEACAP's objectives to determine GHG emission sources, estimate emission levels and trends and evaluate mitigation actions, all aimed at promoting sustainable development.
11	Ghana's Fourth National Communication (NC) to the United Nations (May 2020)	The preparation of NC contributes to raising awareness and strengthening technical capacities on climate change among national stakeholders. It also allows Ghana to highlight critical gaps in national climate efforts. The main objective of the NC4 is to communicate to the COP, the status of Ghana's effort to implement the Convention up to 2020 by highlighting the pertinent achievements and constraints. The updated information in the NC4 covers the period between 2015 and 2020. The SEACAP will support future communications to the COP as it will contribute to the communication at the sub-national level.
12	World Bank: Climate Risk Country Profile 2021: Ghana	The country profile compiles the most relevant data on climate change, disaster risk reduction, and adaptation actions and policies, serving as a quick reference for development practitioners to better incorporate climate resilience into planning and policy-making. This information is largely derived from the Climate Change Knowledge Portal (CCKP), a World Bank Group online platform that provides global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. It also includes an overview of the energy sector, climate change impacts on this sector, and potential adaptation options. Integrating climate resilience into development planning, understanding the sectoral impacts, and exploring adaptation options were key components considered for the SEACAP framework.
13	STMA Medium Term Development Plan (MTDP), 2022-2025	The STMA MTDP gives direction and guidance to the Metropolis and it strives towards the achievement of the NMTDPF goal of building a prosperous society, safeguarding the natural environment, ensuring a

No	Policy, Plan or Strategy	Description
		resilient built environment, and maintaining a stable, united and safe society. The SEACAP further strengthened STMA's future MTDP to integrate sustainable energy access, climate mitigation and adaptation strategies.
14	Accra Climate Plan: First Five-Year Plan (2020-2025)	Accra Metropolitan Assembly (AMA) has developed a Climate Action Plan (CAP), which is the first of its kind to be prepared at a sub-national level. The Climate Action Plan builds on national climate policies and aligns with Ghana's Sustainable Development Goals. The Plan identifies a range of actions that, once implemented, will achieve significant greenhouse gas emissions reductions, improve quality of life, create green jobs and set the city on a path towards climate resilience and carbon neutrality by 2050. The Climate Action Plan also presents actions that will aid Accra's ability to adapt to the societal, economic and environmental changes that result from climate change. STMA drew lessons from the Accra Climate Action Plan to develop a sustainable SEACAP.
15	Greenhouse Gas Protocols: Global Protocol for Community-Scale Greenhouse Gas Inventories. An Accounting and Reporting Standard for Cities Version 1.1	Previous inventory methods employed by cities to track greenhouse gas (GHG) emissions have varied significantly, leading to challenges in comparison, data quality, and aggregation of emissions data across different government levels and greater consistency in GHG accounting is necessary. The updated Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC) provides a robust framework that builds on existing methodologies for calculating and reporting city-wide emissions. This revision incorporates insights from the 2019 Refinement to the 2006 IPCC Guidelines and clarifies ambiguities while aligning with the Global Covenant of Mayors' Common Reporting Framework. The GPC requires cities to measure and disclose a comprehensive GHG inventory using two complementary approaches: one that captures emissions from production and consumption activities within the city boundary, and another that categorises emissions based on their physical location. This method ensures that emissions are accounted for separately to avoid double counting when aggregating data from multiple cities. The updated protocol guided the emissions inventory for the SEACAP and ensured consistency and data integrity in its reporting.
16	The Cities and Infrastructure for Growth – Ghana (CIGG) Programme Phase 2: Pre-Feasibility Report on Sekondi-Takoradi Stormwater Drainage	The project provided support to Sekondi-Takoradi and Tamale, two cities in Ghana, to enhance their understanding of climate change risks and identify potential adaptation solutions. In Sekondi-Takoradi, flood-prone areas were identified, particularly focusing on the Bakado neighbourhood and Sekondi Market. The flooding in Bakado is primarily caused by the Pokuantra stream, where two branches converge and overflow, leading to significant water flow through the settlement. Locals reported frequent flooding, especially near the stream. Additionally, the Sekondi Market area was identified as a flood hotspot, particularly at the intersection of Kwesi Lamptey Avenue and Kwamina Anaesi Boulevard, with significant flooding observed on the sports field. This assessment guided the selection of appropriate flood mitigation measures and adaptation strategies.
17	Joint Research Centre (JRC), Technical Reports: Guidebook: "How to develop a Sustainable Energy Access and Climate	The document aims to support cities and local governments in their climate and energy efforts by presenting the technical framework for the three pillars of the initiative and providing step-by-step recommendations for the entire process of elaborating a climate action plan (SEACAP), from initial political commitment to monitoring. It served as the benchmark for the preparation of the SEACAP for STMA.

No	Policy, Plan or Strategy	Description
	Action Plan (SEACAP) in Sub-Saharan Africa"	
18	Global Covenant of Mayors; Common Reporting Framework Version 7.0 April 2023	Local governments that have committed to the Global Covenant of Mayors (GCoM) pledge to implement policies aimed at reducing greenhouse gas emissions, preparing for climate change impacts, increasing access to sustainable energy, and tracking progress towards these goals. New global recommendations have been established to enhance climate action planning and monitoring, and have been designed to be adaptable to local contexts while facilitating global data aggregation and comparison. The Common Reporting Framework serves as a unified reporting language, guiding local governments on which aspects of their climate response should be publicly reported. This transparency builds trust and credibility in local climate initiatives and aids in advocacy efforts and access to funding. The global recommendations shaped the preparation of the SEACAP.
19	National Development Policy Framework: Agenda For Jobs II Creating Prosperity and Equal Opportunity For All 2022-2025	It provides the overarching policy framework that guides the planning and development at all levels in the country. It commits to among other things the fulfilment of international obligations made towards the SDGs 2030 and Paris Climate Agreement. Among the medium-term goals is to build resilience to withstand threats of different dimensions, including climate change. One of the priority focus areas of the policy includes economic growth; digitization; science, technology, and innovation; urbanisation and infrastructural deficits; youth unemployment; public health; emergency preparedness and the fight against pandemics; and climate change. It also provides valuable information on climate variability and change including the cost of Ghana's carbon emissions trends and the cost to the nation's economy and global community as well as the impacts of Climate Change and Variability (CCV) in the form of unreliable rainfall patterns, flooding, prolonged periods of droughts, increased temperature and rise in sea levels. In developing the SEACAP, this provided national policy context on greenhouse gas emissions, climate variability, and the impacts of climate change.
20	Climate Change Risk Assessment for Sekondi-Takoradi Metropolitan Assembly Enhancing Multi-Sector Planning and Capacity for Effective Adaptation in Ghana	The report contains a clear methodology for producing national climate change scenarios, the development of downscaled/area-based climate change projections, and sub-national level climate risk assessments for STMA. The results of the risk assessment can then be used to inform adaptation planning. The approach emphasises a participatory process, sensitive to issues of gender, youth, and the possible involvement of vulnerable groups. The risk assessment was thoroughly reviewed and used as the basis to develop the SEACAP.
21	Ghana Climate Risk Assessment for Subnational Adaptation	This demonstrates a clear methodology for undertaking climate risk assessment at the subnational level. It also presents the results of the assessment for several district assemblies in Ghana. The methodology and approach informed the risk and vulnerability assessment.
22	Ghana's Adaptation Strategy and Action Plan for the Infrastructure Sector (Water, Energy, and Transport Sectors)	This document demonstrates the process of adaptation planning at the sectoral level highlighting the impacts of climate change on water, energy and transport infrastructure. The result was an adaptation strategy and action plan for Ghana's water, energy, and transport infrastructure, covering all levels of decision-making, to increase the sector's resilience to climate change. This offered a useful approach in preparing the adaptation component of the SEACAP.
23	Annual Electricity Supply Plan 2010-2023	The Annual Energy and Demand Outlook is prepared every year to give government, industry and business, indications of the levels/quantities of

No	Policy, Plan or Strategy	Description
	(prepared annually by a team co-chaired by GridCo and Energy Commission)	all the energy systems from electricity, wood, liquid and gaseous fuels that would be required to be provided by the energy producers and suppliers for the year. For this reason, it covers the demand and supply of all the energy resources, namely electricity, crude oil, petroleum products, natural gas, wood fuels as well as Renewables for the ensuing year. The ESP highlights the anticipated challenges in meeting the power demand for the year and makes recommendations on the best course of action to be taken to ensure a reliable power supply. Finally, it further provides an outlook of electricity demand and supply for the next year and five years, which was useful in developing the SEACAP.
24	Annual Ghana Energy Demand and Supply Outlook (Energy Commission, Ghana 2010-2021)	The Annual Energy and Demand Outlook is prepared every year to give government, industry and business, indications of the levels/quantities of all the energy systems from electricity, wood, liquid and gaseous fuels that would be required to be provided by the energy producers and suppliers for the year. For this reason, it covers the demand and supply of all the energy resources, namely electricity, crude oil, petroleum products, natural gas, wood fuels as well renewables for the ensuing year. This outlook serves as a guide for energy sector operators, potential investors, and the broader business community interested in operating in the country.
25	Annual Energy Statistics 2010-2023 (Energy Commission, Ghana (2010-2021)	The Energy Commission's annual National Energy Statistics report offers a time series analysis of Ghana's energy supply and usage over the past decade, with the 2019 edition covering data from 2009 to 2018. Historical data is also accessible on the Commission's website. This publication compiles information from key energy sector institutions, such as the Ministry of Energy, Volta River Authority, and Ghana Grid Company, as well as data from the Bank of Ghana and the Ghana Statistical Service. Targeting a wide range of users—including planners, policymakers, researchers, and students—the report focuses on historical trends rather than making projections or forecasts, distinguishing it from the Energy Outlook and the Electricity Supply Plan.

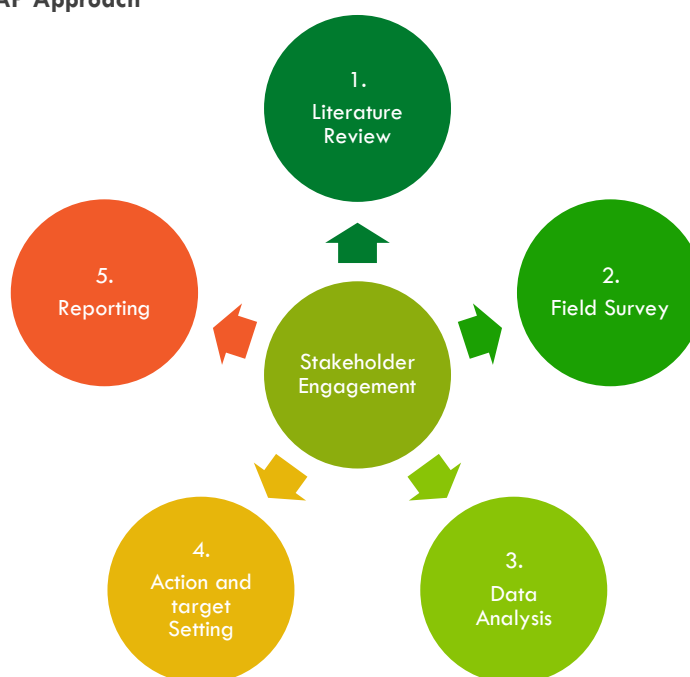
2.2 Methodology for the Development of the SEACAP

The SEACAP was developed through a comprehensive, bottom-up process that prioritised stakeholder engagement and inclusivity. Initial research involved a thorough review of existing literature on climate change mitigation, adaptation, and energy at national, regional, and local levels. This review identified critical knowledge gaps, which served as the foundation for extensive consultations with diverse stakeholders.

To gather primary data, a field survey was conducted, encompassing 772 households and 66 institutions within the metropolis. Figure 2.2 shows the distribution of the communities sampled. A triangulation of qualitative and quantitative research methods was employed to ensure a comprehensive understanding of local needs and perspectives. The data collected were analysed and presented in a detailed 'Baseline Assessment Report'.

This report underwent a rigorous validation process to ensure its accuracy and relevance. The findings served as the basis for developing the specific interventions outlined in each pillar of the SEACAP, including the vision, target goals, and prioritised actions. This participatory approach ensured that the SEACAP was tailored to the unique needs and priorities of the Metropolis.

Figure 2.1 the SEACAP Approach



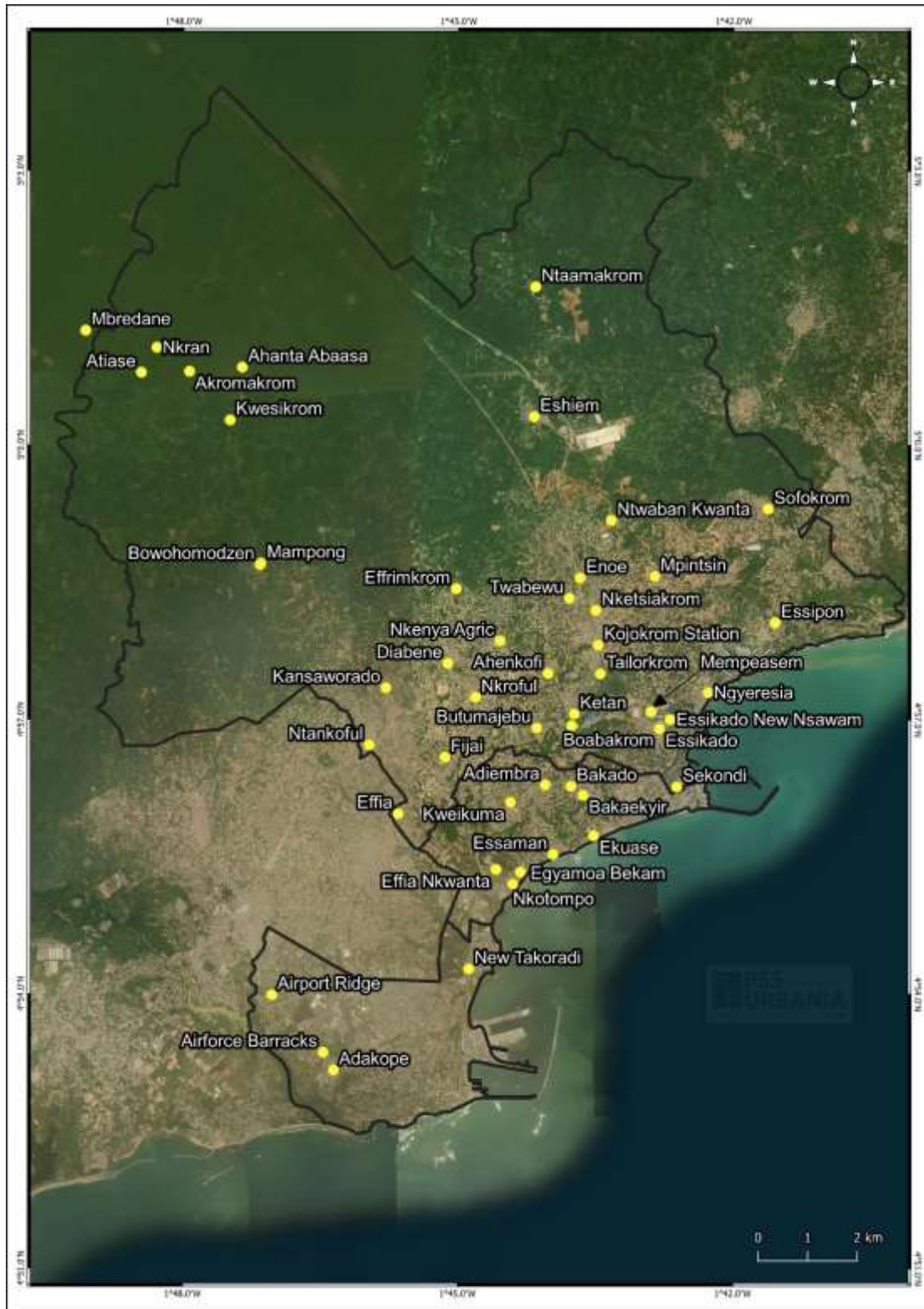
2.3 Summary of the profile of respondents

The survey results revealed that a majority (58%) of respondents were female, compared to 42% male, reflecting the demographic profile of the Sekondi-Takoradi Metropolitan Area (STMA). In terms of sub-metro representation, Essikado Ketan had the largest share of respondents (58.44%), followed by Sekondi (21.17%) and Takoradi (20.39%). Regarding household status, 54% of respondents were heads of household, followed by spouses (7%) and adult children of household heads (15%). While females outnumbered males overall, male household heads outnumbered female counterparts by a ratio of 5:3. Most spouses of household heads were female.

The survey found that 88% of respondents had basic education and were literate, suggesting a potential for a better understanding of climate change concepts. All respondents were over 18 years old, with the majority (43%) aged 18-35, followed by 36-45 (27%). Most respondents were employed (77%), with self-employment being the most common sector (71%), followed by private entities (15%) and government (14%).

Households with more than six members represented the highest percentage in terms of household size (26.1%), likely due to extended family system practices. Compound housing was the most common housing type (47.6%), followed by flats/apartments (23.2%) and detached houses (18.7%). The institutional survey included 66 respondents from public, private, and public-private entities

Figure 2. 1: Surveyed Communities



3. Mitigation

3.1 Introduction

Baseline Emission Inventory (BEI) is a prerequisite for the preparation of the SEACAP. Climate change issues mostly centre around GHGs that are generated as a result of anthropogenic activities of mankind. Within cities, GHGs are emitted because of economic activities as well as household activities. This involves the use of charcoal and firewood for cooking, the increasing use of air-condition units in the cities because of increased temperatures in the urban areas and household waste generation. The amount of GHGs emitted correspond to the level of economic activities such as transportation, access to energy, consumption patterns, waste generation, manufacturing and industrial activities among others.

To provide mitigation and adaptation strategies for climate change, baseline emission data must be established. For the Sekondi-Takoradi Metropolitan Assembly (STMA) Sustainable Energy Access and Climate Action Plan (SEACAP), the following three GHGs are considered as recommended by CoM SSA to undertake a BEI; CO₂, N₂O and CH₄. A BEI quantifies the amount of greenhouse gases (GHGs) emitted due to specific activities in a local government's territory within a calendar year, expressed in tonnes of carbon dioxide equivalent (tCO₂e). The BEI enables the municipal authority to select the appropriate actions to reduce greenhouse gas emissions (CoM SSA, undated).

Description of the Mitigation Assessment Approach

Step 1: Calculation of 2021 BEI

The study computed the Greenhouse Gas (GHG) baseline emission inventory (BEI) for STMA for 2021 as the base year. The BEI covered GHG sources in the fuel combustion (stationery and transport/mobile sources) and waste management activities within the administrative boundary for the Sekondi Takoradi Metropolitan Assembly (STMA). The 2021 BEI covers the three direct greenhouse gases including Carbon Dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (N₂O). The rest of the GHG such as f-gases (PFCs and HFCs) and Sulphur Hexafluoride (SF₆) were excluded from the inventory boundary. This is due to either a lack of data or the emission levels being considered insignificant based on national emission figures. Global warming potential values applied to express all the GHGs into carbon dioxide equivalent (CO₂e) was based on the Fourth Assessment Report (AR4) for 100 years horizon.

Step 2: Business As Usual (BAU) Emission Projections

The 2021 BEI results were used as the reference year for the 2050 BAU projections for all gases and categories of emissions/removals. The BAU emission depict the future emission trends for STMA based on the current policies and drivers that influence the historical emission in the BEI. Thus, in the study the 2021 BEI emission result were projected based on the growth assumption of key parameters such as population growth, gross domestic products, fuels prices and tax.

Step 3: GHG mitigation target setting

In step 3, the mitigation goal was assessed through participatory group work. The group work settled on using business-as-usual (BAU) goal type as it is consistent with Ghana's nationally determined contribution to the UNFCCC. The BAU goal type set to reduce GHG by a defined percentage compared to the projected BAU by 2050.

Step 4: Selection and screening of GHG mitigation measures

The step 4 generated a list of prioritised mitigation actions that is expected to be implemented in STMA to achieve the overall GHG mitigation goal by 2050. The screening of the mitigation measure was done through a group consensus approach based on a set structured criteria.

Step 5: Evaluation of GHG mitigation and sustainable development potential

The GACMO tool was used to evaluate the GHG mitigation potential and the abatement cost of each of the prioritised mitigation measures. This was done by comparing the impact of the base case against the scenario of adopting the measure considering the investment, OM Cost and the fuel cost where appropriate. The results of the Marginal Mitigation Abatement and analysis was further used to inform the selection of the prioritised measures.

Step 6: Development of Action plan

Through a participatory approach, the vision, target, and corresponding actions were developed. The action plans factored in the implementation timeframe, indicators and the linkage with the STMA annual action plans.

Description of the Baseline Emission Inventory

The study computed the Greenhouse Gas (GHG) baseline emission inventory (BEI) for STMA for 2021 as the base year. The BEI covered GHG sources in the fuel combustion (stationary and transport/mobile sources) and waste management activities within the administrative boundary for the Sekondi Takoradi Metropolitan Assembly (STMA). The 2021 BEI covers the three direct greenhouse gases including Carbon Dioxide (CO₂), Methane (CH₄) and Nitrous Oxide (N₂O). The rest of the GHG such as f-gases (PFCs and HFCs) and Sulphur Hexafluoride (SF₆) were excluded from the inventory boundary. This is principally due to either a lack of data or the emission levels being considered insignificant based on national emission figures. Global warming potential values applied to express all the GHGs into carbon dioxide equivalent (CO₂e) was based on the Fourth Assessment Report (AR4) for 100 years horizon.

The methodology for Baseline Emission Inventory (BEI) was based on the GPC and 2006 IPCC Guidelines. The 2006 IPCC guideline was selected for this exercise because it aligns with the methodology used in the national greenhouse gas inventory. Additionally, the guideline allows for adapting the input to suit the level of detail of the available data and to downscale from the national to the sub-national (city) level.

3.2 Inventory Boundary and Emission Sources

The inventory boundary for the STMA SEACAP covers the administrative boundary of STMA as presented in Figure 1.1 of this report. The inventory does not cover activities and emissions outside this STMA administrative boundary. The GHG emissions were quantified and reported according to the classification in the following three main sectors:

- Stationary Energy
- Transportation, and
- Waste management

The following remaining categories were excluded due to lack of data at the time of conducting the baseline inventory. Another reason for not including the identified activities was that the study considered them as insignificant sources of contribution to the total STMA emissions.

- Industrial processes and product use (IPPU)




- Agriculture, forestry, and other land use (AFOLU)
- Out-jurisdiction emissions (emission occurring in the inventory boundary due to activities outside STMA).

3.3 Base Year and Reporting Year

The year 2021 was used as the base year in the BEI inventory because of the availability of the minimum required data. The base year also represents the socio-economic status of STMA that influences emission trends. At the national level, 2021 was also the year the Ghana Statistical Service conducted the Population and Housing Census in Ghana.

3.4 Emission Source Sectors

Table 3. 1: STMA GHG emission per source in 2021

Sector	Description
Stationary Energy 	Stationary energy sources are one of the largest contributors to a city's GHG emissions. These emissions come from the combustion of fuel in residential, commercial and institutional buildings and facilities and manufacturing industries and construction, as well as power plants to generate grid-supplied energy. This sector also includes fugitive emissions, which typically occur during extraction, transformation, and transportation of primary fossil fuels.
Transportation 	Transportation covers all journeys by road, rail, water and air, including inter-city and international travels. GHG emissions are produced directly by the combustion of fuel or indirectly by the use of grid-supplied electricity. Collecting accurate data for transportation activities, calculating emissions and allocating these emissions to cities can be a particularly challenging process. To accommodate variations in data availability, existing transportation models, and inventory purposes, the GPC offers additional flexibility in calculating emissions from transportation.
Waste 	Waste disposal and treatment produces GHG emissions through aerobic or anaerobic decomposition, or incineration. GHG emissions from solid waste shall be calculated by disposal route, namely landfill, biological treatment, incineration and open burning. If methane is recovered from solid waste or wastewater treatment facilities as an energy source, it shall be reported under Stationary Energy. Similarly, emissions from incineration with energy recovery are reported under Stationary Energy.

3.4.1 Emissions Sources and Categorisation

Activities taking place within a city can generate GHG emissions that occur inside the city boundary as well as outside the city boundary. Only the activities occurring within the administrative boundary of STMA were

included in the BEI. GHG emissions generated within the STMA from activities outside the BEI inventory boundary were excluded. The emission sources within STMA were grouped into stationary combustion, mobile/transport combustion and waste according to the 2006 IPCC categorisation.

The stationary combustion[ra2] activities are identified as point sources of greenhouse gas emissions within the STMA for 2021. They included four sub-activities such as electricity and heat generation, manufacture of solid fuel (charcoal production), manufacturing industry, and household (lighting and cooking). Mobile combustion involves transportation activities which are the main sources of GHG emissions. They include, passenger cars, light-duty, buses and coaches, heavy duty and 2/3 wheelers. Emissions from waste include both domestic and industrial solid waste and liquid waste. The GHGs from waste are mostly methane.

3.5 Data Collection

Data for STMA's BEI include administrative data that were from several sources within the region and at the national level. The data used in the BEI include the following; Population statistics, electricity production, Non-electrical energy use statistics i.e. households using firewood, charcoal, LPG, kerosene lamps etc, Fuel sales in the transport sector for petrol and diesel -formal and informal trade and Waste data (volume and management methods)

3.6 Calculating GHG Emissions

The GPC recommends using methodologies aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The GHG emissions for STMA were estimated by multiplying activity data by an emission factor associated with the activity being measured. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time (e.g., volume of gas used, kilometers driven, tonnes of waste sent to landfill, etc.).

An emission factor is a measure of the mass of GHG emissions relative to a unit of activity. For example, estimating CO₂ emissions from the use of electricity involves multiplying data on kilowatt-hours (kWh) of electricity used by the emission factor (kgCO₂/kWh) for electricity, which will depend on the technology and type of fuel used to generate the electricity.

GHG emissions data were reported as metric tonnes of each GHG as well as CO₂ equivalents (CO₂e). Data was gathered from a variety of sources, including STMA, government departments such as GSS, Energy Commission, DVLA, NPA, national GHG inventory report, universities and research institutes, scientific and technical articles in journals and reports, and sector experts/stakeholder organisations.

3.7 Adapting data for inventory use (scaling data)

According to the GPC, where the best available activity data do not align with the geographical boundary of the city or the time period of the assessment, the data can be adapted to meet the inventory boundary by adjusting for changes in activity using a scaling factor.

Due to inadequate data at the STMA, national level data were adapted to meet the inventory boundary by adjusting for changes in activity using a scaling factor to achieve the sub-national level or STMA level inventory. The national level data used was as reported in the Ghana's Fifth National Inventory Report (NIR5)

Assumptions

- Assumed 12.6% of total vehicle population in Ghana is in STMA
- Fuel consumption is based on the ratios of proportional consumption as the national level

3.8 Ghana's Fifth National Inventory Report (NIR5)

The NIR5 has been prepared following the UNFCCC Guidelines for the preparation of national communications from non-Annex I Parties (Decision 17/CP.8) and UNFCCC Biennial Update Report Guidelines for Parties not included in Annex I to Convention (Decision 2/CP. 17, paragraph 40 and Annex III of decision 2/CP.17). Ghana mainly used the 2006 IPCC Guidelines for the GHG inventory.

3.9 Greenhouse Gas Inventory Results

In 2019, Ghana's total GHG emissions, including LULUCF, were estimated to be 59.8 million tonnes (Mt) CO₂-equivalent (CO₂e). The 2019 emissions were 16.3% higher than the 2016 levels and 139.2% above 1990 levels. When the net emissions from LULUCF are excluded from the national total, the emission estimates came down to 45.3 MtCO₂e for 2019.

3.10 Gases Covered in the National Emission Inventory Report

The NIR5 covers information on direct GHGs emissions, SLCPs and selected local air pollutants associated with major economic activities in Ghana. Direct GHG includes Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O) and Fluorocarbons (F-gases). Including the SLCPs and selected local air pollutants in the inventory was useful because it quickly assessed their contribution to public health, agricultural productivity, and sustainable development. Consistent with UNFCCC reporting guidelines, the GHG estimates for all the GHG emissions/removals were expressed in mass units. The IPCC Fourth Assessment Report (AR4) 100-year time horizon GWPs was used to report the CO₂ equivalent of the emissions. With respect to the three GHG being considered in this report, the NIR5 reported the following; CO₂= 41.93MtCO₂e, including LULUCF GH4= 8.2 MtCO₂e and N₂O=8.55 MtCO₂e.

3.11 Calculating GHG Emissions

The GPC recommends using methodologies aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The results of the calculations for STMA are presented in table 3.2 below.

Table 3. 2: GHG Emissions in STMA

Stationary fuel combustion	Fuel	Value	Unit	year	EF CO2 [Kg/TJ]	CH4 [Kg/TJ]	N2O [Kg/TJ]	Emissions (Gg)				
								Carbon Dioxide	Methane	Nitrous oxide	CO2e	
Total emission in STMA								203.48	74.80	16.16	298	
Stationary combustion								166.08	0.06	0.00	168.62	
1. Electricity and Heat generation								31.17	0.00	0.00	31.28	
Karpowership	natural gas	425.26	TJ	2021	73,300	3	0.6	33.84	0.0013	0.0003	8	31.2
2. Manufacture of solid fuel								75.20	0.02	0.00	76.50	
Charcoal Production	firewood	671.4	TJ	2021	112000	30	4	75.20	0.0201	0.0027	0	76.5
3. Household								5.64	0.01	0.00	5.82	
Cooking	charcoal	2.56	3	TJ	2021	112000	200	1	3.65	0.0065	0.0000	3.82
Cooking	firewood	05	5.	TJ	2021	112000	30	4	0.57	0.0002	0.0000	0.58
Cooking	LPG	8.09	1	TJ	2021	63100	5	0.1	1.14	0.0001	0.0000	1.14
Diesel Generator	Diesel	79	3.	TJ	2021	74100	3	0.6	0.28	0.0000	0.0000	0.28
4. Industry								51.41	0.03	0.00	52.34	
Food processing	Diesel	26.58	TJ	2021	74100	3	0.6	1.97	0.0001	0.0000	1.98	



Emissions (Gg)
Carbon
Dioxide Methane Nitrous oxide CO2e

Stationary fuel combustion	Fuel	Value	Unit	year	EF CO2 [Kg/TJ]	CH4 [Kg/TJ]	N2O [Kg/TJ]	Carbon Dioxide	Methane	Nitrous oxide	CO2e	
Food processing	RFO	252.83	TJ	2021	77400	3	0.6	19.57	0.0008	0.0002	3	19.6
Food processing	firewood	154.73	TJ	2021	112000	200	1	17.33	0.0309	0.0002	5	18.1
Food processing	charcoal	16.89	TJ	2021	112000	30	4	1.89	0.0005	0.0001		1.92
Food processing	LPG	149.99	TJ	2021	63100	1	0.1	9.46	0.0001	0.0000		9.47
Wood processing	Diesel	15.99	TJ	2021	74100	3	0.6	1.18	0.0000	0.0000		1.19
Mobile combustion								37.06	0.01	0.00		37.92
5 Road transport								37.06	0.01	0.00		37.92
Passenger vehicles	Diesel	62.75	TJ	2021	74100	3.9	3.9	4.65	0.0002	0.0002		4.73
Passenger vehicles	Gasoline	99.35	TJ	2021	69300	33	3.2	6.88	0.0033	0.0003		7.06
Passenger vehicles	LPG	8.25	TJ	2021	63100	62	0.2	0.52	0.0005	0.0000		0.53
Light-duty	Diesel	3.91	2	TJ	2021	74100	3.9	3.9	1.77	0.0001	0.0001	1.80
Light-duty	Gasoline	9.98	2	TJ	2021	69300	33	3.2	2.08	0.0010	0.0001	2.13
Buses and coaches	Diesel	5.13	1	TJ	2021	74100	3.9	3.9	1.12	0.0001	0.0001	1.14
Buses and coaches	Gasoline	0.19	2	TJ	2021	69300	33	3.2	1.40	0.0007	0.0001	1.43
Heavy duty	Diesel	1.12	3	TJ	2021	74100	3.9	3.9	2.31	0.0001	0.0001	2.35
2/3 wheelers	Gasoline	226.79	TJ	2021	69300	33	3.2	15.72	0.0075	0.0007	2	16.1
2/3 wheelers	Diesel	8.25	TJ	2021	74100	3.9	3.9	0.61	0.0000	0.0000		0.62



Stationary fuel combustion	Fuel	Value	Unit	year	EF CO2 [Kg/TJ]	CH4 [Kg/TJ]	N2O [Kg/TJ]	Emissions (Gg)				
								Carbon Dioxide	Methane	Nitrous oxide	CO2e	
Waste management								0.34	74.73	16.15	91.23	
6. Liquid waste								0	36.929	15.644	52.572	
Domestic liquid									19.68	15.64	3	35.3
Industrial liquid									17.24		4	17.2
7. Solid waste								0.34	37.80	0.51	38.65	
Solid waste disposal									34.79		9	34.7
Open burning								0.34	3.01	0.51	3.87	



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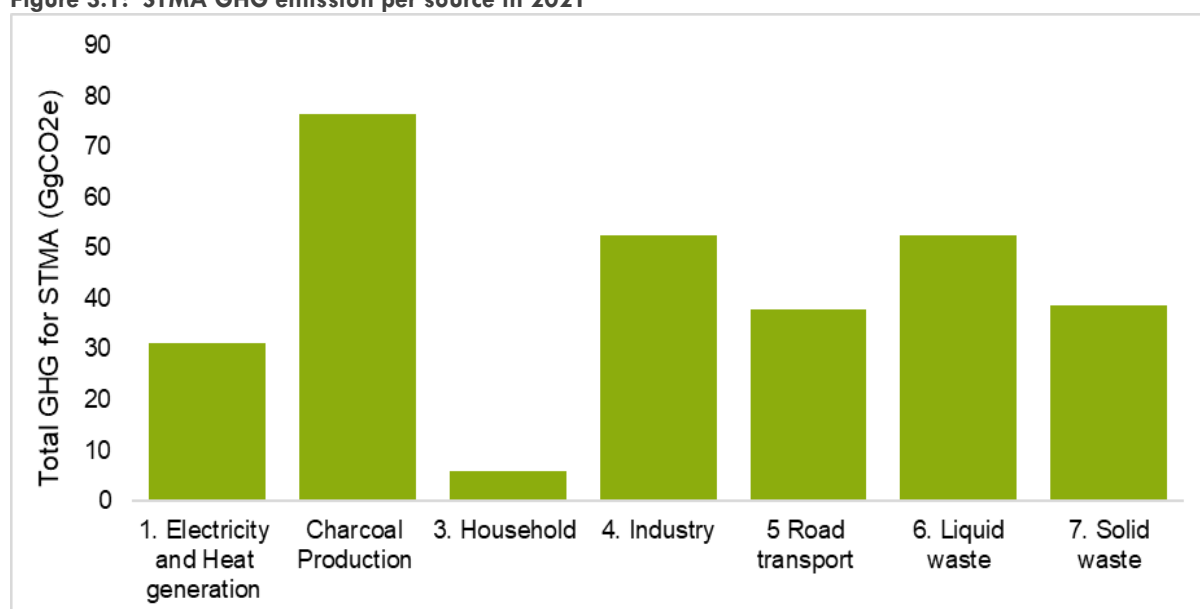


3.12 Greenhouse Gas Emissions in STMA

Based on the scaled data from the national level the total GHG emissions from STMA in 2021 were 298 Gigagrams (Gg) CO₂e (298,000 tCO₂e) The STMA GHG emissions constitute 10% of the total national emissions in 2021.

In all the three sectors, stationary energy combustion had the highest contribution to the total emissions in STMA, followed by waste and transportation with the least contribution. Stationary energy combustion contribution was 168.62 Gg CO₂e, (168,620 tCO₂e) waste had 91.23 Gg CO₂e (91,230tCO₂e) and lastly transport contribution was 37.92 Gg CO₂e (37,920tCO₂e). The emission distribution is represented in figure 3.1 below. When the emissions levels are further broken down, charcoal and liquid waste disposal dominate the emission sources.

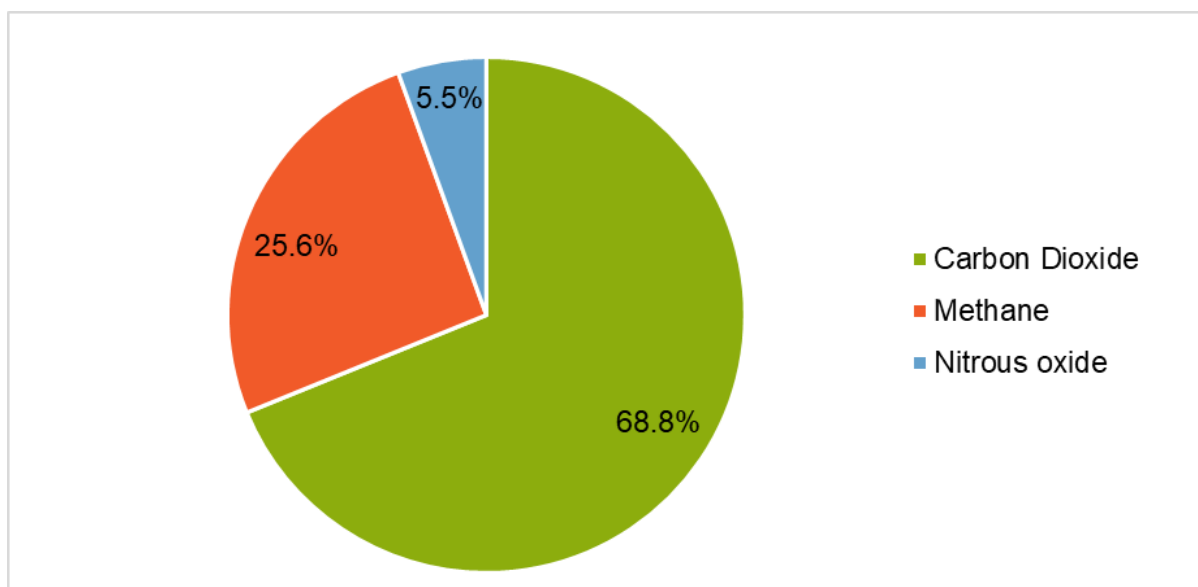
Figure 3.1: STMA GHG emission per source in 2021



3.14 GHG Emissions by Gas

In terms of gases, CO₂ is the largest source of greenhouse in STMA. It accounts for 69% of the total emission in 2021. This is followed by methane (25%) and the remaining being nitrous oxide (6%) (figure 3.2). For CO₂, 81% of the emissions were from stationary fuel combustion sources, particularly, from charcoal production (see table 3.2). When it comes to methane emissions, almost all the emission (approximately 99%) were from the waste sector through solid waste disposal. Similarly, waste management practices in STMA account for more than 98% of the total N₂O emissions in 2021.

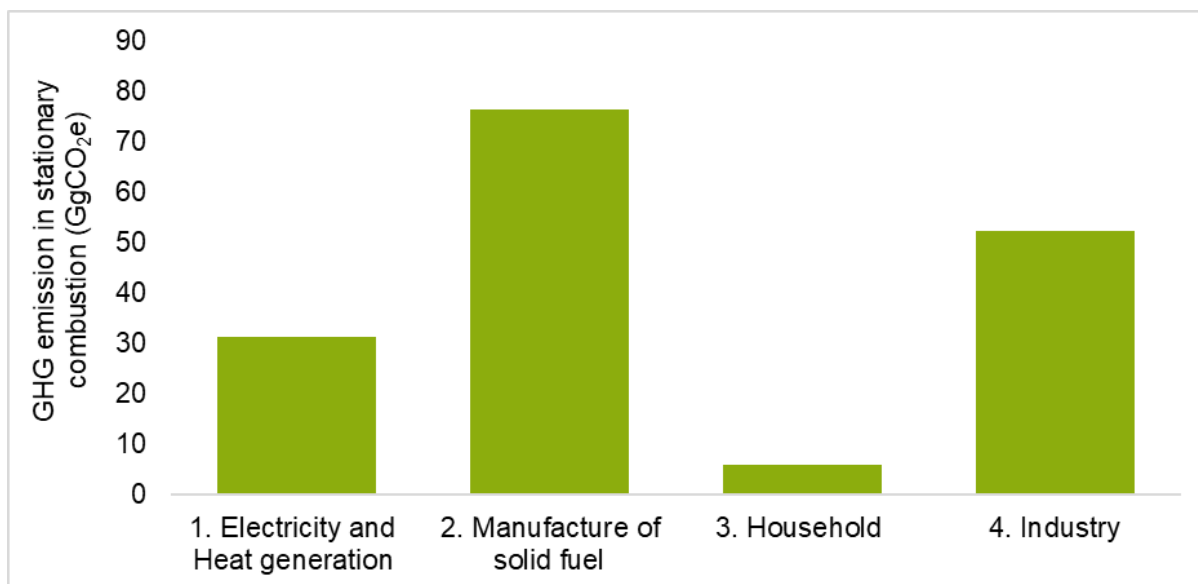
Figure 3. 2: Distribution of STMA emissions according to gases



3.15 Stationary Energy

For stationary energy the following emission sources were considered, electricity generation, charcoal production, residential cooking, residential lighting and industry. In all these sub-sectors/sources, CO₂ contribution was the highest followed by CH₄ and then N₂O, (table 3.2 and figure 3.2)

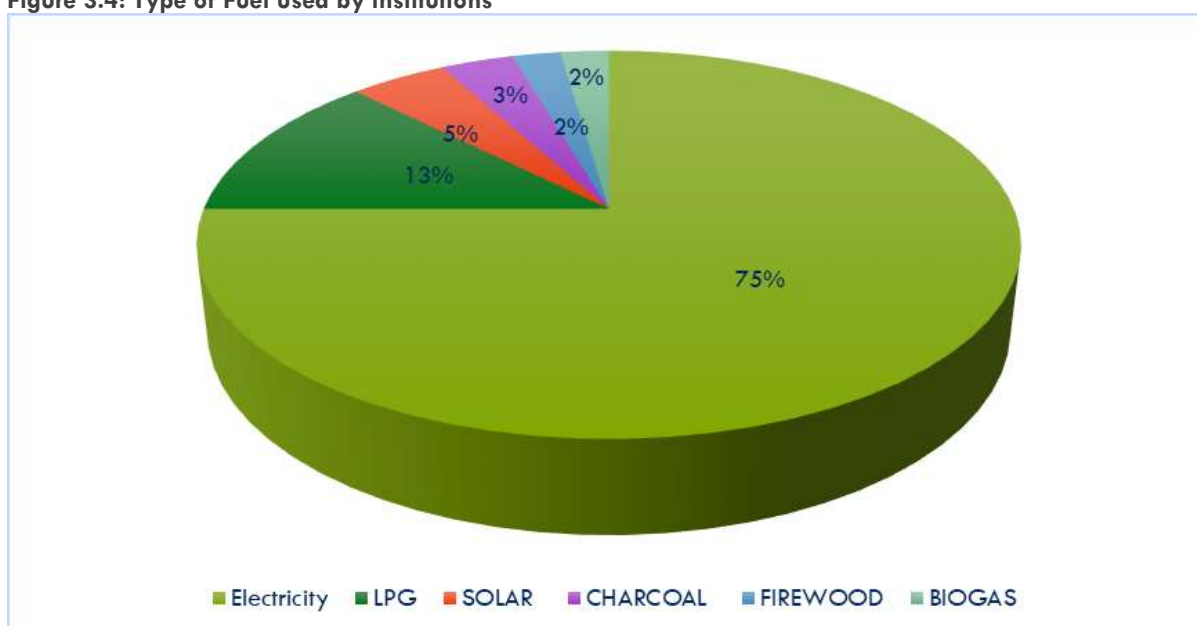
Figure 3. 3: GHG emission in the stationary combustion activities in STMA



3.1.6 Energy Consumption Patterns

Energy patterns have been analysed extensively under the energy pillar in Chapter 5, what this section seeks to do is to summarise the major highlights. The energy consumption patterns in the Sekondi-Takoradi Metropolitan Area reflect a significant reliance on electricity, particularly from the national grid. In the energy mix for institutions (figure 3.4), a substantial 75% of institutions primarily use electricity, with a notable 92% being dependent on the national grid. Sectors such as transport, cocoa processing, and fishing, which do not directly utilize grid-based electricity, highlight areas where alternative energy sources could be impactful. The minor yet important utilization of LPG, solar, firewood, and biogas by these institutions underscores an opportunity for expanding renewable energy use to reduce greenhouse gas emissions and enhance air quality.

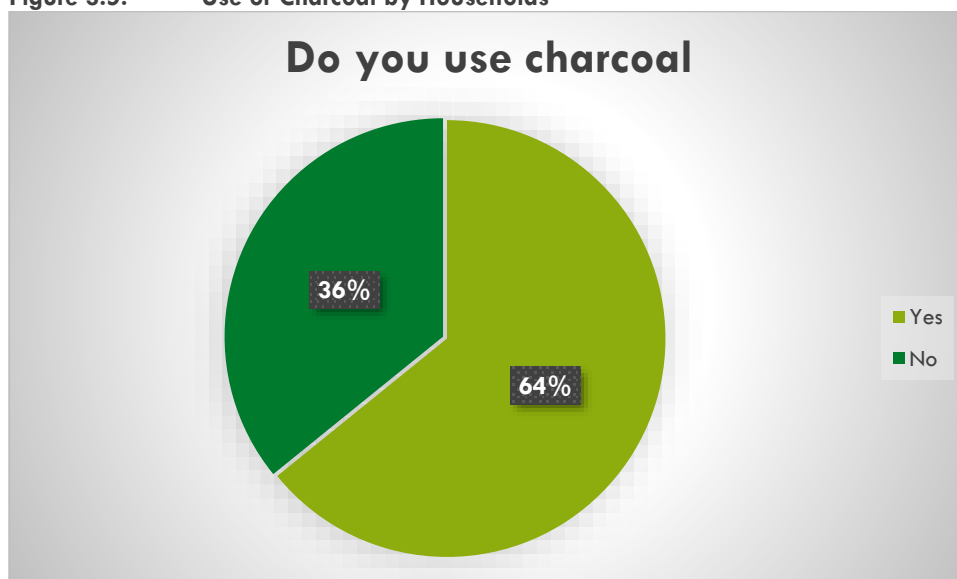
Figure 3.4: Type of Fuel used by institutions



Household energy consumption patterns exhibit a diverse range of fuel types. In the energy mix, electricity is the predominant energy source for 39.9% of households, followed closely by charcoal at 27.4%, and LPG at 23.2%. The heavy reliance on charcoal for cooking poses significant environmental concerns due to the associated deforestation and greenhouse gas emissions. While LPG usage is substantial, its relatively cleaner combustion compared to charcoal and firewood presents a healthier and more environmentally friendly alternative. The adverse implications of the use of charcoal (and the related production) within the region compel a critical and urgent need to promote, plan and implement cleaner cooking technologies and fuels to mitigate environmental and health impacts.

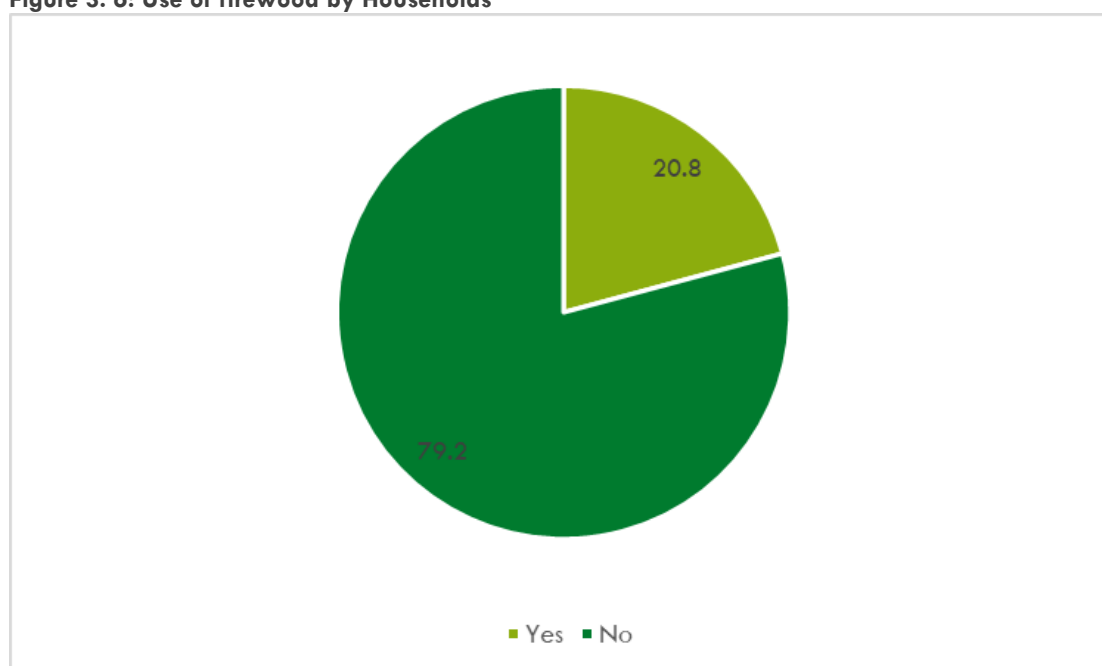
The widespread use of grid electricity, reported by 95.9% of household respondents, highlights the centrality of this energy source in daily life. However, the heavy reliance on grid electricity also underscores vulnerabilities related to energy supply and the potential benefits of diversifying energy sources. Similarly, the use of LPG for cooking by 65% of households reflects a high interest in cleaner energy sources. This disparity suggests an area for policy intervention to encourage greater adoption of LPG and other clean energy sources among institutional users.

Figure 3.5: Use of Charcoal by Households



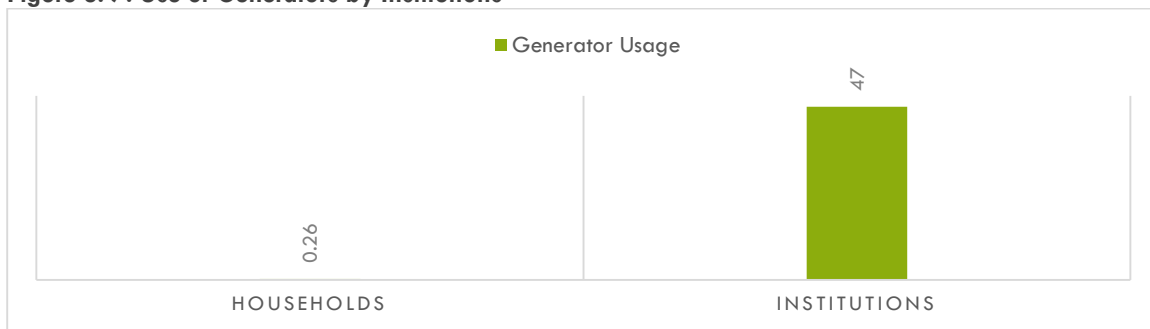
Data analysed from the survey showed that charcoal use alone remains highly prevalent among households, with 64% indicating they use it (figure 3.5). This dependence on charcoal, along with the substantial use of firewood by 20.8% of households (figure 3.6), contributes significantly to greenhouse gas emissions and deforestation. The procurement of firewood, primarily sourced freely from the bush, further exacerbates environmental degradation. Efforts to transition households from these traditional biomass fuels to cleaner alternatives will be crucial for reducing emissions and promoting sustainable energy practices.

Figure 3. 6: Use of firewood by Households



The use of generator sets, although minimal among households (0.26%), is notably higher among institutions, with 47% reporting usage (Figure 3.7). The reliance on diesel and petrol generators by institutions highlights an area where renewable energy solutions, such as solar power, could be effectively implemented to reduce carbon emissions and enhance energy resilience.

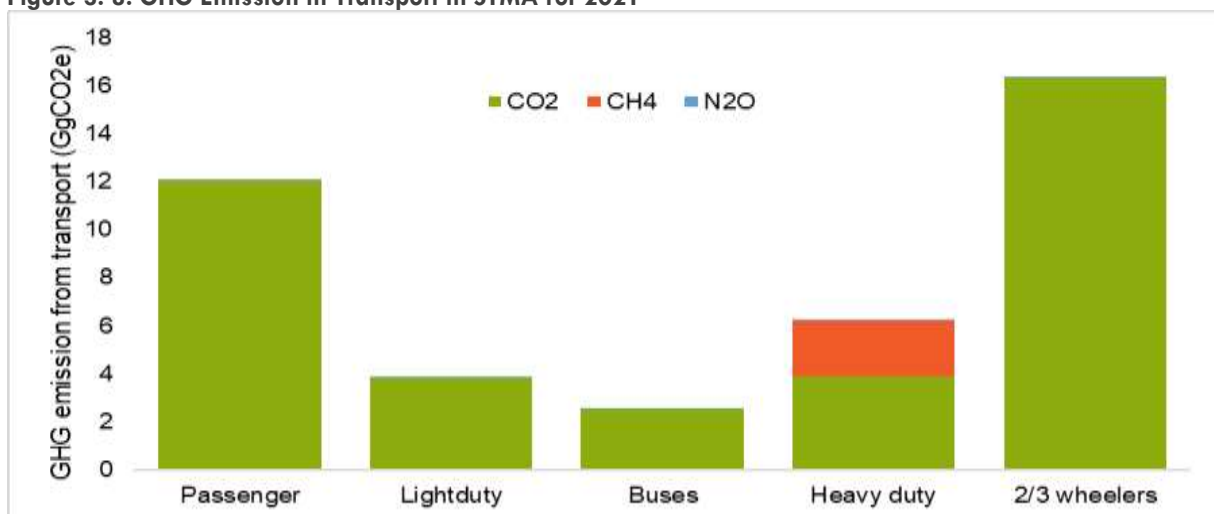
Figure 3. 7: Use of Generators by Institutions



3.17 Transportation

The following sources of emissions were calculated for the transportation sector; passenger cars, light-duty, buses and coaches, heavy duty and 2/3 wheelers. The emissions followed the same trend, CO₂ had the highest contribution followed by CH₄ and N₂O (Figure 3.8). In general, the transport emission in STMA is dominated by passenger cars and 2/3-wheeler motorcycles. This is not surprising especially considering the findings that the majority (72%) depend on vehicles as their mode of transportation. The fact that emissions are dominated by passenger cars and 2/3-wheeler motorcycles, which are commonly used by 72% of the population, highlights the need for targeted interventions in these vehicle categories to reduce emissions. Also, enhancing public transportation options, such as buses and coaches, with cleaner fuel technologies can reduce the number of individual vehicles on the road, thereby decreasing overall emissions. Even though Ghana is now embracing the provisions of the new urban agenda, within the yet-to-be launched National Urban Policy and Action Plan (2024-2035), the need to promote walkability of cities, including non-motorised transport is of essence and structures that support it should be put in place.

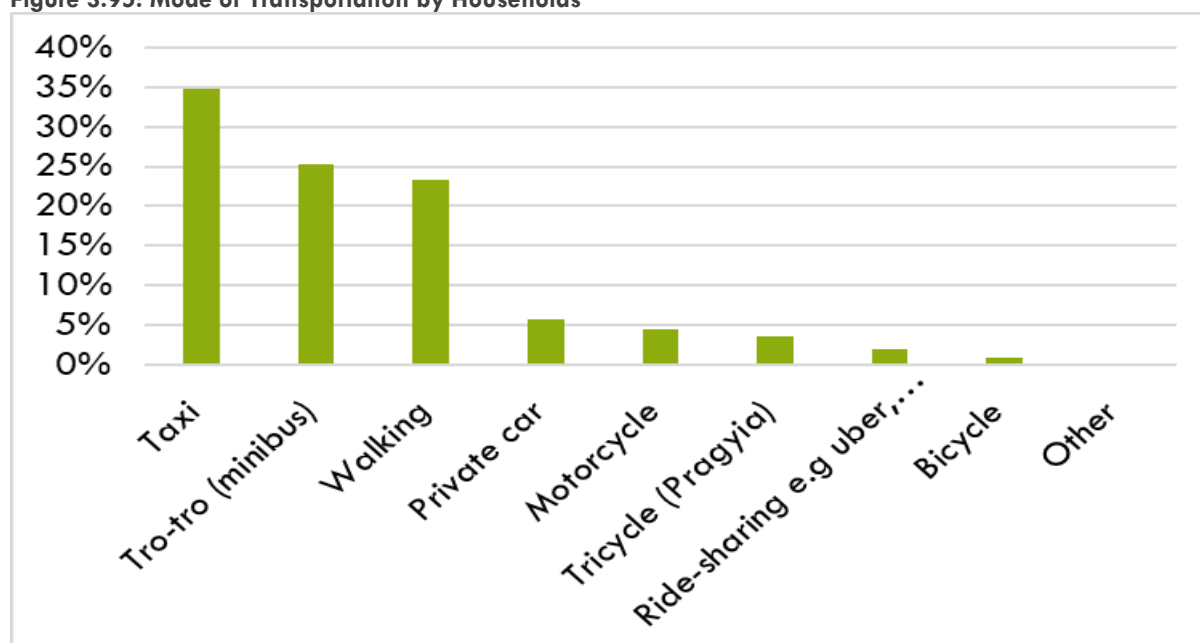
Figure 3. 8: GHG Emission in Transport in STMA for 2021



3.17.1 Mode of Transportation by Households

As seen in Figure 3.9, the primary mode of transportation for households in STMA is taxis (35%), followed by tro-tro (25%), walking (23%), private cars (6%), motorcycles (4%), tricycles (4%), ride-sharing (2%), and bicycles (1%). Apart from Walking and bicycle riding which are the most sustainable modes of transportation, contributing to zero emissions, most of the other modes of transportation use fuel that contributes to GHG emissions in STMA. Encouraging these modes can significantly improve air quality. However, to promote walking and cycling, investment in pedestrian-friendly infrastructure and safe cycling paths is needed. This can make these alternative modes more attractive and accessible to the population.

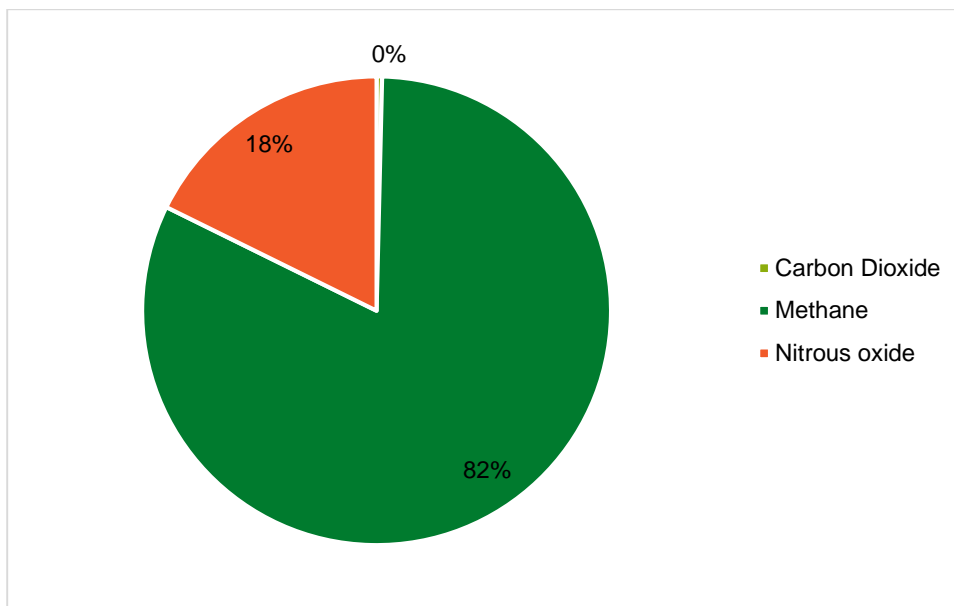
Figure 3.95: Mode of Transportation by Households



3.18 Waste

The waste sector GHG emissions is dominated by methane and nitrous oxide among liquid and solid waste management practices. Methane was mainly recorded from solid waste disposal, liquid waste treatment and discharge practices. Methane from solid waste disposal and liquid waste treatment can be captured and used as a source of renewable energy providing a sustainable energy source and reducing reliance on fossil fuels.

Figure 3.10 GHG Emissions in the Waste Sector



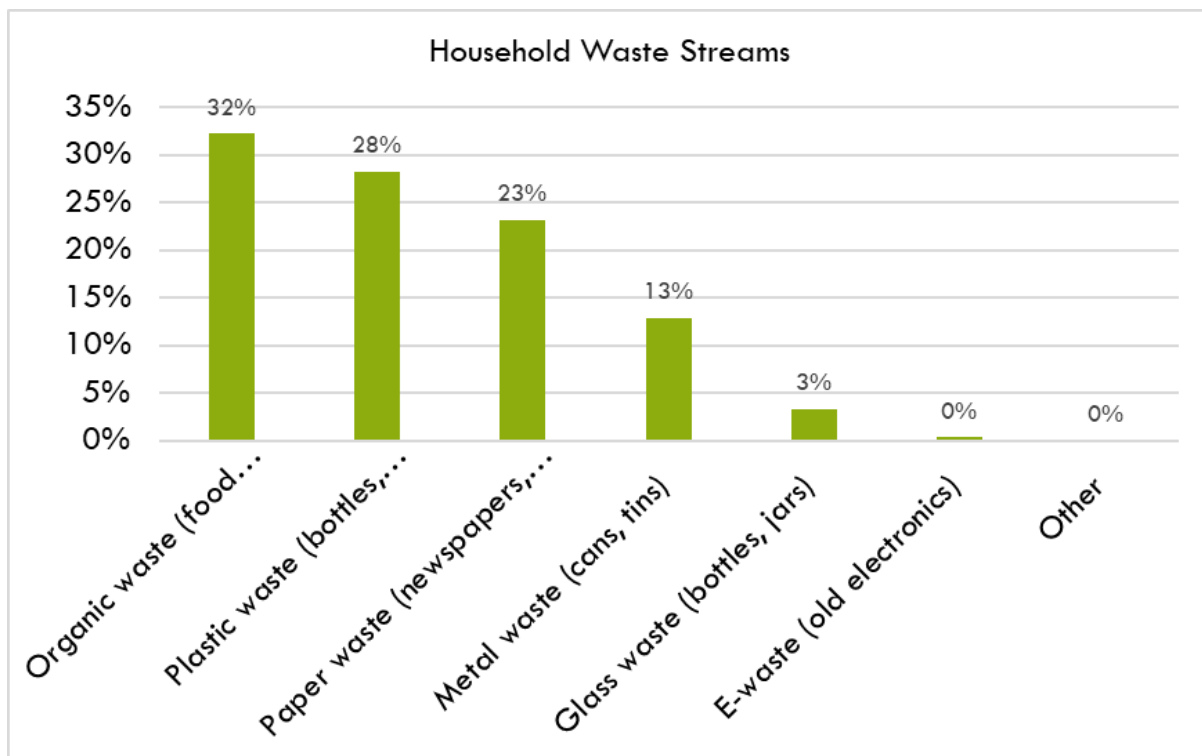
3.18.1 Household Solid Waste

The household waste generation patterns in the Sekondi-Takoradi Metropolitan Assembly (STMA) reveal a varied distribution among residents. A majority, 53%, generate between 1kg to 5kg of waste daily, while 15% produce between 6kg and 10kg. Only 12% of households generate more than 10kg of waste. Notably, 20% of households were unable to estimate their waste output.

The municipality generates a substantial total of 614 tons of waste per day, equating to approximately 224,724 tons annually. However, the waste collection efficiency stands at only 59%, with 360 tons of the 614 tons collected daily. Consequently, 254 tons of waste remain uncollected each day, often ending up in informal disposal sites. This uncollected waste can lead to open burning or decay, releasing methane, carbon dioxide, and other pollutants that contribute significantly to air pollution and greenhouse gas emissions.

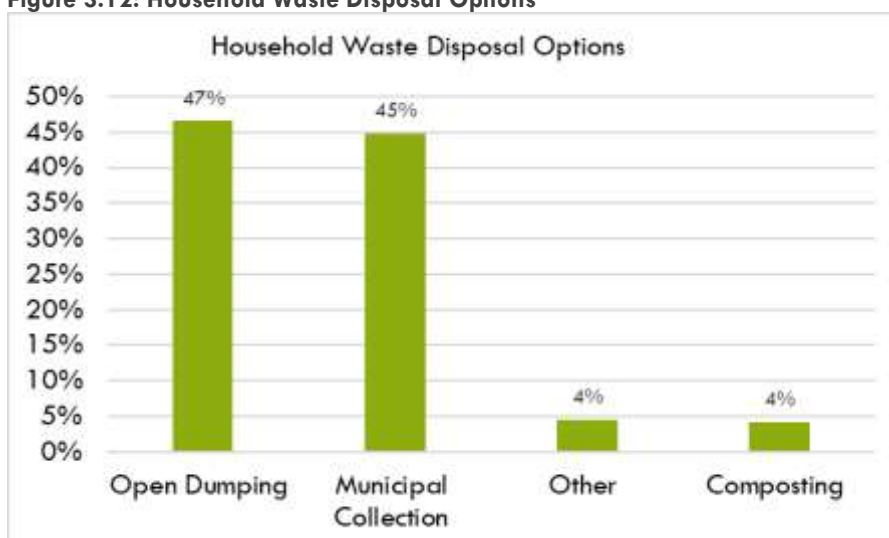
The diverse waste streams in STMA include organic waste, plastics, paper, metals, glass, and e-waste. The management of these waste streams is crucial, as the improper handling and disposal of waste can exacerbate environmental and health issues. The substantial amount of uncollected waste highlights a pressing need for increased funding to improve waste management infrastructure.. Addressing these issues effectively will mitigate the negative environmental impacts associated with waste disposal and improve overall waste management practices in the municipality. The household waste stream is presented in figure 3.11 below;

Figure 3.11: Household Waste Streams



Organic waste which forms about 32% is mainly disposed of through open dumping (47%). About 45% is collected and disposed of by the Municipal Waste Management Department. Only 4% go through composting which means that a large portion of valuable organic material is not being used to its full potential. Composting organic waste can produce nutrient-rich soil amendments, which are beneficial for agriculture and can reduce the need for chemical fertilizers, further promoting environmental sustainability. The remaining 4% is disposed of through other means such as burning, (figure 3.12). Open dumping of organic waste, which accounts for 47% of disposal methods, leads to uncontrolled decomposition and significant methane emissions. Methane is a potent greenhouse gas that contributes to global warming and climate change. Additionally, open dumping can cause odor problems and attract pests, further degrading the quality of life and air in surrounding areas.

Figure 3.12: Household Waste Disposal Options

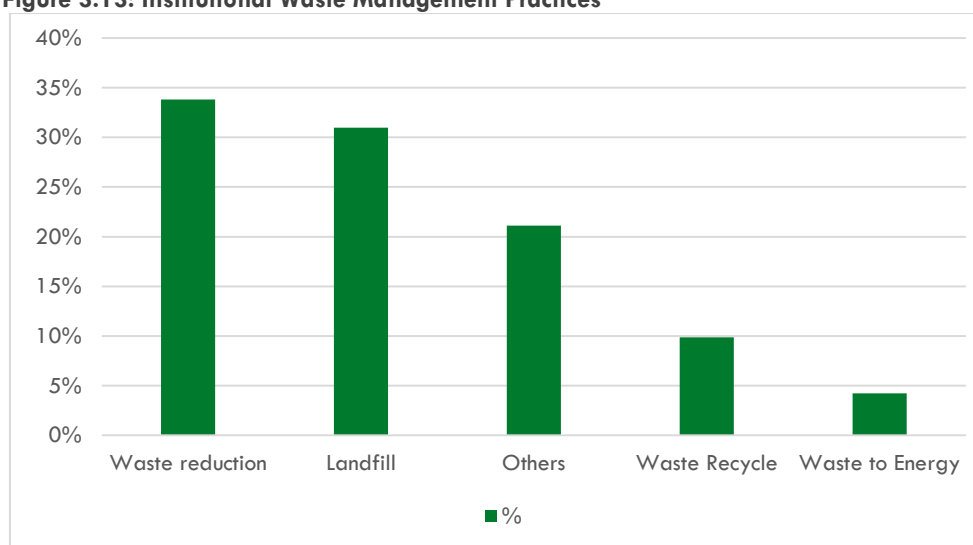


Only 2% of the respondents indicated that their waste is recycled, and currently, there are no plans to undertake waste recycling. This means that a significant amount of potentially reusable materials ends up in landfills or is improperly disposed of. This represents a lost opportunity to recover valuable resources and reduce the demand for raw materials, which often require substantial energy to extract and process.

3.18.2 Institutional Waste Management Practices

At the institutional level, 34% of the institutions practice waste reduction while 31% send their waste to landfill. 10% also practice waste recycling and 4% transform their waste to energy. As seen in Figure 3.13, 15% use other means of managing their solid waste such as open dumping and burning.

Figure 3.13: Institutional Waste Management Practices



Comparing the households and the institutions with regards to waste management practices, while institutions are prioritising waste reduction (34%), households are promoting composting for agricultural purposes.

3.19 Business-As-Usual (BAU) GHG Emissions Projections

The 2021 BEI (Baseline Emission Inventory) results were used as the reference year for projecting the 2050 BAU (Business as Usual) scenarios across all gases and emission/removal categories. The BAU scenario outlines future emission trends for STMA (Sekondi Takoradi Metropolitan Assembly) based on current policies and historical drivers reflected in the 2021 BEI. The projections are informed by key growth assumptions, including population growth, GDP, fuel prices, and taxes. The projections were developed using the Greenhouse Gas Abatement Cost Model (GACMO), version of 1 January 2022.

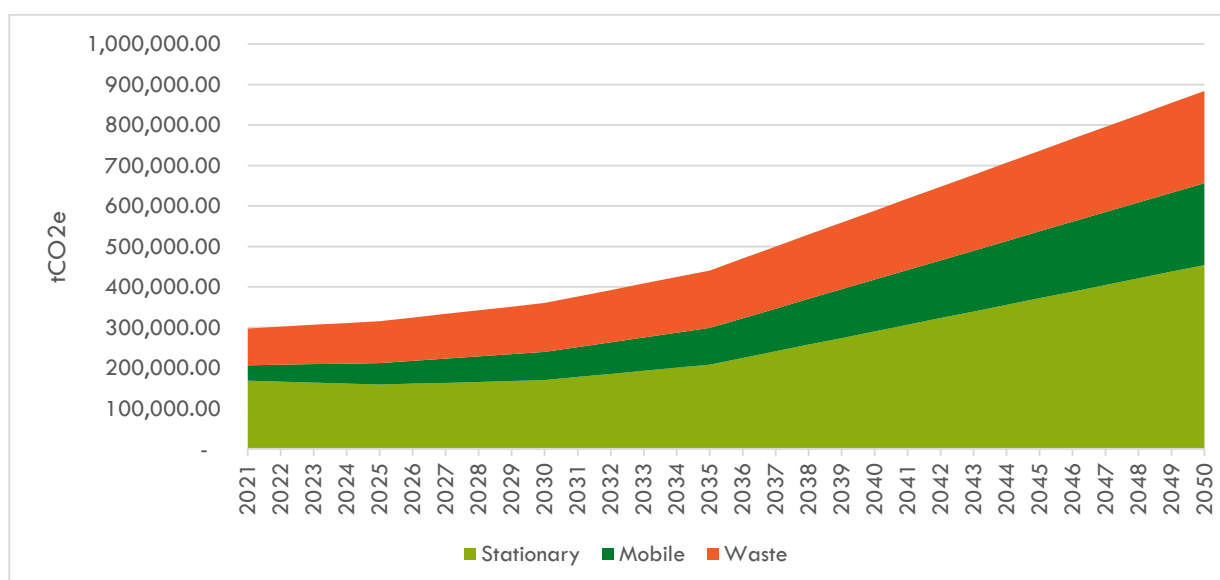
Table 3.3 and Figure 3.18 show a significant projected increase in greenhouse gas emissions (tCO₂e) in the Sekondi-Takoradi Metropolitan Area (STMA) from 2021 to 2050. Total emissions are expected to rise from 297,767.30 tCO₂e to 884,138.11 tCO₂e, representing a substantial increase of 196.8%. This growth is driven by increases in all three major sectors: stationary emissions (169.5%), mobile emissions (430.9%), and waste emissions (149.4%). These projections highlight the urgent need to implement comprehensive measures to mitigate climate change impacts. To achieve this, a focus on energy efficiency, renewable energy adoption, sustainable transport, and improved waste management practices is required. Additionally, developing and implementing effective policies and regulations will be crucial in guiding STMA towards a more sustainable and resilient future.

Table 3.3 BAU GHG Emissions for 2021 to 2050

tCO ₂ e/year	2021	2025	2030	2035	2050
Total	297,767.30	315,641.29	360,568.55	440,887.19	884,138.11
Stationary	168,621.81	159,088.93	170,073.59	208,437.87	454,314.56
Mobile	37,919.44	53,076.83	69,369.30	90,662.90	202,402.79
Waste	91,226.05	103,475.53	121,125.66	141,786.42	227,420.76

These BAU emissions were used to set targets and develop actions/interventions for the reduction of GHG emissions for the target years.

Figure 3.21 BAU Emission Projections for STMA (2021-2050)



Risk and Vulnerability Analysis

4.1 Introduction

The STMA, which is located along the western coast of Ghana, is highly vulnerable to the impacts of sea-level rise and coastal flooding. Sekondi-Takoradi is ranked number **122** (out of 216 districts) in terms of climate change vulnerability in Ghana. Its rank does not necessarily reflect the expected impacts and risks associated with sea level rise due to climate change. There is an increased risk of coastal erosion, flooding, and the loss of valuable land and infrastructure in the Metropolis.

Adapting to climate change is crucial for protecting Sekondi-Takoradi from current and future risks and would ensure the city's future prosperity, sustainability, and well-being in a changing climate. Through proactive adaptation strategies, STMA can build resilience, safeguard its residents, and continue to thrive in the face of climate challenges.

4.1.1 Objectives

This section of this report presents the Risk and Vulnerability Assessment (RVA) within the Sekondi-Takoradi Metropolitan Assembly (STMA). As a critical component of STMA's Sustainable Energy Access and Climate Action Plan (SEACAP), it aims to identify and analyse the key baseline vulnerabilities and risks posed by climate change, and provides essential insights and data to inform and guide the development and implementation of effective adaptation strategies, ensuring that STMA can enhance its resilience and sustainability in the face of climate challenges.

The RVA process involved defining clear objectives and scope, such as identifying climate-related risks, evaluating the vulnerability of assets, and developing adaptation strategies while determining the geographical area, sectors, and systems to be assessed (Palermo et al., 2018). It also includes identifying current and future climate hazards, vulnerable sectors, and population groups, and assessing adaptive capacity. Figure 4. 1 illustrates a summary of the phases for developing an Adaptation plan.

Figure 4. 1: Approach to Adaptation Planning

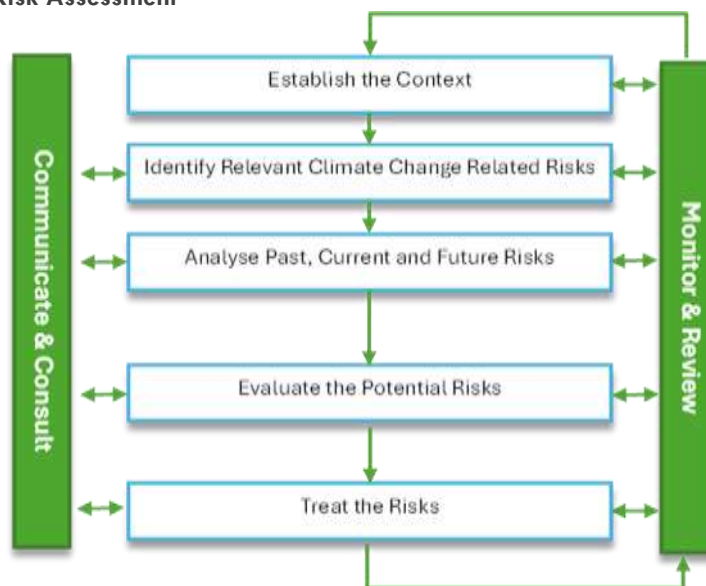


4.2 Methodology

A Risk and Vulnerability Assessment (RVA) evaluates the nature and extent of risks by analysing potential hazards and assessing vulnerabilities that may threaten people, property, livelihoods, and the environment (IPCC, 2014; Sharma & Ravindranath, 2019). This can be a comprehensive assessment or sector-specific evaluations. The RVA helps local authorities identify their exposure to current and future climate hazards, understand vulnerabilities, and recognize city-specific factors that worsen climate impacts. It establishes the basis for prioritizing adaptation actions, investments, and monitoring the effectiveness of measures (Flax et al., 2002). RVAs are essential tools for identifying, quantifying, and prioritizing climate change risks, but addressing all identified issues can be challenging due to budget constraints. Therefore, a cost-benefit analysis is necessary to balance the costs of resilience investments against the benefits of reduced losses and damages. Numerous tools and methods are available for vulnerability and adaptation assessments, with the choice depending on the assessment's purpose, spatial scale, and available resources. Common methodologies include indicator-based, model and GIS-based, and participatory approaches, each varying in resource and skill requirements (EU, 2019).

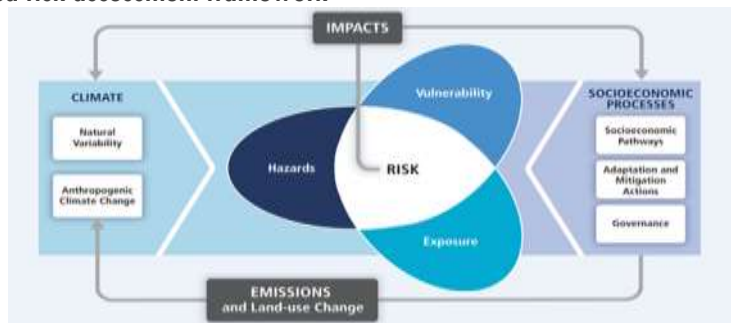
This assessment utilized an indicator-based approach, incorporating desktop research, surveys, and a participatory process. Figure 4. 2, adapted from Norman et al. (2014), illustrates the methodology used for the Climate Risk Assessment (CRA).

Figure 4. 2: General Risk Assessment



The IPCC's Fifth Assessment Report (AR5), also provides an integrated framework (see figure 4. 3 below), focusing on exposure, sensitivity, and adaptive capacity. Which incorporates both quantitative and qualitative data and ensure stakeholder engagement through participatory approaches to conduct multi-scale assessments to capture diverse climate risks and identify areas of higher vulnerabilities to inform adaptation strategies, prioritizing actions based on the severity of impacts and adaptive capacity.

Figure 4. 3: Integrated risk assessment framework



Source: IPCC's Fifth Assessment Report (WGII AR5), (IPCC, 2015)

4.2.1 Desktop Literature/Policy Review

In the initial phase of conducting a comprehensive Climate Risk and Vulnerability Assessment (CRVA), it is essential to undertake an exhaustive desk review encompassing a broad range of existing literature and policy documents. For the STMA CRVA, this review includes national-level documents such as the National Climate Change Policy (2013), the National Climate Change Adaptation Strategy (2012), and the Nationally Determined Contributions (2015). These documents collectively establish fundamental frameworks and priorities for climate change mitigation and adaptation strategies at the national level (Owusu Essegbey, 2016). Additionally, insights from the National Adaptation Plan (NAP) Framework (2018) and the National Climate Change Master Plan Action Programmes for Implementation (2015–2020) are crucial for understanding the strategic implementation of adaptation measures nationwide. At the local level, specific documents such as the Sekondi-Takoradi Metropolitan Assembly (STMA) Drainage Master Plan and the recent 2023 STMA Climate Change Risk Assessment (CCRA) provide localized data and tailored strategies to address vulnerabilities and enhance resilience within the STMA area. These documents provided a foundational step in synthesizing critical information, offering essential insights into policy frameworks, adaptation strategies, and local climate resilience initiatives that inform subsequent phases of the CRVA process. Due to the comprehensive and current nature of the CCRA document, it was then adopted, reviewed, and validated through a local-level validation process and a survey to augment the assessment process with primary observatory evidence.

4.2.1.1 Climate Change Risk Assessment for Sekondi-Takoradi Metropolitan Assembly (STMA)

The Sekondi-Takoradi Metropolitan Assembly Climate Risk Assessment (STMA CCRA) forms an integral component of Ghana's Adaptation Planning Process, facilitated by funding secured from the Green Climate Fund (GCF) in 2020. Managed by the Environmental Protection Agency (EPA) under the Ministry of Environment, Science, Technology, and Innovation (MESTI), this three-year initiative "Enhancing multi-sector planning and capacity for effective adaptation in Ghana," aimed to bolster capacity for the National Adaptation Plan (NAP) in Ghana, with oversight from the United Nations Environment Programme (UNEP) as the Delivery Partner. "

4.2.2 Adoption and Validation of the STMA-CCRA

The initial STMA-CCRA was incorporated into the Climate Risk and Vulnerability Assessment (CRVA) of the SEACAP due to its compliance with established standards and operational guidelines. After its formal adoption, a comprehensive validation workshop was convened in June 2024 in STMA to verify the accuracy

and reliability of the information contained within the document. This workshop engaged local stakeholders to ensure the data's credibility and relevance. Additionally, primary data collection was conducted among 776 households in 50 communities and 68 public and private sector institutions within the STMA jurisdiction to supplement the validation process. This approach was designed to capture a broad spectrum of perspectives, thereby enhancing the document's inclusivity and ensuring that it accurately reflects the diverse views and experiences of the community. Such measures are integral to fostering a robust and participatory assessment process (Least Developed Country (LDC) Expert Group, 2012) which is critical for effective climate adaptation planning.

The validation workshop was conducted on 19th and 20th June 2024 with officials from the STMA, sector representatives, selected civil society organisations (CSOs), and other vulnerable groups such as transport owners, farmers, and fishermen. Participants were organised into four groups based on their sector expertise, backgrounds, and operational sectors. These sectors included:

1. Water Resources
2. Agriculture, Forestry, Coastal Ecosystems, and the Fishing Industry
3. Health and Health Systems
4. Infrastructure

The results from these group activities were consolidated, analysed, and compared with the initial STMA-CCRA conducted under the National Adaptation Plan (NAP) project. This data was further validated with survey results collected from households and institutions within the STMA jurisdiction in addition to the feedback from the validation workshop. This comprehensive approach ensured that the findings and recommendations were robust, inclusive, and reflective of the diverse perspectives and experiences within the community, thereby enhancing the effectiveness and relevance of the CRVA.

4.2.2.1 Identification and classification of climate hazards

The identification and classification of climate hazards is a crucial step in the CRVA process. This stage is designed to systematically recognise potential climate-related threats, evaluate their occurrence frequency, and assign values to their impacts. This process ensures a comprehensive understanding of climate hazards, enabling the development of effective adaptation strategies.

Each sector group engaged in a structured activity to collaboratively identify and evaluate climate hazards pertinent to their sector by listing all potential climate hazards relevant to their sector. This included both historical hazards and those projected to increase in frequency or intensity due to climate change. Each hazard was classified based on specific criteria such as intensity, duration or frequency of occurrence, duration, and potential impact. This classification helps in prioritizing hazards that pose the greatest threat to the sectors involved. This can be done through analysing historical data, climate models, and expert knowledge. This analysis is crucial for understanding the cumulative impact of multiple hazards and for identifying the most vulnerable sectors and communities.

The identification and classification of climate hazards, along with the determination of their frequency and the assignment of impact values, provided a solid foundation for the SEACAP CRVA and synchronises with the extant literature (Gallina et al., 2016). This rigorous process ensured that the assessment was based on comprehensive, sector-specific insights, enabling the formulation of targeted and effective adaptation strategies. The validated findings from this SEACAP CRVA exercise were integrated with survey data and historical records, ensuring robustness and accuracy in the final assessment as described by the Inter-American Development Bank (2019) in Figure 4. 4. Table 4. 1 shows a consolidated summary of the findings.

Figure 4. 4: Disaster and Climate Change risk assessment methodology



Source: Inter-American Development Bank (2019)

Table 4. 1: Summary of Identified Hazards, Occurrence Levels, and Impact/Vulnerability Areas

Hazard	Average level of occurrence	Reason	Systems and Assets affected	Vulnerable group affected
River flood	Moderate	<ul style="list-style-type: none"> It occurs when rain intensity is high, and when there is siltation of river bodies. Human activities along the riverbanks exacerbate the flooding incidence. 	<ul style="list-style-type: none"> Farmlands Infrastructure 	<ul style="list-style-type: none"> Homeless people Elderly people People with disabilities Low income people
Urban flood	Very High	<ul style="list-style-type: none"> The topography Development of land causes high run-off water which leads to flooding (e.g. pavement of the entire compound) Building in waterways Smaller and silted drains Construction activities 	<ul style="list-style-type: none"> High number of communities Infrastructure 	<ul style="list-style-type: none"> People with substance use Indigenous people Marginalised people
Coastal flood	High	<ul style="list-style-type: none"> Increased sea volume. Impart high especially Heavy with High Tide Expansion works Sand winning activities along the beach and Loss of natural barriers including lagoons, mangroves and Ramsar sites. 	<ul style="list-style-type: none"> Reduces the number of fish Coastal communities Beach sand erosion Protective vegetation 	
Earthquake	Very low	Occurred once in 1909		
Landslide	Moderate	Excavating of hills for construction	Urban roads	
Tsunami	Very low	Never Occurred		
Volcano				
Cyclones				

Water Scarcity	Moderate ¹	<ul style="list-style-type: none"> • Illegal mining • Siltation 	<ul style="list-style-type: none"> • Reduce the quantity of water available for Human consumption, industrial uses, and agriculture. • Affects the health of rivers and wetlands and alters support of communities who rely on the 	<ul style="list-style-type: none"> • Homeless people • Elderly people • People with disabilities • Women and children • Children and youth • Low income people • People with Chronic disease • Low-income households • Indigenous people • Marginalised groups/people
Extreme Heat	Moderate ²	<ul style="list-style-type: none"> • Deforestation • Method and design of building infrastructure • Land degradation 	Death to humans, livestock and ecosystems and their related services	<ul style="list-style-type: none"> • Low income persons and communities • Elderly people • People with Chronic Disease • Homeless people
Wildfire	Low	Rarely occurs		

Comparing the findings to the initial CCRA reveals a high degree of similarity, except for three indicators: river flooding, urban flooding, coastal flooding, and wildfire, which exhibited some discrepancies. These discrepancies can be attributed to the tools and data compared to the expert observation approach by participants. Additionally, the variation in the wildfire indicator is partly due to differences in the definition of wildfire versus human-induced fires. Table 4. 2 below presents the levels of occurrence as identified by the ‘Thinkhazard!’ tool used in the initial CCRA. Regarding vulnerabilities, the STMA-CCRA did not extensively address which vulnerable groups are most affected by various hazards. This contrasts with the findings from the SEACAP validation exercise, which provided a more detailed analysis of how different hazards impact specific vulnerable populations. As indicated in Table 4.2, the validation exercise highlighted the varying degrees of vulnerability among different groups, offering insights into the specific impacts on these populations. This comprehensive assessment highlights the importance of understanding and addressing the unique needs and challenges faced by vulnerable groups in the context of climate hazards. Detailed information from the validation exercise is crucial for developing targeted adaptation strategies that effectively mitigate the risks and enhance the resilience of these groups.

Table 4. 2: Summary of critical climate-related hazards for STMA from ThinkHazard! Tool

Hazard	Level of occurrence
<i>River flooding</i>	Low
<i>Urban flooding</i>	Low
<i>Coastal flooding</i>	Medium
<i>Earthquake</i>	Very low
<i>Landslide</i>	Very low

¹ This measure has a high tendency to change to high in the near future not necessarily due to climate change but rather through pollution from ongoing illegal mining activities afflicting all water bodies which then could be compounded by climate change induced poor precipitation in the catchment.

² This measure has a high tendency to change to high in view of ongoing urbanization and deforestation activities in STMA and boundary jurisdictions

<i>Tsunami</i>	Low
<i>Volcano</i>	N/A
<i>Cyclones</i>	N/A
<i>Water Scarcity</i>	Medium
<i>Extreme Heat</i>	Medium
<i>Wildfire</i>	Medium

Source: ThinkHazard! (Global Facility for Disaster Reduction and Recovery (GFDRR), 2022)

4.2.2.2 Assessing the impacts of identified Climatic Hazards

The table 1 provides a detailed overview of the significant impacts that various climate hazards have on different systems and assets within the Sekondi-Takoradi Metropolitan Assembly (STMA) area. These impacts were grouped into the major economic sectors in STMA as follows:

1. The Fishing industry

The Fishing industries face substantial challenges due to coastal flooding, storms, and changes in precipitation. Coastal flooding damages landing beaches and distorts fish habitats, while storms disrupt fishing activities, cause breakdowns of canoes, and jeopardise the safety of fishermen. Changes in precipitation patterns can further disrupt offshore activities, affecting the industry's productivity and safety.

2. Water Resources

Water supply systems are highly vulnerable to climate hazards, including water scarcity, river flooding, and urban flooding. Water scarcity can lead to poor hygiene, increased costs of water, and negatively impact economic activities. River flooding can cause pollution and increase the costs of water production, while urban flooding can submerge alternative water sources, exacerbating the challenges in maintaining a reliable water supply.

3. Infrastructure

Critical infrastructure such as roads, power lines, and drainage systems are at risk from flooding and mudslides. Flooding renders vehicles immobile, destroys power infrastructure, collapses drain, and leads to back surges due to high water levels. This results in reduced transportation services and increased infrastructure repair costs. Mudslides and landslides can damage buildings, roads, and drains, causing further delays in transportation, particularly affecting the transport of petroleum products.

4. Agricultural Activities

Agriculture is severely impacted by flooding and water scarcity. Flooding destroys farmlands, leading to significant losses in livelihoods for farmers and fishermen. Water scarcity affects irrigation processes, thereby reducing the production of food crops and exacerbating food insecurity in the region.

5. The Health Sector

Health and health systems are particularly vulnerable to both flooding and extreme heat. Flooding can damage health infrastructure, reduce the potency of drugs, delay the provision of essential services, and limit access to health facilities. It can also create poor hygienic environments and lead to outbreaks of waterborne diseases and water pollution. Extreme heat exacerbates health risks by increasing the incidence of skin and

respiratory diseases, causing dehydration and heatstroke, and displacing marine life, which can affect local food sources and biodiversity.

6. Ecosystem

Coastal ecosystems face significant threats from coastal flooding, erosion, and extreme heat. Coastal flooding and erosion can displace coastal habitats, lead to the loss of mangroves, and destroy coastal settlements. These changes can contaminate water bodies, affecting marine health and bringing sediments into ecosystems that degrade water quality. Extreme heat can cause plant diseases and hinder both afforestation and reforestation efforts, further weakening the resilience of these ecosystems.

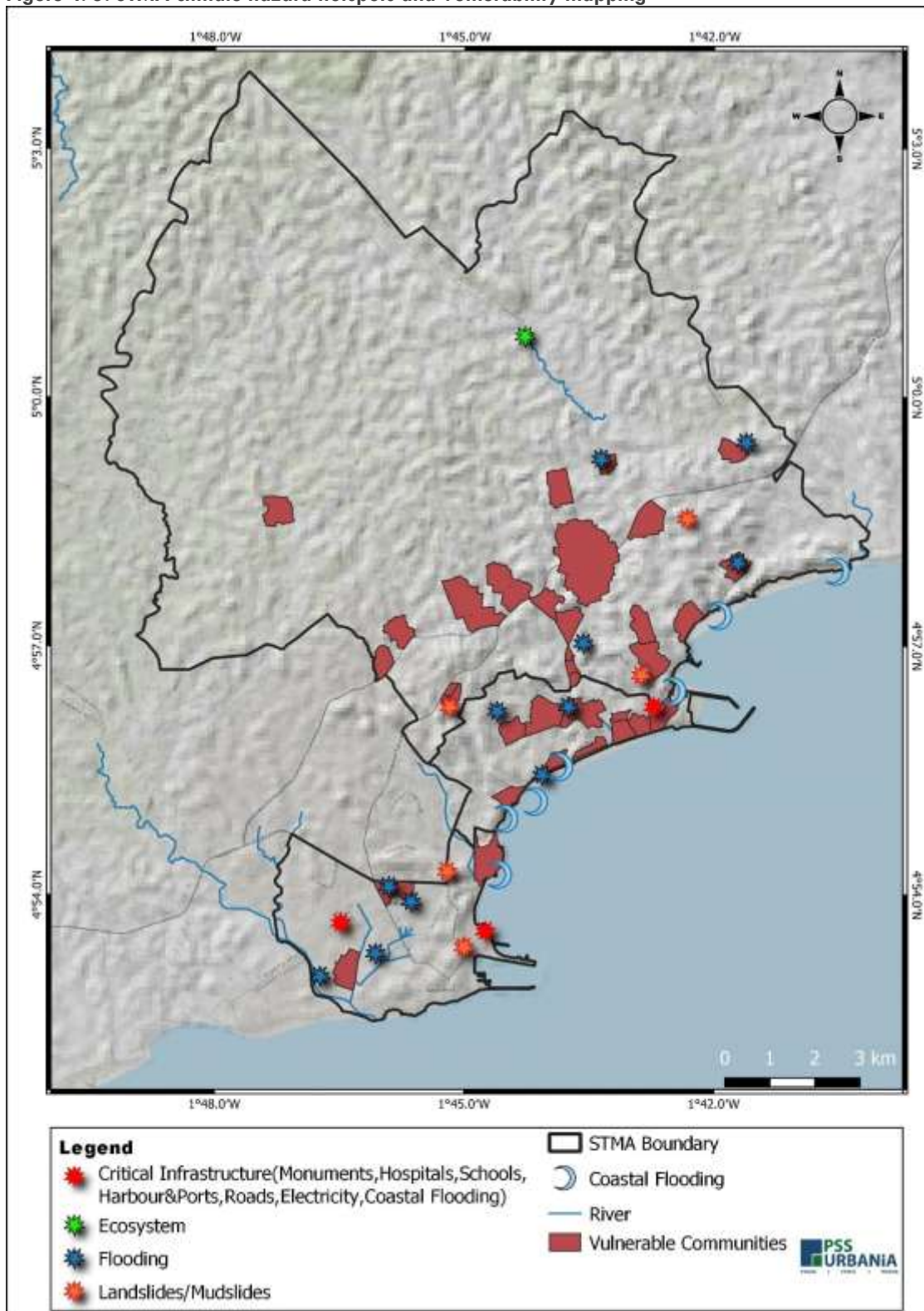
Table 4. 3: illustrates the broad and interconnected impacts of climate hazards on the STMA's fishing industries, water supply, critical infrastructure, agriculture, health systems, and coastal ecosystems. Each of these sectors faces unique challenges that require targeted adaptation and mitigation strategies to enhance resilience and reduce vulnerability to climate change. The areas that are vulnerable to these hazards are depicted in Figure 4. 5.

Table 4. 3: Summary impacts of identified Climatic Hazards on Socio-economic factors of STMA

Systems and Assets Exposed to Hazard	Climate Hazard	Climate risk and potential impacts
<i>Fishing Industries</i>	Coastal Flooding	Landing beach affected Fish habitat distorted
	Storm	Fishing Activities (Breakdown of Canoes etc.) Safety of fishermen
	Precipitation	Disruption of offshore activities
<i>Water Supply</i>	Increase in Water Temperature	Impact fish habitats, health, and populations Leads to economic losses
	Water Scarcity	Poor Hygiene Increased cost of water Economic activities impacted negatively
	River Flood	Pollution High cost of water production Disease Outbreak
	Urban Flood	Submerge alternative sources of water
<i>Critical infrastructure</i>	Flooding	Immobility of vehicles destruction of power(electricity) infrastructure Destruction of roads Collapsed drains Back surge due to high water levels Low patronage of transportation services
	Mudslide/landslide	Damage to buildings, roads and drains Delay in the transportation of petroleum products
<i>Agriculture</i>	Flooding	Destruction of farmlands, loss of livelihoods

	Reduction of livelihood of fisherman/ fish managers	
<i>Health and Health systems</i>	Water scarcity	Affects irrigation processes that involve the production of food crops
	Flooding	Damage to health infrastructure (buildings and equipment, reduction of drug potency) Delay in provision of essential services, including health care Limited access to health facility Poor hygienic environments Outbreak of Water borne diseases Water Pollution
	Extreme Heat	Increase skin diseases. Respiratory diseases. Dehydration/ Heatstroke Displaces Marine life.
<i>Coastal Ecosystems</i>	Coastal Flooding /erosion	Displaces coastal habitat, loss of mangroves, affects the growth of mangroves. Destruction of coastal settlement. (Contamination of water bodies affecting Marine health. Brings sediments to the ecosystem, affects water quality
	Extreme heat	Causes plant diseases, retard afforestation and re-afforestation

Figure 4. 5: STMA climate hazard hotspots and vulnerability mapping



4.2.2.3 Assessing Observed and Current Climate Risks

The IPCC defines risk as the potential adverse consequences for human and ecological systems, taking into account their diverse values and objectives (Sharma & Ravindranath, 2019). These risks arise from both the direct impacts of climate change and human responses to it. Potential adverse effects include harm to lives, livelihoods, health, well-being, economic, social, and cultural assets, infrastructure, services (including ecosystem services), ecosystems, and species. The risks associated with climate change impacts are driven by the interactions between climate-related hazards and the exposure and vulnerability of affected systems, with uncertainties in hazard magnitude, exposure, and vulnerability influenced by socioeconomic changes and human decisions.

Additionally, risks from climate change responses emerge from the potential failure to achieve intended goals or from negative trade-offs with other societal objectives, such as the Sustainable Development Goals. These risks are influenced by uncertainties in the implementation, effectiveness, and outcomes of climate policies, investments, technology development, and system transitions.

Climate Change Risk Assessments (CCRAs) typically adopt either an "impacts-driven" or "vulnerability-driven"

approach (Burton, 2002). When assessing the priority risk domains for specified ecosystem types, it is essential to understand both the potential impacts and the overall vulnerability of the region. This understanding is crucial to informing a comprehensive and detailed risk assessment process.

The methodology used in the STMA-CCRA involved a high-level, qualitative risk assessment approach, guided by the conceptual framework of risk outlined in the IPCC's Fifth Assessment Report (AR5) from 2014. According to this framework, risk encompasses vulnerability as a fundamental component. A crucial aspect of this approach is to identify the entities and assets exposed to climate hazards, thereby potentially facing adverse impacts or harm.

This will help to effectively prioritize risk domains and understand pertinent climate hazards. The component of climate vulnerability and climate risk, adapted from IPCC AR5 is a function of exposure (E), hazard (H) and vulnerability (V) as illustrated below:



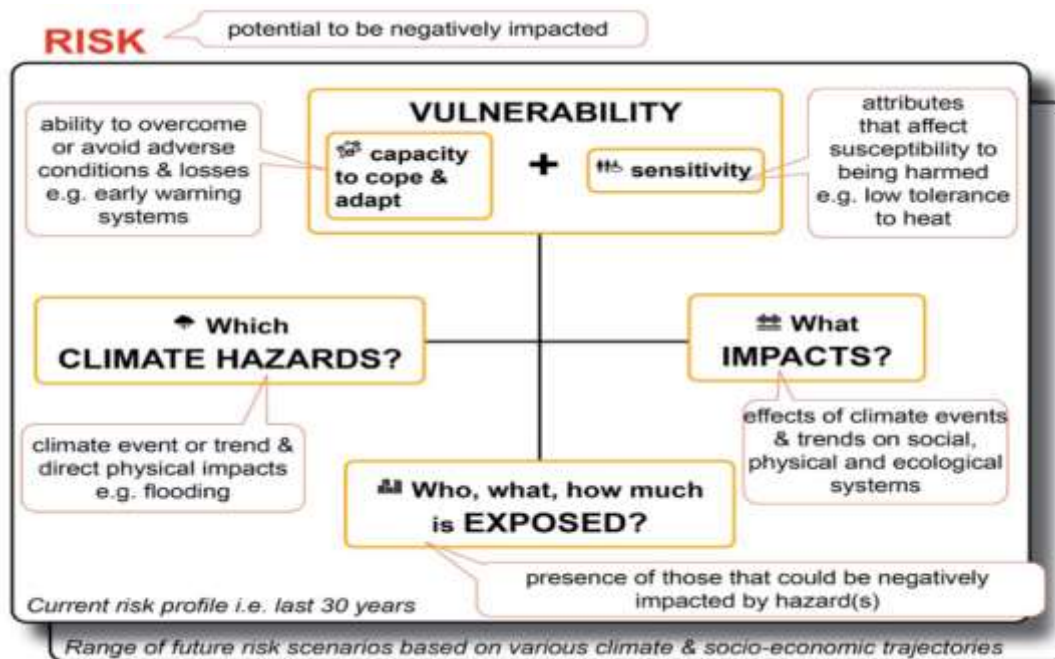
Conducting risk assessments at the local level presents significant challenges, primarily due to the paucity of detailed data, including high-resolution climate data and granular socioeconomic data. Additionally, the complex and dynamic interactions between community capacities and the multifaceted challenges they face, both persistent and acute, further complicate the process. The uneven distribution of community capacities, influenced by power dynamics, exacerbates the difficulty of uniformly addressing vulnerabilities. To effectively inform risk management, it is imperative that risk assessments be locally based, thereby fostering increased awareness and a sense of ownership among community members regarding the process and potential solutions for mitigating identified risks.

Furthermore, vulnerability assessment of natural ecosystems or socioeconomic systems considered their sensitivity to hazards and their adaptive capacity to mitigate these sensitivities (Szlafsztein & Sterr, 2007). High vulnerability indicates high sensitivity to climate risks coupled with low adaptive capacity. This is illustrated mathematically as:



In all, a provisional list of first and second order risk domains were presented to the key stakeholders to determine the relative importance to STMA with accompanying justifications. After all, it noted interconnectivity between the first and second-order risk domains that require refinement of the final priority risk domains. This aligns with the validation exercise which analyzed risk levels based on the function of exposure (E), hazard (H) and vulnerability (V). Table 4.4 provides a summary of the various feedback in analyzing risk by the participants

Figure 4. 6: The component of climate vulnerability and climate risk, adapted from IPCC AR5



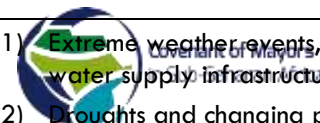
Source: National Climate Risk and Vulnerability (CRV) Assessment Framework summary document, 2020

Table 4. 4: Consolidated assessment of Climate Change Risk from SEACAP Validation exercise



Asset / System	Hazard Description	H	E	HxE	AC	S	V	CCR	Impacts
Fishing Industries	The observed changes in temperature, sea-level rise, extreme weather events, such as heatwaves, drought and storms have led to the loss of coastal habitats such as wetlands and estuaries, reduced fish populations, and impacts to the economic viability of fishing industries.	3	4	12	2	3	1	12	<ol style="list-style-type: none"> 1. Extreme weather events such as flooding and heat waves damages fishing infrastructure, affect coastal communities (safety) and disrupt fishing activities for extended periods. 2. Fishing patterns have changed, for instance, the Shama fishing industry has collapsed. Fishers used to fish in wetlands or other areas, which are now dry. 3. This has impacted which areas the fishers go to fish. 4. The changes in temperature and PH level of the sea cause significant changes in the composition of fish populations, affecting the livelihoods of communities and the availability of seafood. 5. The sea-level rise leads to the loss of coastal habitats such as wetlands and estuaries, the reduction in fish populations, and impacts the economic viability of fishing industries. 6. The wetlands and estuaries can be inundated, losing essential spawning and nursery areas for fish and other marine species.
Water Supply /Systems	Extreme weather events, such as storms, floods, droughts and changing precipitation patterns, are affecting the availability and the quality of the water for communities and businesses.	4	3	12	2	4	2	24	<ol style="list-style-type: none"> 1. The sea-level rise leads to coastal habitat losses such as wetlands and estuaries, the reduction in fish populations, and impacts the economic viability of fishing industries. The wetlands and estuaries can be inundated, losing essential spawning and nursery areas for fish and other marine species. 2. Droughts and changing precipitation patterns affect the availability and the quality of the water for communities and businesses using both local sources and regional water sources. 3. Prolonged dry periods contributes to lower river and stream flows. 4. Flooding causes erosion and increased sediment loads in rivers, leading to the reduced flow of water and and reduced quality of water resources.

<p>Infrastructure</p>	<p>The observed sea-level rise is causing coastal flooding, storm surges, high tides and coastal erosion. All of these hazards damage infrastructure and disrupt operations and business activities. The extreme weather events such as erratic rainfall and flooding, are now becoming common. Communities reported that some roads that used to only occasionally (seasonally) be flooded, are now flooded often at high tide or during heavy bouts of precipitation.</p>	4	5	20	2	5	3	60	<p>1) Extreme weather events, such as storms and floods causes damage to water supply infrastructure and disrupt operations.</p> <p>2) Droughts and changing precipitation patterns affect the availability and the quality of the water for communities and businesses using both local sources and regional water sources.</p> <p>3) Sea-level rise will cause coastal flooding, storm surges, high tides and coastal erosion and all of these hazards damage infrastructure and disrupt operations and business activities. The Ghana gas pipeline is exposed in some areas due to coastal erosion.</p> <p>4) Many reports of beaches, houses and communities that have been washed away over the years, due to sea-level rise.</p> <p>5) The increased sea-level heights impede drainage systems as there is more backwash.</p> <p>6) Increased coastal flooding damages critical infrastructure such as roads, bridges, gas pipelines and buildings, disrupting transportation and business activities.</p> <p>7) Floods also cause inundation of beach areas and ecosystems, landslides, and erosion, rendering roads impassable and difficult to access.</p> <p>8) Storm surges damage or destroy roads, bridges and other infrastructure along the coast, causing disruptions to business activities, transportation and access to essential services.</p> <p>9) High temperatures cause roads to expand and contract, leading to cracking, potholes and other types of damage.</p> <p>10) In some cases, people are forced to leave their homes due to flash floods, leading to homelessness and other social disruptions.</p>
<p>Agriculture</p>	<p>Rising temperatures, extreme weather events, changing precipitation patterns, waterlogging, drought, extreme heat, and storms are adversely affecting agriculture production</p>	4	4	16	2	4	2	32	<p>1) Rising temperatures, more extreme weather events, and changing precipitation patterns all have adverse effects on crop yields and livestock health.</p> <p>2) Crops fail due to floods, water logging, drought, extreme heat and storms.</p> <p>3) Potential change in crop suitability.</p>



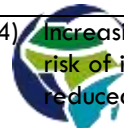
	and increase the risk of infestation of pests and diseases leading to crop failure and reduced livestock production.								 <p>4) Increasing temperatures and precipitation are likely to increase the risk of infestation of pests and diseases leading to crop failure and reduced livestock production.</p>
Human Health and Health systems	Floods, stagnant water, increased temperatures and other extreme climate events negatively affect human health and health systems.	5	5	25	2	5	3	75	<p>1) Extreme weather events, such as storms and floods cause damage to water supply infrastructure and disrupt operations.</p> <p>2) Droughts and changing precipitation patterns affect the availability and the quality of the water for communities and businesses using both local sources and regional water sources.</p> <p>3) The increased sea-level heights impede drainage systems as there is more backwash.</p> <p>4) Increased coastal flooding damages critical infrastructure such as roads, bridges, gas pipelines and buildings, disrupting transportation and business activities.</p> <p>5) More cases of Malaria are being reported during the rainy season.</p>
Coastal Ecosystems	The observed changes in temperature, sea-level rise, extreme weather events such as hurricanes, typhoons, and storms, have led to the loss of coastal habitats such as wetlands and estuaries, reduced fish populations, and impacted the coastal ecosystems,	4	5	20	3	5	3	60	<p>1) The changes in temperature and PH level of the sea causes significant changes in the composition of fish populations, affecting the livelihoods of communities and the availability of seafood.</p> <p>2) The sea-level rise affects the loss of coastal habitats such as wetlands and estuaries, the reduction in fish populations, and impact the economic viability of fishing industries. The wetlands and estuaries can be inundated, losing essential spawning and nursery areas for fish and other marine species.</p> <p>3) Fishing patterns have changed - for instance, the Shama fishing industry has collapsed. Fishers used to fish in wetlands or other areas, which are now dry.</p> <p>4) Impacts of climate change in coastal ecosystems include losses of species habitat and diversity, and degradation of ecosystem functions. During the stakeholder consultation, fishers attested to the increased runoff from rivers into the ocean.</p> <p>5) Loss of endangered animal species</p>

Table 4. 5: Initial STMA-CCRA Assessment of current climate change risks

Asset / System	Hazard Description	H	E	HxE	AC	S	V	Comment: Impacts	CCR
Fishing Industries	The observed changes in temperature, sea-level rise, extreme weather events, such as hurricanes, typhoons and storms have led to the loss of coastal habitats such as wetlands and estuaries, reduced fish populations, and impacts to the economic viability of fishing industries.	High	High	High	Moderate	High	High	<p>1) The changes in temperature and PH level of the sea causes significant changes in the composition of fish populations, affecting the livelihoods of communities and the availability of seafood.</p> <p>2) The sea-level rise may lead to the loss of coastal habitats such as wetlands and estuaries, the reduction in fish populations, and impact the economic viability of fishing industries. The wetlands and estuaries can be inundated, losing essential spawning and nursery areas for fish and other marine species.</p> <p>3) Extreme weather events, such as hurricanes, typhoons and storms, can damage fishing infrastructure, affect coastal communities (safety) and disrupt fishing activities for extended periods.</p> <p>4) Fishing patterns have changed - for instance, the Shama fishing industry has collapsed. Fishers used to fish in wetlands or other areas, which are now dry.</p>	High
Water Supply Systems and Infrastructure	Extreme weather events, such as storms, floods, droughts and changing precipitation patterns, are affecting the availability and the quality of the water for communities and businesses.	High	High	High	Low	High	High	<p>1) Extreme weather events, such as storms and floods can cause damage to water supply infrastructure and disrupt operations.</p> <p>2) Droughts and changing precipitation patterns can affect the availability and the quality of the water for communities and businesses using both local sources and regional water sources.</p> <p>3) Prolonged dry periods can lead to lower river and stream flows.</p> <p>4) Flooding causes erosion and increased sediment loads in rivers, leading to the reduced flow of water and reduced quality of water resources.</p>	High

Asset / System	Hazard Description	H	E	HxE	AC	S	V	Comment: Impacts	CCR
Critical infrastructure	The observed sea-level rise is causing coastal flooding, storm surges, high tides and coastal erosion. All of these hazards damage infrastructure and disrupt operations and business activities. The extreme weather events such as erratic rainfall and flooding, are now becoming common. Communities reported that some roads that used to only occasionally (seasonally) be flooded, are now flooded often at high tide or during heavy bouts of precipitation.	High	High	High	Moderate	High	High	<p>1) Sea-level rise will cause coastal flooding, storm surges, high tides and coastal erosion and all of these hazards damage infrastructure and disrupt operations and business activities. The Ghana gas pipeline is exposed in some areas due to coastal erosion.</p> <p>2) Many reports of beaches, houses and communities that have been washed away over the years, due to sea-level rise.</p> <p>3) The increased sea-level heights impede drainage systems as there is more backwash.</p> <p>4) Increased coastal flooding damages critical infrastructure such as roads, bridges, gas pipelines and buildings, disrupting transportation and business activities.</p> <p>5) Floods can also cause inundation of beach areas and ecosystems, landslides, and erosion, rendering roads impassable and difficult to access.</p> <p>6) Storm surges can damage or destroy roads, bridges and other infrastructure along the coast, causing disruptions to business activities, transportation and access to essential services.</p> <p>7) High temperatures can cause roads to expand and contract, leading to cracking, potholes and other types of damage.</p> <p>8) In some cases, people were forced to leave their homes due to flash floods, leading to homelessness and other social disruptions.</p>	High
Agriculture	Rising temperatures, extreme weather events, changing precipitation patterns, waterlogging, drought, extreme heat, and storms are adversely affecting agriculture production	High	High	High	Moderate	High	High	<p>1) Rising temperatures, more extreme weather events, and changing precipitation patterns all have adverse effects on crop yields and livestock health. Crops fail due to floods, water logging, drought, extreme heat and storms. Potential change in crop suitability.</p>	High

Asset / System	Hazard Description	H	E	HxE	AC	S	V	Comment: Impacts	CCR
	and increase the risk of infestation of pests and diseases leading to crop failure and reduced livestock production.							2) Increasing temperatures and precipitation are likely to increase the risk of infestation of pests and diseases leading to crop failure and reduced livestock production.	
Health systems	Floods, stagnant water, increased temperatures and other extreme climate events negatively affect human health and health systems.	High	High	High	Moderate	High	High	More cases of Malaria are being reported during the rainy season.	High
Coastal Ecosystems	The observed changes in temperature, sea-level rise, extreme weather events such as hurricanes, typhoons, and storms, have led to the loss of coastal habitats such as wetlands and estuaries, reduced fish populations, and impacted the coastal ecosystems,	High	High	High	Low	High	High	Impacts of climate change in coastal ecosystems include losses of species habitat and diversity, and degradation of ecosystem functions. During the stakeholder consultation, fishers attested to the increased runoff from rivers into the ocean. The inlets affect the ocean current and release a lot more sediment into the ocean. This has impacted which areas the fishers go to fish.	High

a. Fishing Industries

The fishing industry in STMA is significantly affected by increased temperatures, sea-level rise, and extreme weather events. These factors lead to habitat loss, reduced fish populations, and economic impacts (Tanner et al., 2014; MoFAD, 2015). The risk scores for this sector is a moderate Hazard (3) occurrence and high Exposure (4), it also indicates a low level of Adaptive Capacity (2) and a moderate Sensitivity (3), computationally indicating that the fishing industry has a very high level of Vulnerability (V) to Climate risk. However, there is a very low level of CCR (12). Extreme weather damages fishing infrastructure, alters fishing patterns, impacts fish composition, and causes the loss of coastal habitats essential for fish spawning and nurseries. This is compared to STMA-CCRA, which categorizes hazard, exposure, sensitivity, and vulnerability as high, with moderate adaptive capacity, leading to an overall high CCR. It notes similar impacts but highlights a more severe risk level.

b. Water Supply/Systems

Water supply/systems face threats from extreme weather events such as storms, floods, droughts, and changing precipitation patterns. These events affect water availability and quality (Ray & Brown, 2015). The risk scores a high level of exposure to climate hazards and a moderate occurrence, and a low level of adaptive capacity with high sensitivity levels. Sea-level rise and droughts lead to habitat loss and reduced water quality, while flooding increases sediment loads in rivers, lowering water availability and quality. However, it still shows a lower CCR. The STMA-CCRA presented a more severe assessment of climate risks as a result of high rating for hazard, exposure, sensitivity, and vulnerability, with low adaptive capacity.

c. Infrastructure

Most critical infrastructure in STMA is at risk due to sea-level rise, causing coastal flooding, storm surges, high tides, and erosion. These hazards damage infrastructure and disrupt operations. The risk high levels of Climate Hazard occurrences and a very high exposure and sensitivity with low adaptive capacity, giving a moderate level of CCR. Extreme weather events damage water supply infrastructure, impede drainage systems, and affect roads, bridges, and pipelines. Coastal flooding and erosion disrupt transportation and business activities. Juxtaposing that to the STMA-CCRA, both assessments highlight significant risks to critical infrastructure from climate change, particularly due to sea-level rise, extreme weather events, and coastal erosion. While the initial assessment categorizes the CCR as medium, the STMA-CCRA assessment considers it high, reflecting the severity and frequency of impacts observed in the region. Adaptive capacity is noted as moderate in the STMA-CCRA, suggesting some existing measures to mitigate risks, though both assessments highlight the need for enhanced resilience and adaptation strategies to address these challenges effectively.

d. Agriculture

Agriculture is adversely affected by rising temperatures, extreme weather, changing precipitation patterns, waterlogging, drought, and storms. These factors lead to reduced agricultural production. The risks assessment scores High for Hazard, Exposure and sensitivity and low for adaptive capacity with low vulnerability and risk. However, it indicates that crop yields and livestock health suffer from extreme weather and temperature changes. Increased pest and disease risks lead to crop failure and reduced livestock production. Comparatively, the STMA-CCRA and the validation exercise identify high levels of hazard, exposure, and sensitivity to climate change impacts on agriculture. This includes risks from rising temperatures, extreme weather events, and changing precipitation patterns affecting crop yields and livestock health. On Adaptive Capacity and Vulnerability, the STMA-CCRA assessment rates adaptive capacity as moderate, indicating some existing measures to cope with climate risks, albeit insufficient to fully mitigate impacts. In contrast, the validation exercise describes low adaptive capacity and vulnerability, suggesting a less resilient agricultural sector with a higher susceptibility to climate hazards. In all, the STMA-CCRA assigns a high CCR due to the cumulative impact of high hazard, exposure, and sensitivity scores. This reflects the severe and increasing risks faced by the agriculture sector in the region. The validation exercise underscores the risk of reduced

agricultural production, aligning with the STMA-CCRA findings but focusing more on the immediate impacts rather than long-term resilience.

e. Human Health and Health Systems

Health systems are vulnerable to floods, stagnant water, increased temperatures, and extreme climate events. These factors negatively impact human health and health infrastructure. The risk assessment scores high exposure, sensitivity, and Hazard with low adaptive capacity indicating moderate vulnerability and CCR. Extreme weather events damage health infrastructure, disrupt operations, and increase sea-level heights impede drainage systems, leading to more cases of malaria, cholera, and typhoid fever among others during the rainy season while dehydration, heat exhaustion, and heatstroke as well as respiratory problems in dry seasons. With a close comparison to the STMA-CCRA, both assessments highlight the high vulnerability of health systems to climate change impacts, particularly floods, stagnant water, increased temperatures, and extreme weather events. They both rate the hazard and exposure as high, indicating significant risks to health infrastructure and human health. While the STMA-CCRA notes moderate adaptive capacity, suggesting some readiness to cope with these challenges, the validation exercise emphasizes low adaptive capacity, suggesting inadequate preparedness. Sensitivity is rated high in both assessments, underscoring the susceptibility of health systems to climate-related disruptions. They indicate that climate change risk is high for the health sector in STMA, (WHO., 2015), necessitating urgent measures to enhance resilience and mitigate the impacts on health systems, including infrastructure improvements and adaptive strategies.

f. Coastal Ecosystems

Coastal ecosystems are affected by changes in temperature, sea-level rise, and extreme weather events. These changes lead to habitat loss, reduced fish populations, and impacts on coastal ecosystems. The validation exercise rated very high levels for exposure and sensitivity, high levels for hazards and moderate levels for adaptive capacity, vulnerabilities and CCR. Habitat loss and changes in fish populations affect livelihoods and seafood availability. Coastal flooding and erosion degrade ecosystem functions and lead to species loss. The assessments from STMA-CCRA and the SEACAP validation exercise converge on the profound vulnerability of coastal ecosystems to climate change impacts. Both highlight high exposure to hazards such as temperature changes, sea-level rise, and extreme weather events, which have led to significant habitat loss, reduced fish populations, and ecosystem degradation. While the STMA-CCRA identifies low adaptive capacity, indicating limited ability to cope with these impacts, the validation exercise suggests a moderate capacity, implying some existing resilience measures. Common concerns include the degradation of ecosystem functions and the socioeconomic ramifications of declining fish stocks, emphasizing the urgent need for adaptive strategies to bolster resilience and mitigate these multifaceted climate impacts on coastal communities and ecosystems. (Ghana Forestry Commission, 2021)

4.2.2.4 Assessing Climate Risk Functions through Field Surveys: An Analytical Approach

The next approach towards the CRVA apart from the desktop review exercise and the validation of the STMA-CCRA, was a household and institutional survey conducted to gather primary data to confirm information from the review and the validation activity (Zennaro, 2021). The data gathered from the survey was analysed in two forms. Aside from the initial generic analysis of the survey (annex 1), the data was again assessed based on the functions of computing CRVA (Exposure, sensitivity, hazard, vulnerability and adaptive capacity). The assessment based on the climate risk functions provides a detailed understanding of how climate change impacts various aspects of life and infrastructure in the region.

a) Exposure

The STMA faces multiple climate hazards, including coastal erosion, water scarcity, flooding, and rising temperatures. These hazards are exacerbated by its coastal location, making it particularly vulnerable to sea-level rise and extreme weather events. Coastal erosion threatens critical infrastructure such as roads,

bridges, and buildings, while flooding disrupts transportation networks, access to essential services like water and electricity, and poses risks to livelihoods and public health.

b) Sensitivity

The population's sensitivity to these hazards is high, affecting a wide range of demographic groups. Vulnerable populations such as children, elderly individuals, and those with disabilities are disproportionately impacted due to their limited ability to cope with and recover from climate-related disruptions. The reliance on sectors like agriculture, fishing, and tourism further heightens sensitivity, as these sectors are directly dependent on stable environmental conditions.

c) Adaptive Capacity

The adaptive capacity in STMA varies, influenced by socio-economic factors and institutional capabilities. While some adaptation measures are in place, such as diverse water sourcing strategies and infrastructure improvements, there are significant constraints. These include limited financial resources for climate adaptation projects, insufficient technical expertise to implement robust resilience strategies, and governance challenges in coordinating multi-stakeholder efforts.

d) Vulnerability

The region exhibits high vulnerability due to the widespread impacts on health, economic activities, and social cohesion. Rising temperatures contribute to heat-related illnesses and increased demand for water, affecting both urban and rural populations. Water scarcity events intensify pressures on agriculture and public health, exacerbating food insecurity and health risks. Flooding events disrupt daily life, damage property and infrastructure, and lead to economic losses, particularly in vulnerable communities along the coast and low-lying areas.

This means addressing climate change impacts in STMA requires integrated strategies that enhance adaptive capacity, reduce sensitivity, and mitigate exposure to climate hazards. This involves investing in resilient infrastructure, improving access to climate information, enhancing public awareness and education, and fostering multi-sectoral collaboration to overcome institutional and financial barriers. By prioritizing climate resilience and adaptive strategies tailored to local needs.

4.2.2.5 Assessment of Future Risk

The assessment of future climate change risks in the STMA highlights significant vulnerabilities across key sectors. Fishing industries face declining catch potential due to ocean warming and acidification, posing risks to food security and livelihoods. Future climate projections indicate that the Sekondi-Takoradi Metropolitan Assembly could face significantly higher temperatures, with increases of about 2°C by mid-century, even under scenarios of lower greenhouse gas concentrations. By the end of the century, temperature increases could range from 1.5°C to 4°C, depending on the emission scenario. Precipitation projections remain highly variable and uncertain, with an approximately equal likelihood of small increases or decreases in annual average precipitation—around 10% either way compared to the base years. However, extremes could see changes of up to ±20% in mean annual precipitation. Heavy rainfall events are expected to become more frequent in the future, particularly under high-emission scenarios, as maximum daily rainfall is projected to increase under RCP 4.5 and RCP 8.5 scenarios across most models, potentially leading to a greater risk of flooding. **(UNEP/2019/010 (4700017333))**

Water supply systems are threatened by increased evaporation and extreme weather events, leading to water scarcity and potential conflicts over access. Critical infrastructure is at high risk from sea-level rise and storm impacts, jeopardizing transportation, energy, and sanitation services. Agriculture faces challenges such

as saltwater intrusion and flooding, impacting crop yields and farmer livelihoods. Health systems are vulnerable to increased disease risks exacerbated by higher temperatures and extreme weather events. Coastal ecosystems are highly exposed to ocean warming and sea-level rise, threatening biodiversity and livelihoods dependent on marine resources. Overall, these sectors exhibit extreme climate change risks with moderate adaptive capacities, underscoring the urgent need for robust adaptation measures and resilience-building efforts in STMA.

Table 6 provides a synthesis of future risks and their impact on the various socioeconomic sectors in STMA predicted by the participants of the validation workshop. This prediction aligns to the information in the STMA-CCRA which used Representative Concentration Pathways (RCPs) to

project the rate of

occurrence of climatic hazards.

- *RCPs are scenarios used to project future greenhouse gas concentrations in the atmosphere. These pathways represent different trajectories of future emissions and are categorized by their radiative forcing levels in watts per square meter (W/m^2) by the year 2100 relative to pre-industrial levels.*
- *The RCP scenarios range from RCP2.6 (low emissions) to RCP8.5 (high emissions), with each scenario describing a different level of future greenhouse gas concentration and its corresponding impact on global temperature rise and climate outcomes.*

IPCC, 2014.

Table 4. 6: Future risk impact

Asset / System	Comments on future risk
Fishing Industries	<ol style="list-style-type: none"> 1) Communities along the coast depend on fisheries for food and livelihoods. A decrease in the catch potential of fisheries, can lead to a decline in economic benefits, potential job losses and food security. 2) Impacts of climate change in coastal ecosystems include losses of species habitat and diversity, and the degradation of ecosystem functions. 3) The loss of coastal ecosystems will adversely impact coastal communities by affecting income, livelihoods, and food security of marine resource-dependent communities. 4) The extreme sea-level events will likely cause disruptions and damage to transportation systems, energy systems, water supply and sanitation, ports and shipping infrastructure, and communication infrastructure. 5) The impacts are far-reaching with cascading effects on the functioning of society. 6) Access to basic services will become difficult and the livelihoods and economy will be negatively impacted.
Water Supply Systems and Infrastructure	<ol style="list-style-type: none"> 1) Water scarcity can lead to an increased risk of waterborne diseases, as people may resort to using unsafe water sources if clean sources are unavailable. 2) Water scarcity can also lead to conflicts over access to water, as different groups may compete for limited supplies. This can lead to social and political tensions within communities. 3) Water scarcity can have economic impacts, as it can lead to a decline in agricultural productivity. 4) The extreme sea-level events will likely cause disruptions and damage to transportation systems, energy systems, water supply and sanitation, ports and shipping infrastructure, and communication infrastructure. 5) The impacts are far-reaching with cascading effects on the functioning of society. 6) Access to basic services will become difficult and the livelihoods and economy will be negatively impacted. 7) Saltwater intrusion into freshwater aquifers and agricultural lands can lead to reduced yields or even complete loss of crops. 8) Climate change is also expected to increase the frequency and intensity of extreme weather events, such as hurricanes, typhoons, and flooding, that will cause extensive damage to crops, infrastructure, and to the livelihoods of farmers. 9) Climate change impacts on health will include the increased risk of waterborne diseases, heat-related illnesses, malnutrition due to food insecurity, vector-borne diseases, and potential psychological issues due to displacement and migration because of sea-level rise and other climate-related events

Asset / System	Comments on future risk
Critical infrastructure	<ol style="list-style-type: none"> 1) The extreme sea-level events will likely cause disruptions and damage to transportation systems, energy systems, water supply and sanitation, ports and shipping infrastructure, and communication infrastructure. 2) Climate change is also expected to increase the frequency and intensity of extreme weather events, such as hurricanes, typhoons, and flooding, that will cause extensive damage to crops, infrastructure, and farmers' livelihoods.
Agriculture	<ol style="list-style-type: none"> 1. Higher temperatures can lead to heat stress in crops and livestock, affecting productivity and quality. Heat stress can reduce crop yields and quality. 2. RCP 8.5 scenarios often project more variable precipitation patterns, with increased frequency and intensity of extreme weather events such as heavy rainfall and droughts. This variability can disrupt planting and harvesting schedules, reduce crop yields, and increase the risk of soil erosion. 3. Changes in precipitation coupled with increased evaporation rates due to higher temperatures can exacerbate water scarcity in agricultural regions. This leads to reduced water availability for irrigation, impacting crop growth and productivity. Farmers may face challenges in accessing reliable water sources for agriculture. 4. Increased pests and diseases due to warmer conditions can harm crops, requiring more management. Extreme weather events like storms can damage crops and infrastructure. 5. Coastal areas may suffer from saltwater intrusion, reducing soil fertility and threatening food security.
Health systems	<ol style="list-style-type: none"> 1) Water scarcity can lead to an increased risk of waterborne diseases, as people may resort to using unsafe water sources if clean sources are unavailable. 2) The impacts are far-reaching with cascading effects on the functioning of society. 3) Access to basic services will become difficult and the livelihoods and economy will be negatively impacted. 4) Climate change impacts on health will include the increased risk of waterborne diseases, heat-related illnesses, malnutrition due to food insecurity, vector-borne diseases, and potential psychological issues due to displacement and migration because of sea-level rise and other climate-related events. 5) An increase in mean annual temperature, and in the intensity and frequency of heatwaves, could result in a greater number of people being placed at risk of heat-related medical conditions. 6) The extreme sea-level events will likely cause disruptions and damage to transportation systems, energy systems, water supply and sanitation, ports and shipping infrastructure, and communication infrastructure. 7) Saltwater intrusion into freshwater aquifers and agricultural lands can lead to reduced yields or even complete loss of crops.
Coastal Ecosystems	<ol style="list-style-type: none"> 1) Communities along the coast depend on fisheries for food and livelihoods. A decrease in the catch potential of fisheries, can lead to a decline in economic benefits, potential job losses and food security.

Asset / System	Comments on future risk
	<ul style="list-style-type: none"> 2) Impacts of climate change in coastal ecosystems include losses of species habitat and diversity, and the degradation of ecosystem functions. 3) The loss of coastal ecosystems will adversely impact coastal communities by affecting income, livelihoods, and food security of marine resource-dependent communities. 4) The extreme sea-level events will likely cause disruptions and damage to transportation systems, energy systems, water supply and sanitation, ports and shipping infrastructure, and communication infrastructure. 5) Access to basic services will become difficult and the livelihoods and economy will be negatively impacted. 6) Saltwater intrusion into freshwater aquifers and agricultural lands can lead to reduced yields or even complete loss of crops. 7) Climate change impacts on health will include the increased risk of waterborne diseases, heat-related illnesses, malnutrition due to food insecurity, vector-borne diseases, and potential psychological issues due to displacement and migration because of sea-level rise and other climate-related events.



4.2.2.6 Adaptation Options

Adaptation options are strategies to mitigate climate change impacts which aim to boost resilience and reduce vulnerabilities to climate hazards. The methodology for developing adaptation options begins from assessing vulnerabilities to climate impacts, engaging stakeholders to understand their concerns, and identifying potential adaptation measures. Adaptation options are then prioritized based on criteria like effectiveness, feasibility, and stakeholder preferences, with detailed plans developed for implementation, monitoring, and evaluation. This process is iterative, requiring ongoing adjustments based on new information and changing climate conditions (Singh et al., 2020).

During stakeholder workshops, a ranking and prioritization exercise was conducted to assess the suitability and priority of various sectoral adaptation practices. Multi-Criteria Analysis (MCA) was recommended as a decision analysis tool to evaluate adaptation options based on criteria such as risk reduction potential, implementation level, SDGs and national/district policy alignment, cost-effectiveness, and social acceptance. This approach allows for the comprehensive assessment of adaptation strategies considering technical feasibility, governance implications, environmental impacts, and gender as well as vulnerability considerations. It ensures that adaptation measures are not only effective in mitigating climate risks but also socially inclusive and aligned with sustainable development goals. Table 7 illustrates some adaptation measures focusing on both short and long terms.



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4.3 Survey Results and Analysis

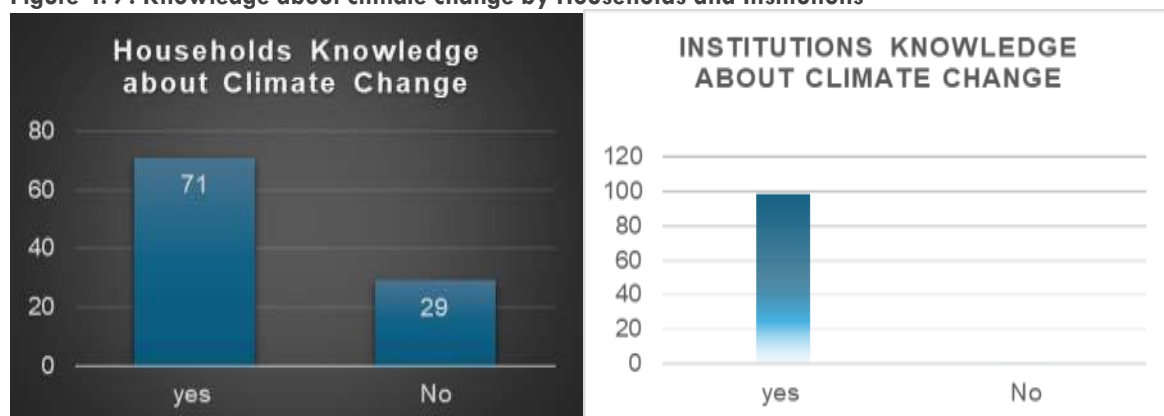
The household survey for the adaptation component of the SEACAP solicited information on the following areas:

- Awareness about climate change and sources of information
- Climate Related Hazards in the last 10 years
- Impact of Climate Change Hazards.
- Persons Impacted by Climate Change hazards
- Climate Hazards and Peoples Concerns
- Constraints to Climate Change Adaptation
- Coping Strategies to climate hazards and impacts

4.3.1 Climate Change Information

There are numerous sources where one can hear information about climate change, these include formal and informal sources such as media outlets, workshops, CSOs, Academic and research institutions, family and friends, community meetings among others. Knowledge about climate change and information is very critical for adaptation actions. The study revealed that 71% of household respondents have heard about climate change as presented in Figure 4.7. Comparatively 98.5% of the institutions interviewed have heard about climate change. This demonstrates respondents' ample knowledge of the environment and climate variability (Mattah et al, 2018).

Figure 4. 7: Knowledge about climate change by Households and Institutions

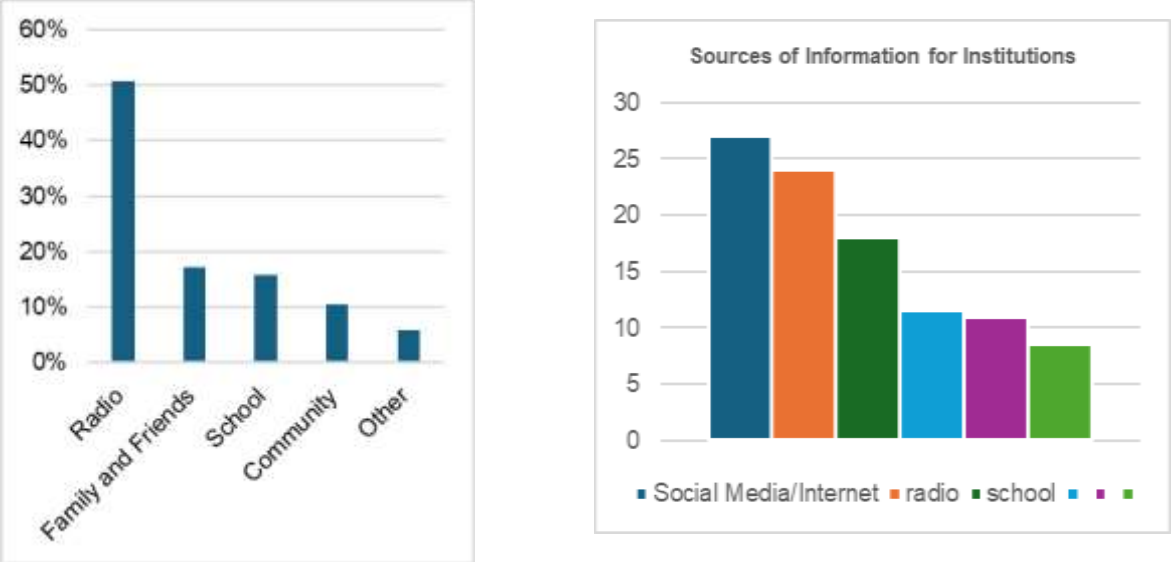


The key medium of information on climate change for households was through the radio accounting for 57% of respondents (Figure 4.8). Other sources identified were through family and friends, schools and community. Social media/Internet was the major source of information for Institutions.

4.3.2 Impact of Climate Change Hazards

Climate change hazards can have varied degrees of impacts on natural systems, human societies, ecosystems, economies among others. The impacts can be diverse and varied depending on the type of hazard, the magnitude of change and vulnerability of the receiving systems.

Figure 4. 8: Sources of Information about Climate Change for Households and Institutions

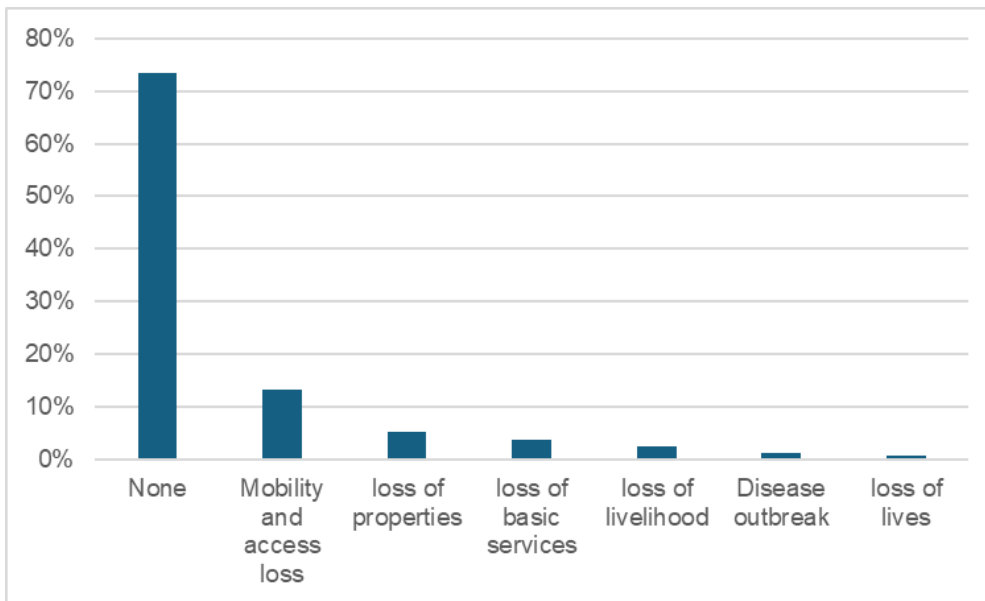


This information is relevant in developing a communication strategy for climate change in the Metropolis

4.3.2.1 Coastal Erosion

Rising temperatures are causing sea levels to rise which is leading to the increasing threat of coastal flooding, erosion and saltwater intrusion. Coastal erosion can have significant impacts on the Sekondi-Takoradi Metropolis as it is a coastal area that is vulnerable to such natural hazards. The impacts may include damage to critical infrastructure including the port, roads, bridges, buildings, and utilities which can disrupt transportation networks, access to essential services, and economic activities in the metropolis. Homes, businesses, and other properties located along the coast are at risk of damage or destruction due to erosion sea level rise and flooding. Property owners may experience financial losses and displacement as a result of these events. The livelihoods of those dependent on fishing, agriculture, and tourism may be impacted. The impact of coastal erosion has been experienced by only 27% of the respondents in the form of loss of mobility and access, properties, basic services, livelihoods, lives and disease outbreaks as presented in Figure 4.9.

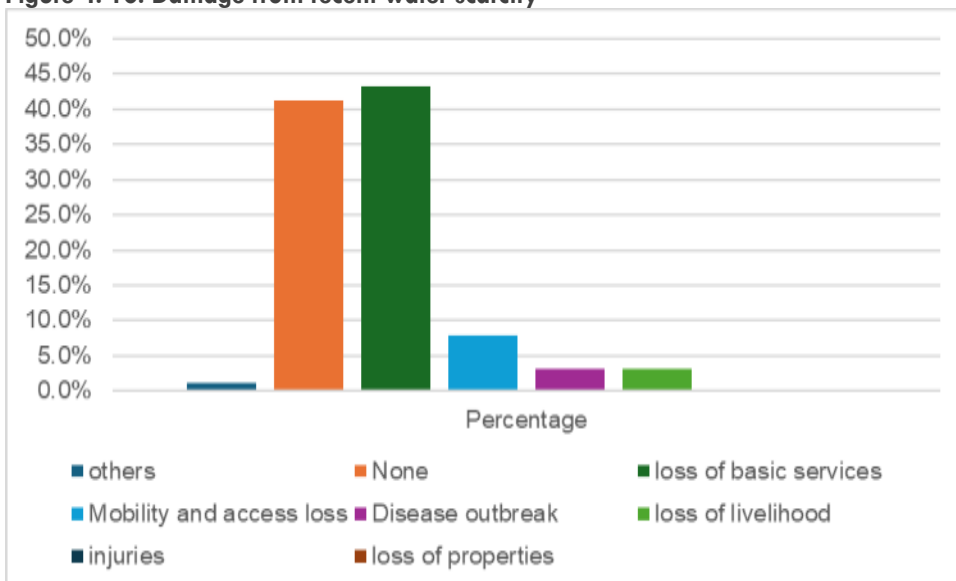
Figure 4. 9: Experience with the Impact of Coastal Erosion



4.3.2.2 Water Scarcity

Water scarcity events can have severe consequences for the population and environment of the STMA. Potential damage includes impacts on health, agriculture, economy, social cohesion and quality of life. Forty-three per cent of households have experienced damage from water scarcity in terms of loss of basic services, disease outbreaks, (3.2%), and loss of livelihoods especially those whose businesses are dependent on the availability of water, forty-one percent of the households have not experienced any damage from water scarcity.

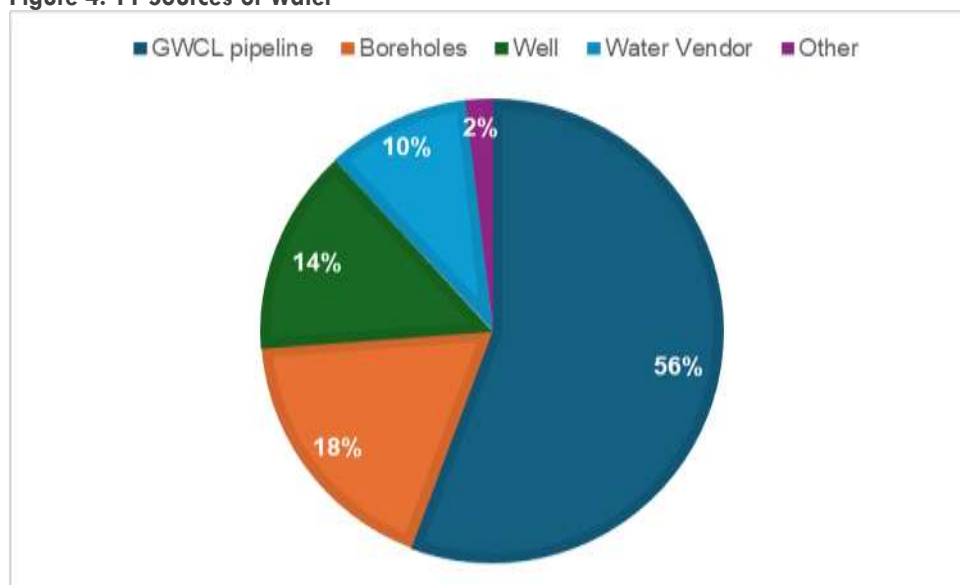
Figure 4. 10: Damage from recent water scarcity



4.3.2.2.1 Sources of Water

Water scarcity was identified as one of the impacts of climate change in the STMA CCRA. It was therefore necessary to determine the sources of water in the metropolis since the availability of clean and safe water is a critical component of public health, sanitation and overall well-being. Generally, almost all the households interviewed got water from various sources with the majority from the municipal water supply pipelines (56%), 32% from groundwater sources (32%), and the rest from water vendors.

Figure 4. 11 Sources of Water

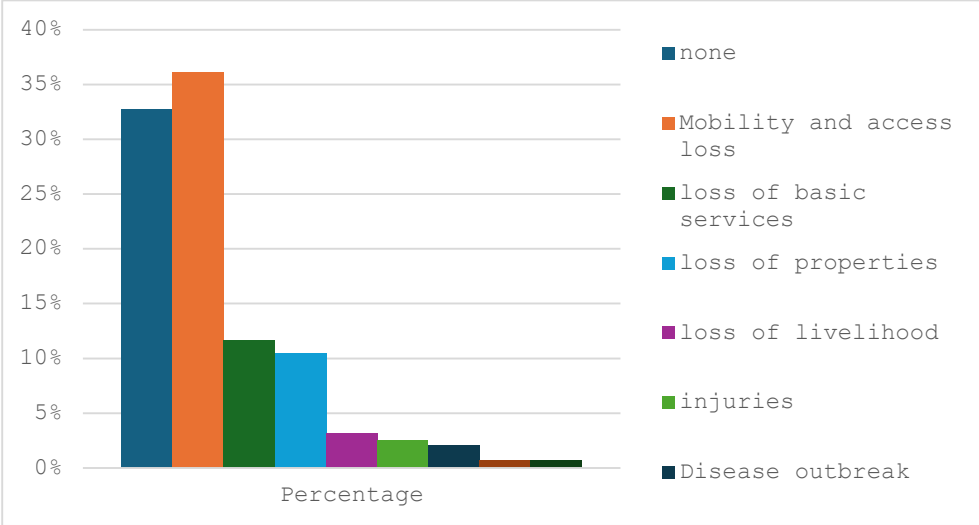


4.3.2.3 Flooding

Sekondi-Takoradi by its location and topography along the coast is vulnerable to floods which impacts negatively properties, basic infrastructure, lives and businesses. The climate change risks assessment of 2023 concluded that Sekondi-Takoradi is exposed to the risk of flooding which is mainly confined to the southern part of the catchment where the denser urbanised area is. The northern part of the catchment seems to have little flood risk because it mostly consists of elevated and permeable green areas. Nonetheless, several high-risk areas in urban Sekondi-Takoradi were identified.

The survey solicited information about the recent experiences from recent flooding events. About two-thirds of the respondents have experienced damage from recent flooding events in the form of loss of mobility and access to basic services, properties and livelihoods as per Figure 4.12 below.

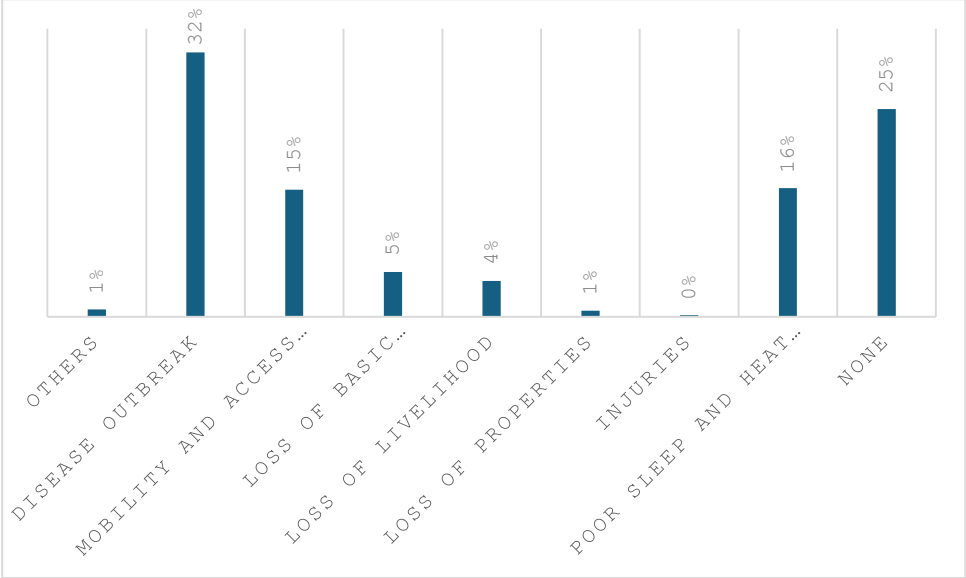
Figure 4. 12: Damage from Recent flooding Event



4.3.2.4 Rising Temperatures

Sekondi-Takoradi currently enjoys temperatures of around 26.5°C which is expected to change as extreme heat events are expected to be more frequent and intense over time. STMA was projected to experience a temperature increase from 1.5 °C under RCP 2.6 to 3.5/4 °C under RCP 8.5, with RCP 4.5 Suggesting a mid-point of about 2.0 °C, by the end of the century. (UNEP/2019/010 (4700017333) Higher temperatures can have direct impacts on human health leading to health-related illnesses, exacerbated respiratory diseases and the spread of vector borne diseases such as malaria and dengue fever. Changes in temperature can affect water availability leading to droughts and increased demand for water. Ultimately it can lead to significant economic losses due to increased health care cost, loss of productivity and disruptions to water services. About 75% of the respondents have experienced damage from rising temperatures in the form of disease outbreaks (32%), poor sleep and heat rashes (16%), mobility and access loss (15%), and loss of basic services among others. (see figure 4.13)

Figure 4. 13: Damage from rising temperatures experienced by household



4.3.2.6 Climate Related Hazards in the Last 5 –10 Years

The most prominent climate hazards for the metropolis are extreme heat, sea-level rise and river and urban flooding. The observed changes in temperature, sea level rise, and extreme weather events have been observed by respondents. Both the household and institutional surveys revealed that respondents have observed changes in temperature and rainfall patterns in the last five to thirty years with majority of the respondents experiencing climate-related hazards of extreme heat, rainfall, water scarcity and drought, severe winds among others as per figures 4.14 and 4.15. This positively corroborates risks identified in the STMA-CCRA and other studies on STMA (Mattah et al 2018, Kwadwo Owusu et al 2019)

Figure 4. 14: Climate Related Hazards Experienced in the last 5-10 Years by Households

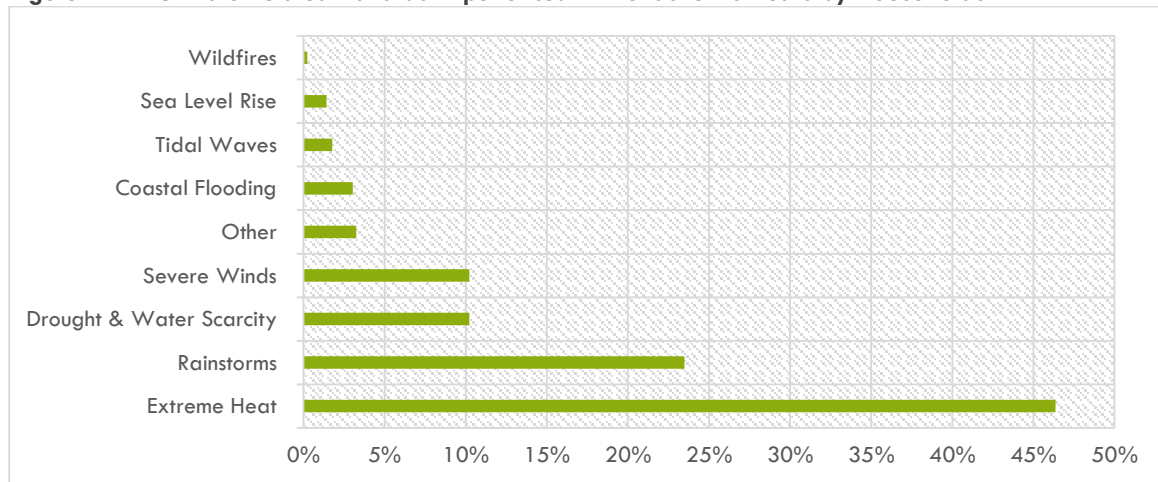
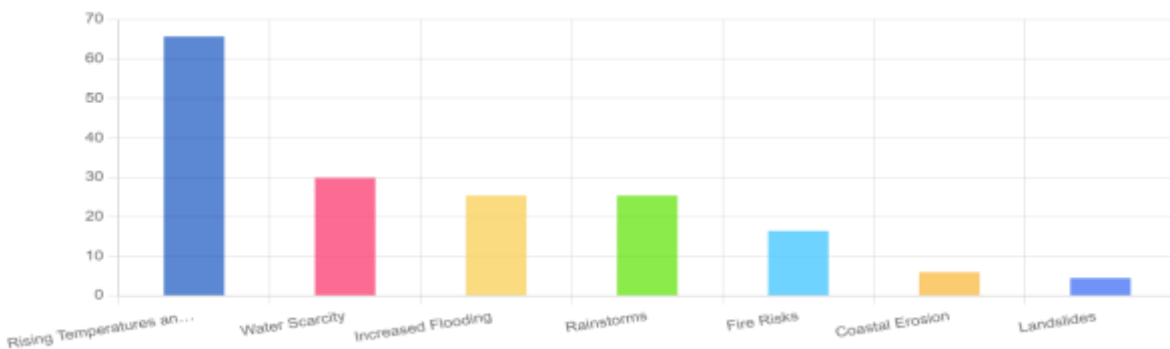


Figure 4. 15: Climate Related Hazards Experienced in the last 5-30 Years by Institutions

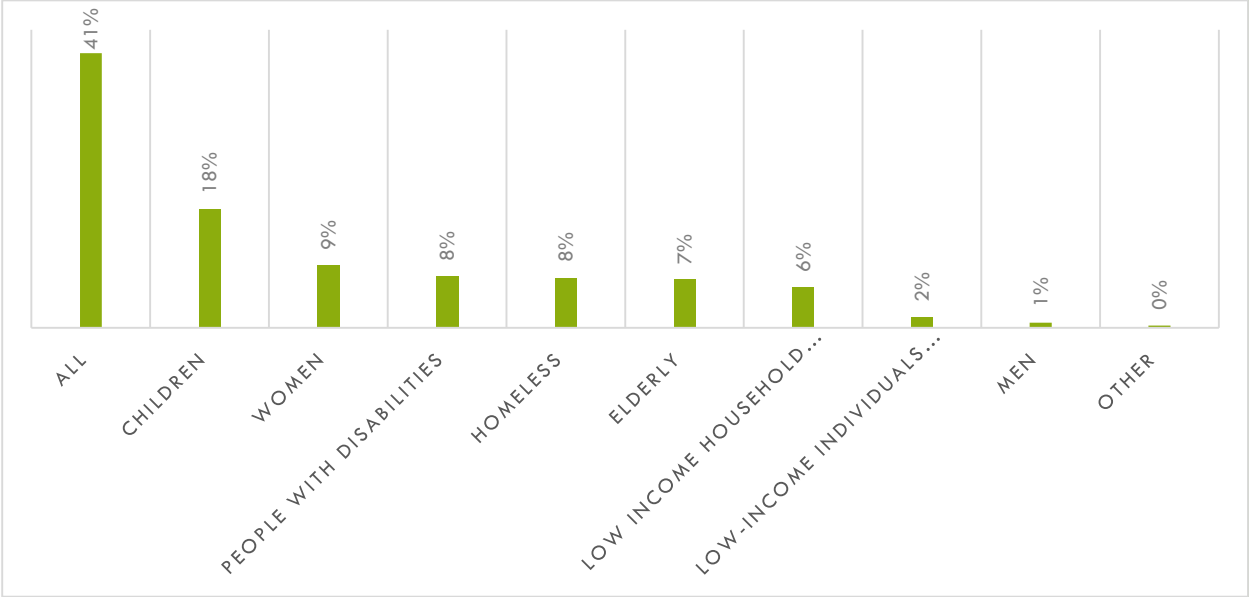


4.4 Persons Affected by Coastal Erosion

In Sekondi-Takoradi various groups of people are likely to be affected by coastal erosion. These include people living in coastal settlements, fisherfolks, operators in the tourism sector, local businesses, marginalized or disadvantaged groups, including low-income families, elderly individuals, persons with disabilities, and informal settlers. The impact of coastal erosion affects all as indicated by about 41% of all respondents.

However, children, women, persons with disabilities, the homeless and the elderly were thought to be affected most by coastal erosion as presented in figure 4.16

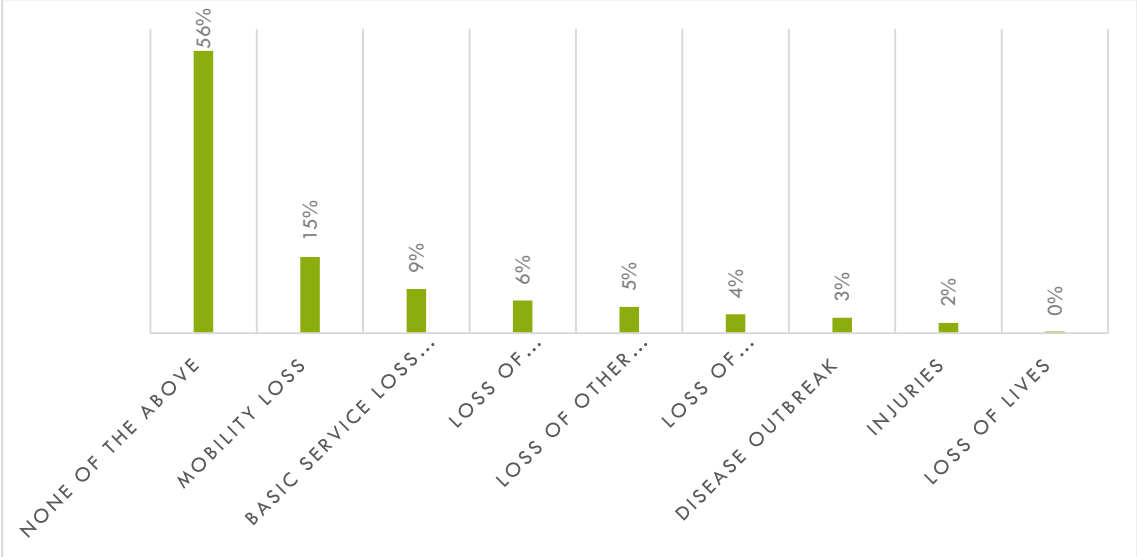
Figure 4. 16: Persons affected by Coastal Erosion



4.5 Damage from Recent Floods

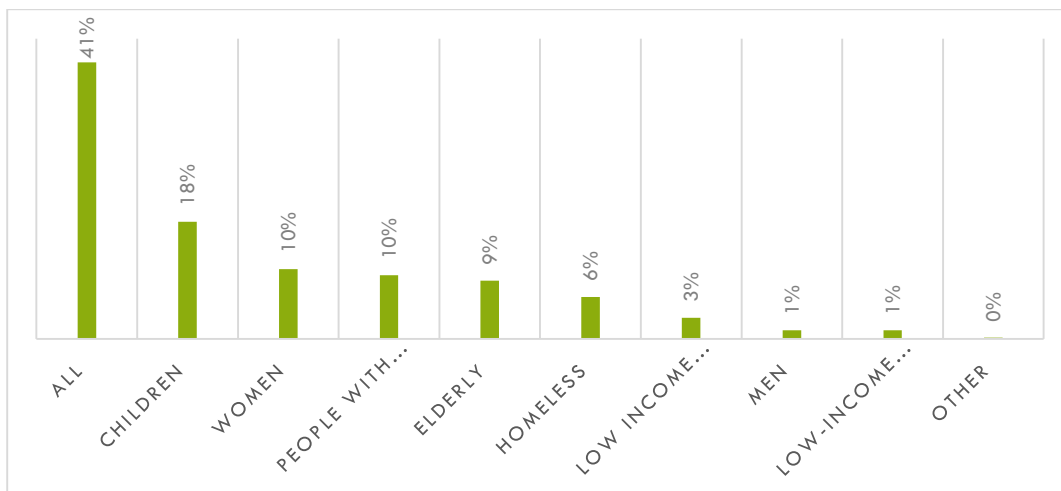
Flooding events can lead to damage to property, infrastructure, farmlands and crops, Health risks, displacement of persons, economic losses and environmental impacts. The survey responses indicated that 56% of the respondents did not appreciate the impact of flooding on the metropolis. However, the remaining 44% considered damage from recent floods to include loss of mobility, access to basic services (such as water, and electricity), homes, and livelihoods among others as presented in figure 4.17 below

Figure 4. 17: Damage from recent floods



The impact of floods affects all as indicated by about 41% of all respondents. However, children, women, persons with disabilities, the homeless and the elderly were thought to be affected most by coastal erosion as presented in Figure 4.18

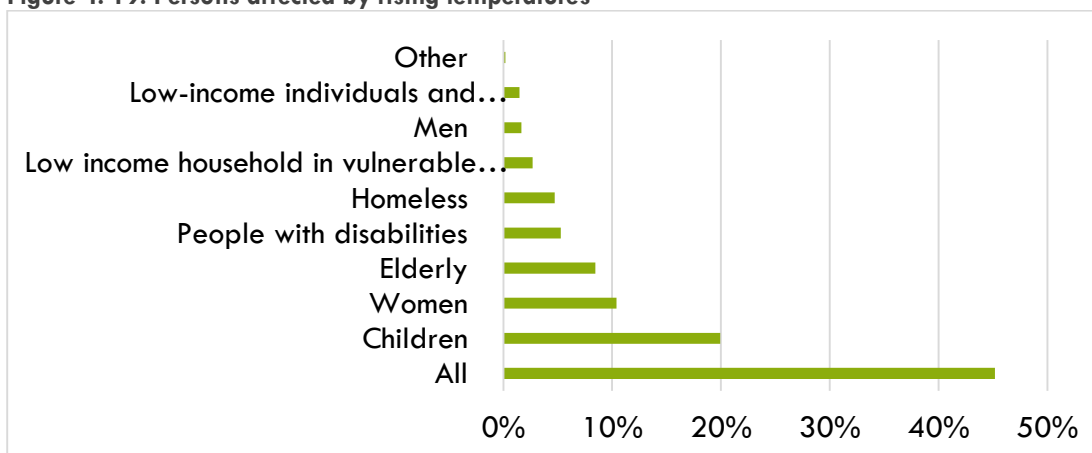
Figure 4. 18: Persons likely to be affected by floods



4.6 Damage from Rising Temperatures

Rising temperatures can have various impacts on individuals and communities in Sekondi-Takoradi. Particularly outdoor workers, the elderly population, children and infants, are at higher risk of heat-related illnesses due to their bodies' limited ability to regulate temperature. Also, due to their reliance on caregivers to keep them cool and hydrated, they are at higher risk of heat-related illnesses. People living in low-income neighbourhoods who lack access to cooling and adequate housing, as well as the homeless population may experience heat-related illnesses. This is because they often lack access to shelter, water, and other resources to stay safe during extreme heat events. Furthermore, farmers, herders, and individuals working in the agricultural sector may face challenges in managing livestock and crops in extreme heat, leading to reduced productivity and economic losses. Rising temperatures are considered by 45% of the respondents to affect all as presented in Figure 4.19. This was followed by Children (20%), women (10%), Elderly (8%) and people with disability. The Intergovernmental Panel on Climate Change (IPCC) 2021 report indicates that climate change will impact human health by altering the distribution and prevalence of vector-borne diseases like dengue fever and malaria. These diseases are expected to become more widespread with a temperature increase of 1.5°C, and even more so with a 2°C rise, in many regions (Hoegh-Guldberg et al., 2019).

Figure 4. 19: Persons affected by rising temperatures

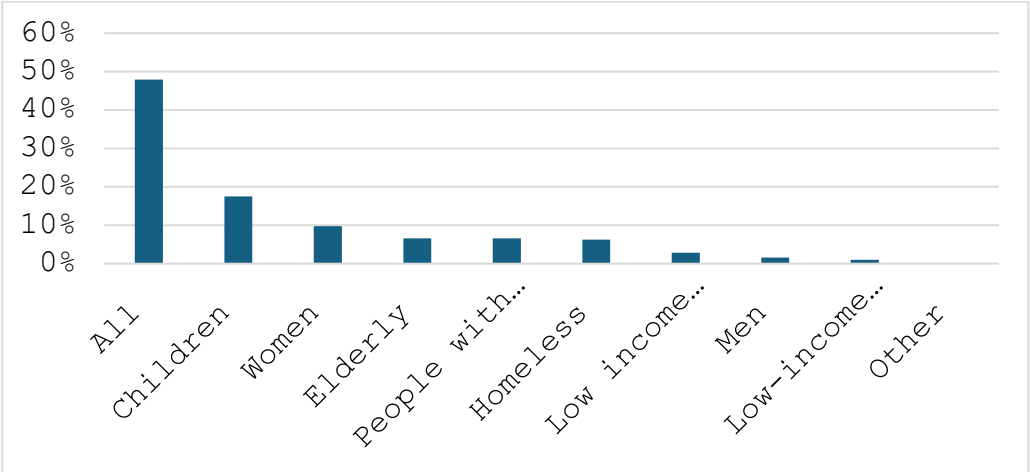


4.7 Persons Affected by Precipitation Patterns and Storms

Changes in precipitation patterns and storms can have various impacts on different groups of people. The impacts include the risk of flooding, landslides due to soil saturation, erosion due to changes in precipitation

patterns and more intense storms. All the inhabitants of STMA are exposed to the impacts of precipitation patterns and storms as indicated by 48% of the respondents in Figure 4.20 below. Children, women, the elderly, people with disability and the homeless are mostly affected by precipitation patterns and storms.

Figure 4. 20: Persons affected by Precipitation Pattern and Storms



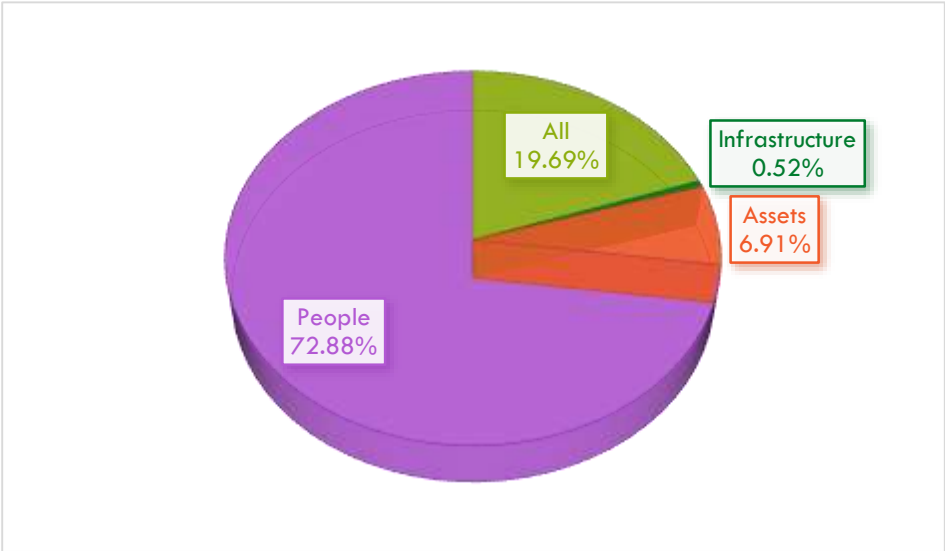
4.8 Climatic Hazards and Peoples Concerns

In the face of climatic hazards, people may have various concerns and priorities related to their safety, well-being, and livelihoods. Some of the things that residents in STMA may be concerned about in the context of climatic hazards include:

- Personal safety and the safety of families during extreme weather events such as floods, storms, and landslides related to the risk of injury, property damage, and displacement.
- Damage to homes, businesses, and infrastructure
- Health Risks such as waterborne diseases, vector-borne illnesses, heat-related illnesses, and respiratory problems due to air pollution or mould growth after flooding.
- Disruptions to essential services such as water supply, electricity, transportation, and communication networks
- Food availability and affordability
- Livelihoods and Income

In the face of climate change related hazards 73% of the respondents are more concerned about people's lives and safety than assets and infrastructure as presented in Figure 4.21.

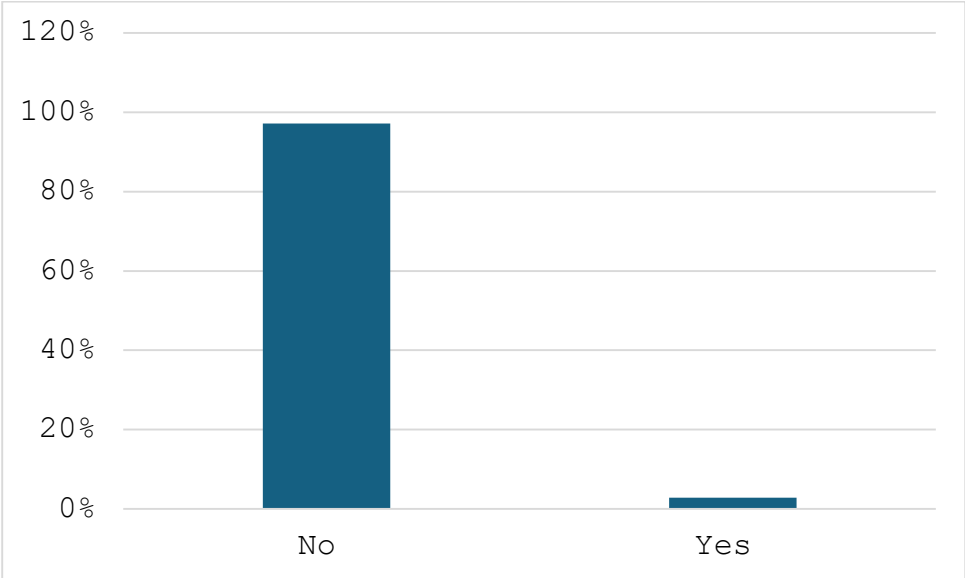
Figure 4. 21: Climatic Hazards and Peoples Concerns



4.9 Cultural Heritage at Risk

In the face of climatic hazards such as flooding, erosion, storms, and sea-level rise, cultural heritage sites in the Sekondi-Takoradi Metropolitan Area may be at risk. These risks can threaten the preservation and integrity of important forts, historical sites, archaeological remains, cultural artefacts located near the coastline, and traditions that hold historical, social, and cultural significance for the local community and beyond. However, only 3% were concerned about the risks climate change-related hazards pose to the cultural heritage of the metropolis as presented in figure 4.22. There is therefore the need to include the need for protection of cultural heritage in climate change education and awareness programmes.

Figure 4. 22 Concerns about Cultural Heritage



4.10 Climate Change Impacts on Businesses

Climate change can have significant impacts on businesses in the Sekondi-Takoradi Metropolitan Area (STMA) which may include infrastructure damage, supply chain disruption, increased Operational Costs and business Interruptions. It is instructive to note that almost 60% of respondents have not experienced any impact of climate change on their businesses per Figure 4.23. The institutional survey however showed that 46.2% of the business have been impacted by climate change, and the impacts were estimated to be moderate on the scale of 1-10. For instance, small-scale coastal fisheries in STMA are exposed to climate (such as increasing coastal erosion, stronger waves and more storms) and non-climate stressors, such as poor governance, lack of alternative employment, overfishing and diseases. Stressors, in this context, constitute environmental and socio-economic changes or events at local, national or global levels making the fisheries sector or fishers vulnerable. Climate change is expected to compound the consequences of these stressors on fisheries and livelihoods (Freduah et al 2017).

Figure 4. 23: Households' Concerns about Businesses

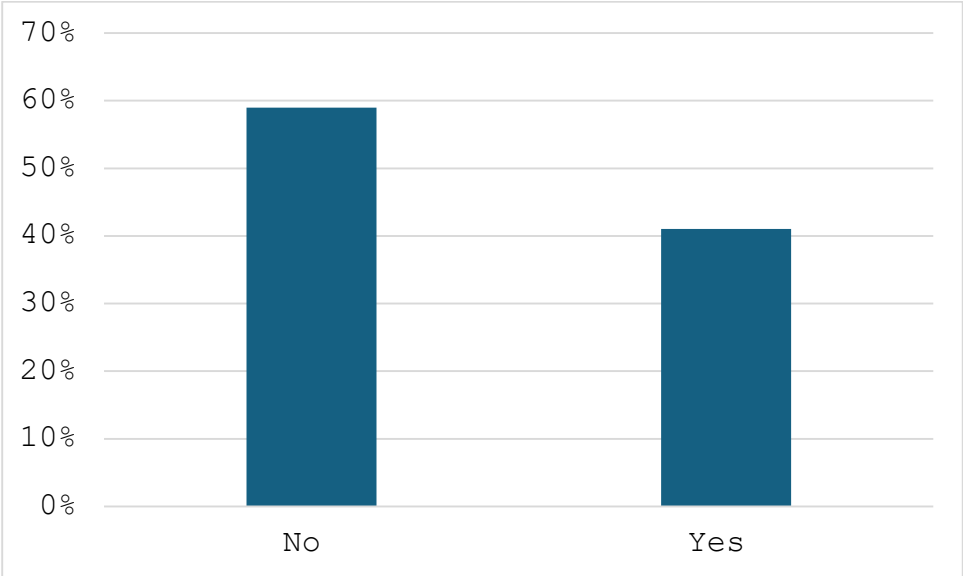
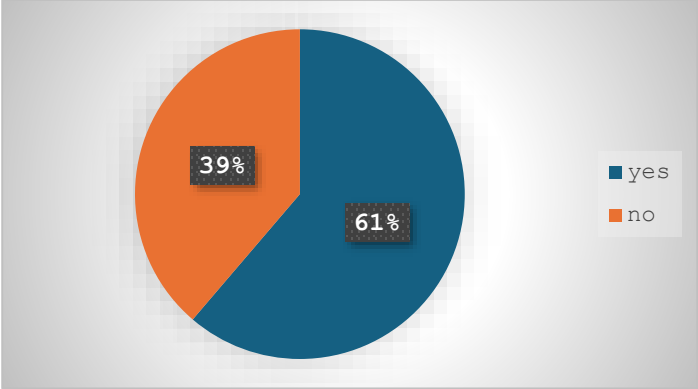


Figure 4. 24 Impact of Climate Change on Businesses (Institutions)

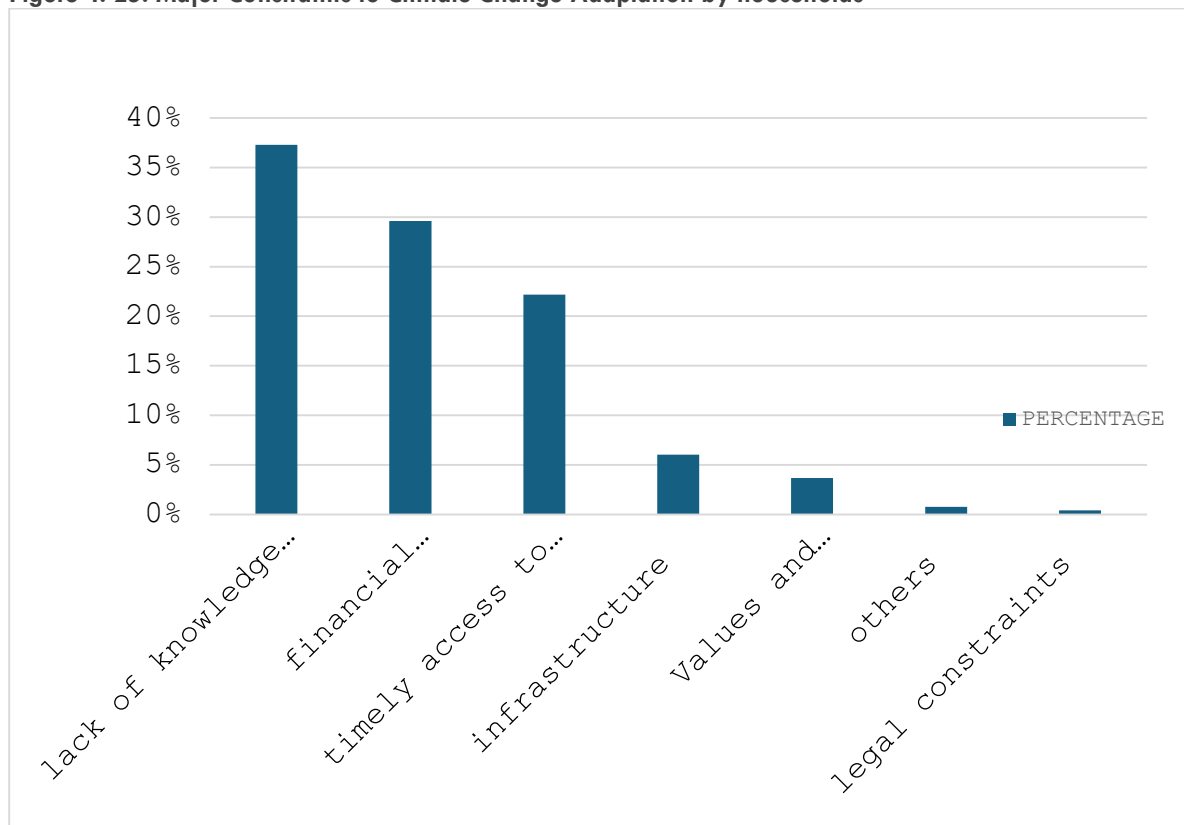


4.1.1 Major Constraints to Climate Change Adaptation

Several significant constraints hinder the ability of municipalities in the Sekondi-Takoradi Metropolitan Area (STMA) to effectively adapt to climate change. These include limited funding for adaptation measures, lack of technical capacity, inadequate regulations and policies, data limitations, governance and coordination challenges, and limited public awareness and engagement. As highlighted in Figure 4.25, key constraints identified in both household and institutional surveys include lack of information, knowledge, skills, and financial constraints. Previous studies have also confirmed these challenges.

Addressing these constraints is crucial for effective climate change adaptation in STMA. Efforts to overcome these barriers will require external support through increased funding and capacity building, and actions from STMA to develop and review existing local policies, improve data access, enhance governance and coordination, and increase public awareness of the issues. By addressing these challenges, STMA can improve its resilience to climate change and ensure a more sustainable future.

Figure 4. 25: Major Constraints to Climate Change Adaptation by households



5 Energy Assessment

5.1 Introduction

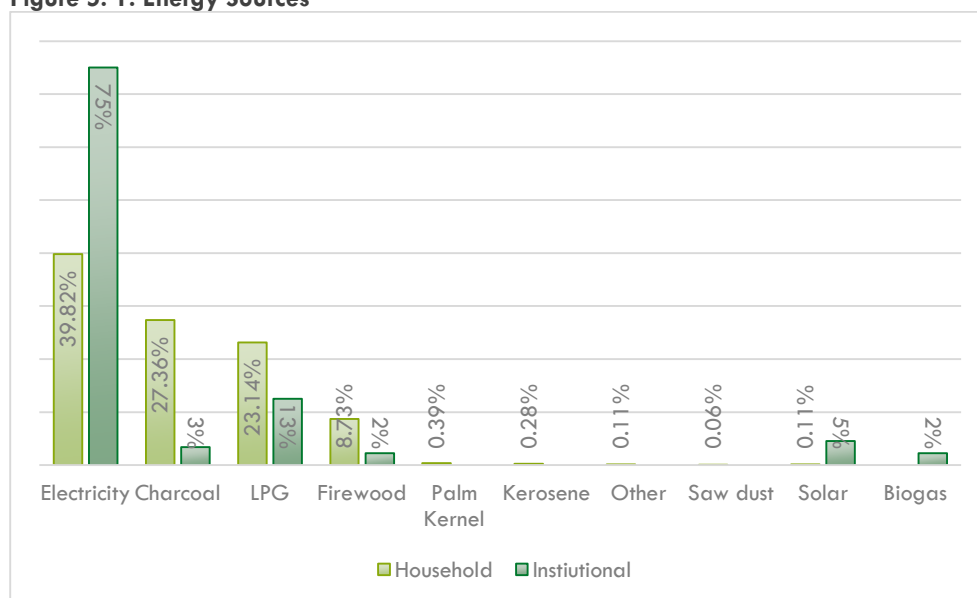
This section analyses the baseline energy situation in Sekondi-Takoradi Metropolitan Assembly. The data is based on an analysis of the results of the STMA household and institutional survey as described in the methodology.

5.2 Energy Use Mix of Sekondi-Takoradi Metropolitan Assembly

Energy use in the Sekondi-Takoradi Metropolis is diverse, with residents and entities relying on a mix of sources, including grid electricity, charcoal, LPG, firewood, solar, and biogas. Among these, electricity is the most widely used, accounting for 39.82% of household energy consumption and 75% of institutional energy use, as shown in Figure 5.1. This high reliance on electricity is largely driven by urbanisation and industrialisation, which demand reliable, affordable, and consistent power.

Charcoal remains a major energy source, particularly for households, where it accounts for 27.36% of usage due to its affordability. However, its widespread use raises environmental and health concerns, as discussed in Section 5.4. Liquefied Petroleum Gas (LPG) is used by 23.14% of households and 13% of institutions. Firewood, though less common, is still used by 8.73% of households and 2% of institutions, especially in rural and less developed areas. Like charcoal, firewood poses sustainability challenges. Meanwhile, renewable energy sources like solar power have a minimal presence in household energy use, but about 5% of institutions have adopted it, reflecting a growing trend towards sustainable energy solutions.

Figure 5. 1: Energy Sources



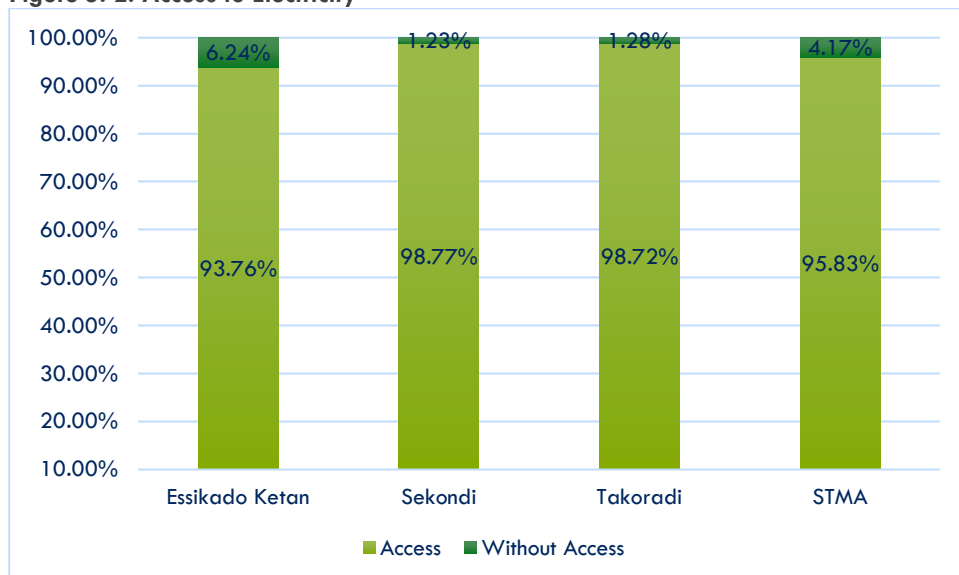
5.3 Household Energy Access

5.3.1 Access to Electricity

Access to electricity is a crucial driver of social, economic, and industrial development. The survey results reveal that access to electricity in the Sekondi-Takoradi Metropolitan Area (STMA) is generally high, with approximately 96% of residents connected to the grid (Figure 5.2). Across the sub-metros, electricity access exceeded 90%. In Sekondi and Takoradi, fewer than 2% of residents lacked access, primarily because they lived in temporary structures, such as kiosks or unfinished buildings.

In the Essikado-Ketan sub-metro, around 6.24% of residents did not have access to electricity as seen in Figure 5.2. The main reasons cited were financial constraints, disconnections due to inability to pay, or delays in being supplied with a meter. These challenges were particularly evident in communities like Mmeradane and Nkran. Notably, those without access to electricity were predominantly low-income earners, with monthly incomes of less than GHC 1,000.

Figure 5. 2: Access to Electricity



5.3.2 Electricity Uses

Electricity in STMA is primarily used for lighting (36.4%), followed by powering appliances (32.4%) as seen in Figure 5.3(A). Cooling, which includes fans, refrigeration, and air conditioning, accounts for 20.7%, while heating and cooking together makeup 9.9%. Appliances commonly found in homes which consumed electricity were dominated by fans (Figure 5.4 (B)), which 85.84% of residents confirmed. The high usage of fans indicates a significant demand for cooling solutions in the area which is consistent with the warm climate and increasing average temperatures.

Figure 5. 3A: Electricity Uses

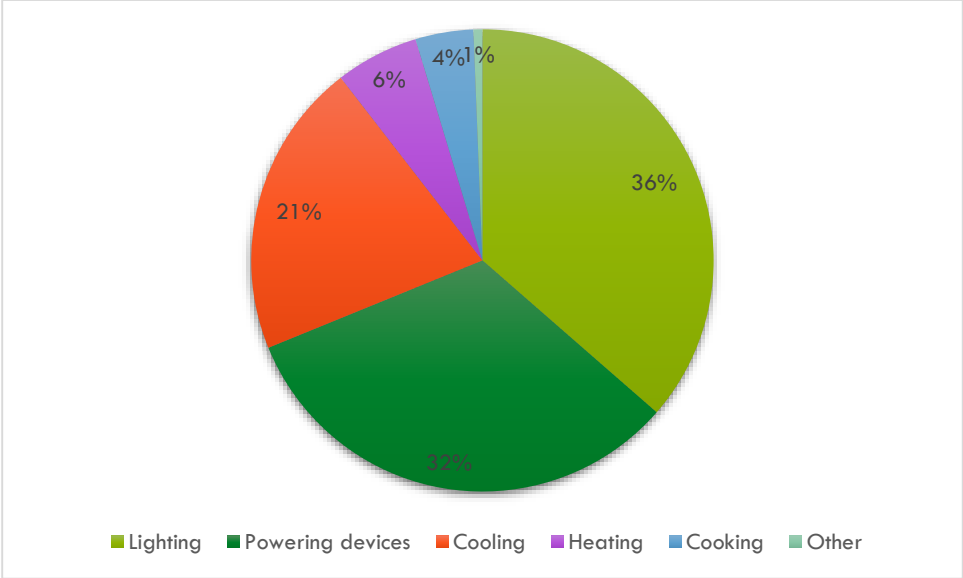
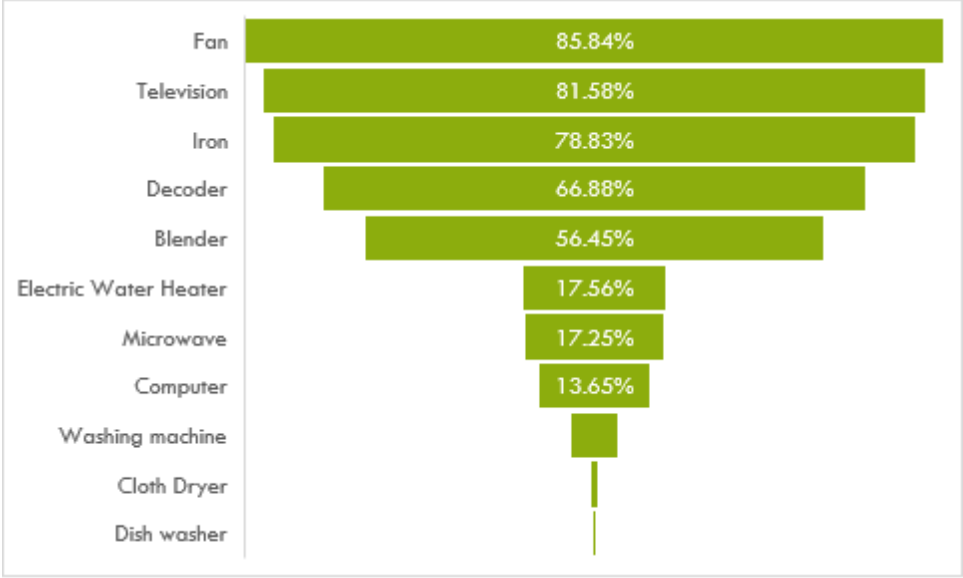


Figure F.3B Household Appliances powered by electricity



Television sets followed as the second most used appliance, with 81.58% of surveyed households providing a response. The presence of satellite decoders (66.88%) indicates a significant penetration of cable or satellite television services, which aligns with the high television usage. The high usage of television sets suggests that a large proportion of households have access to electronic media and entertainment, which is indicative of a level of economic development and quality of life that can be the basis for targeted climate communication. The usage of blenders (56.45%) indicates a substantial reliance on electricity for food preparation and the adoption of modern methods to save time and for convenience.

Both water heaters and microwaves have relatively low usage rates, 17.56% and 17.25% respectively. Which is indicative of concerns about affordability and high usage consumption of electricity. Hence, there is a preference for relatively affordable methods of heating water and cooking using either LPG or Charcoal.

From Figure 5.3(B), personal computers are not as prevalent, which may reflect economic constraints, limited need, or reliance on mobile devices for digital access.

Despite the essential nature of electricity especially for basic household activities, 72% of residents reported challenges with the grid, especially with frequent power interruptions³. The majority of residents (57.91%) reported the grid interruptions as weekly, 24.50% indicated daily interruptions, 4.90% indicated monthly and 12.69% indicated others. Data on power interruptions from the Electricity Company of Ghana was hard to come by for STMA. However, based on national data released by the PURC from ECG for the 4th quarter of 2023, the following deductions were made (PURC, 2023). Ghana's electric power distribution system showed both strengths and areas for improvement in the fourth quarter, as evaluated by key indices: SAIFI, SAIDI, and CAIDI. The **System Average Interruption Frequency Index (SAIFI)**, which measures the average number of power outages experienced by each customer, was recorded at 9.90—significantly exceeding the regulatory benchmark of 6.0. This high frequency of outages, particularly in urban and rural areas, underscores a critical need to address the reliability of the grid. The **System Average Interruption Duration Index (SAIDI)**, which captures the total duration of outages for the average customer, stood at 18.16 hours. This is well below the regulatory thresholds of 48 hours for metropolitan areas, 72 for urban, and 144 for rural areas, indicating that while outages occurred frequently, they did not last long.

Furthermore, the **Customer Average Interruption Duration Index (CAIDI)**, which measures the average time taken to restore power after an outage, was 5.59 hours—again, comfortably below the benchmark range of 8 to 24 hours depending on the area. This suggests relatively efficient response times, particularly in metropolitan areas, where the CAIDI was an impressive 2.03 hours. While metropolitan areas performed better in terms of both outage frequency and duration, the elevated SAIFI across non-metropolitan areas highlights the need for targeted investments in infrastructure to reduce outage occurrences. This underscores the importance of prioritising improvements in grid reliability, particularly in urban and rural areas, to meet Ghana's regulatory standards and enhance the resilience of the power system in the face of growing energy demand and climate-related challenges.

5.3.3 Grid Electricity bills

On average, per month residents spend GHC 157 on electricity. By sub-metro, residents in Takoradi spend more (GHC 216.32) compared with residents in Sekondi (GHC 184.89) and Essikado Ketan(GHS126.75) as seen in Figure 5.4 (A) which is reflective of the city's economic activities and commercial status. The amount of electricity frequently purchased by residents was GHC100.

³ The time of the survey was within a period when Ghana was facing significant challenges with its power supply which could have influenced results.

Figure 5. 4 (A): Average Electricity Purchased

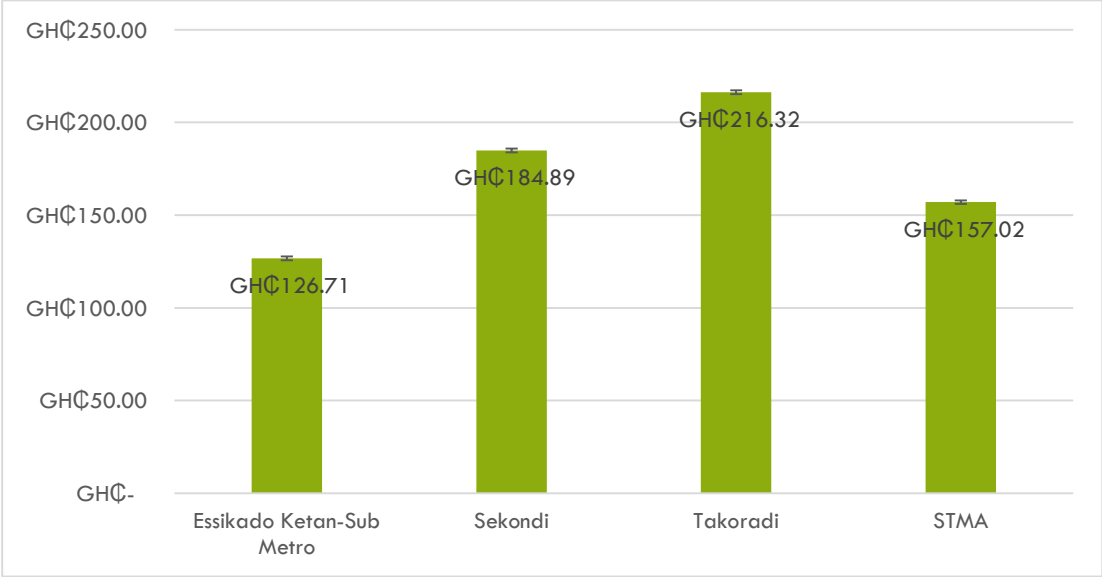
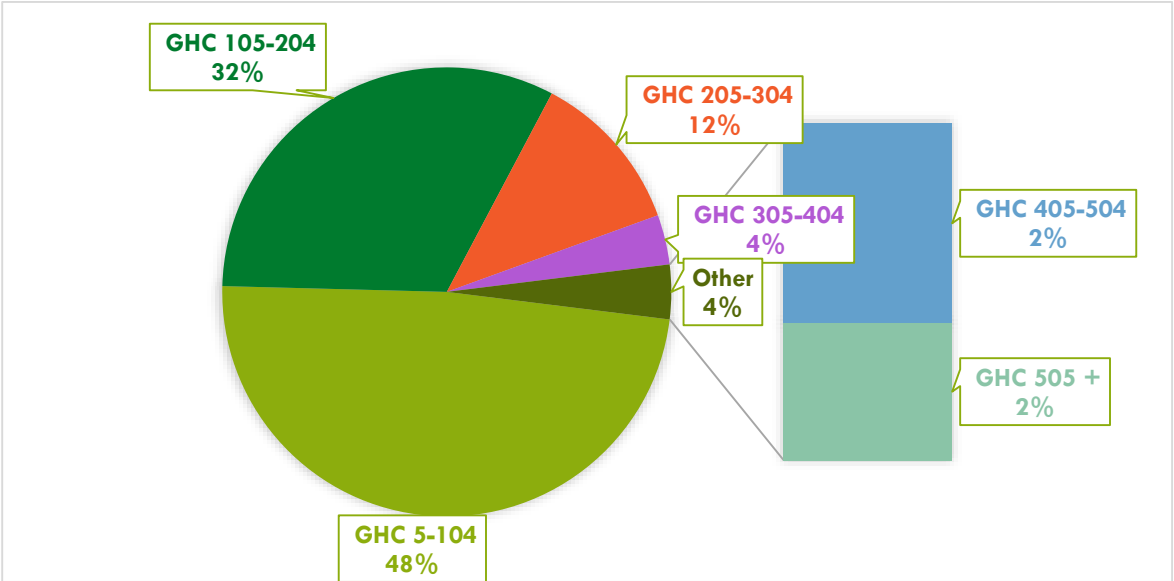


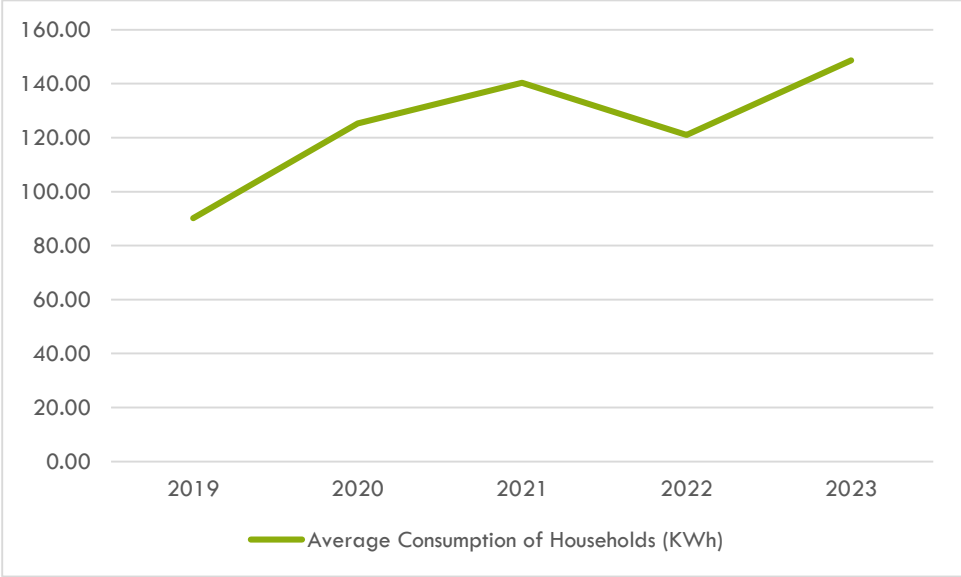
Figure 5. 5 (B): Percentage Distribution of Amounts of Electricity Purchased



As seen in Figure 5.4 (B) Overall, about 48% of the residents purchase electricity between GHC5 - GHC104, 32% purchase between GHC 105-204, 12% purchase between GHC 205-GHC 304, and about 8% purchase above GHC 300.

The average consumption of households in kilowatt-hours (KWh) shows a gradual upward trajectory as it had increased from 90.18KWh in 2019 to 148.68 KWh in 2023. This reflects increased electricity usage, due to growing household demand, increased grid connections, and economic factors driving consumption.

Figure 5. 6: Average household kilowatt hour consumption of electricity



Source: ECG, 2024

5.3.4 Affordability

In the Sekondi-Takoradi Metropolitan Area, the majority of respondents (60%) earned a monthly income of GHC1,000 or less, while 24% earn between GHC1,001 and GHC2,000, and only 17% earned above GHC2,000. In 2024, Ghana’s minimum wage was set at GHC18.15, equating to approximately GHC562.65 per month. Although most residents earn above the minimum wage, 10.4% of the population still live in multidimensional poverty, with 42.7% experiencing average poverty intensity (GSS, 2023) which raises concerns about energy affordability in the metropolis.

Electricity costs have risen sharply, further exacerbating the issue. In the fourth quarter of 2023, the average residential electricity tariff had increased from 53.12 GHp/kWh in 2019 to 129.68 GHp/kWh, representing a 144.13% rise (PURC, 2023). This steep increase, in contrast to the slow growth in incomes, poses significant affordability challenges for households, particularly those in the lower-income brackets. With poverty levels still high, ensuring access to affordable energy remains a critical issue for sustainable living standards in STMA.

Based on the income levels and the average electricity payment of GHC 157.01, an energy burden assessment as captured in Table 5.1 provides an opportunity to gauge the affordability of electricity. Normally, a threshold of 6% for energy affordability is deemed acceptable. The calculation is based on the following formula:

Figure 5. 7a: Energy Burden Formula

$$energy\ burden = \frac{total\ money\ spent\ on\ energy}{total\ gross\ income}$$

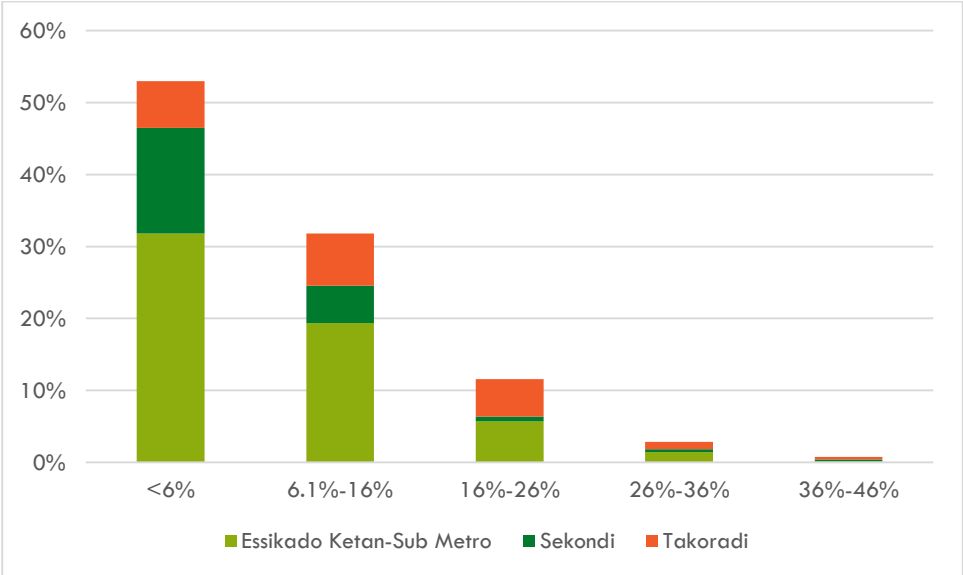
Table 5. 1: Electricity Burden Assessment

Average Monthly Income (GHC) /AVI	Average annual Income (GHC) (AVI x12months)	Average annual electricity payment (GHC) (Average electricity per month x12monhs)	Electricity Burden
1000	12,000	1884.12	15.70%
1500	18,000	1884.12	10.47%
2000	24,012	1884.12	7.85%

The electricity burden for residents earning GHC 1000 and below is 15.70% which indicates significant affordability issues for those in that income bracket. This group faces a high financial strain due to electricity costs. An energy burden of 10.47% indicates moderate affordability issues for the residents who earn between GH¢1,001 and GH¢2,000. This group still faces considerable financial strain due to electricity costs. From Table 5.1, an energy burden of 7.85% indicates relatively better affordability for the residents earning above GH¢2,000. However, this is still above the typical threshold of **6% for energy affordability**.

An in-depth analysis as seen in Figure 5.6b shows a computation based on the actual determined income of respondents and their energy consumption cost. The results indicate the percentage of resident's income spent on electricity. Overall, 53% of residents spent less than six per cent of their income on electricity, followed by those who spent above 6% but less than 16% which accounted for 32%. About 16% of residents spent above 16% of their incomes on electricity.

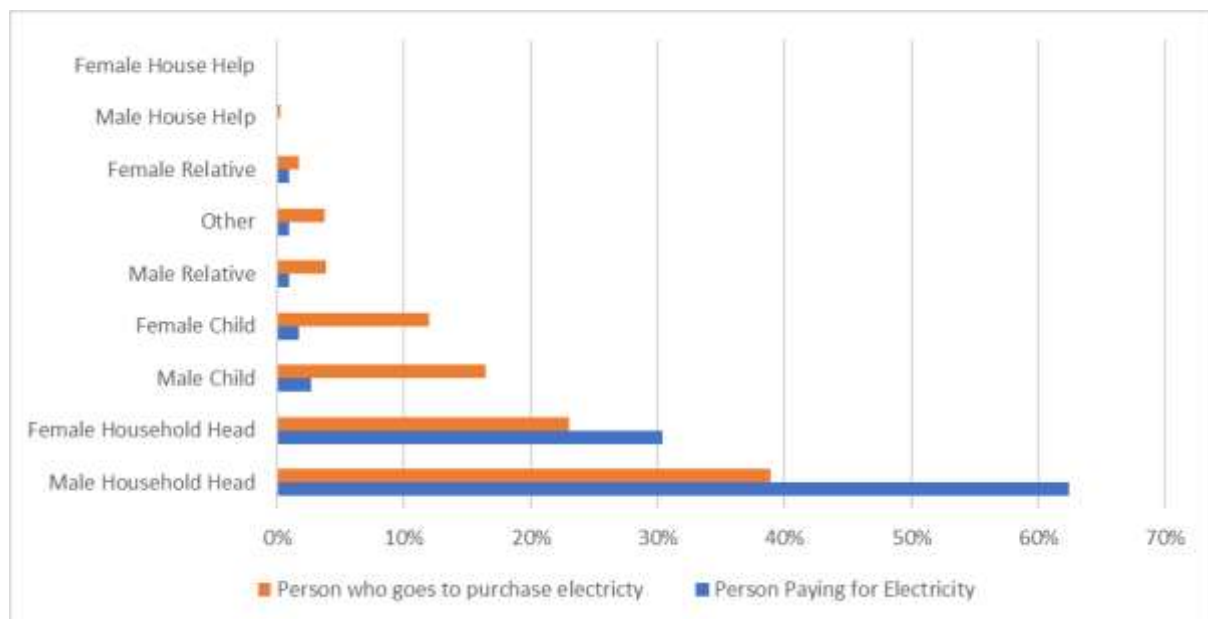
Figure 5.6b: Electricity burden of residents in Sekondi-Takoadi



5.3.5 Gender and Electricity

Gender dynamics emerge in both the purchase and payment of electricity. In the payment of electricity male dominance is seen, as male household heads (62%) are the primary individuals responsible for paying electricity bills. This reflects a traditional gender role where men are often seen as the primary financial providers in households. Female household heads also play a notable role in paying for electricity at 30%, though significantly less than their male counterparts. The responsibility of paying for electricity among adult-children and relatives is minimal, with male and female adult children contributing 3% and 2% respectively, and other relatives each contributing 1%. This suggests that the responsibility for electricity payment is predominantly seen as a “parental responsibility” (Figure 5.7).

Figure 5. 8: Gender and Electricity

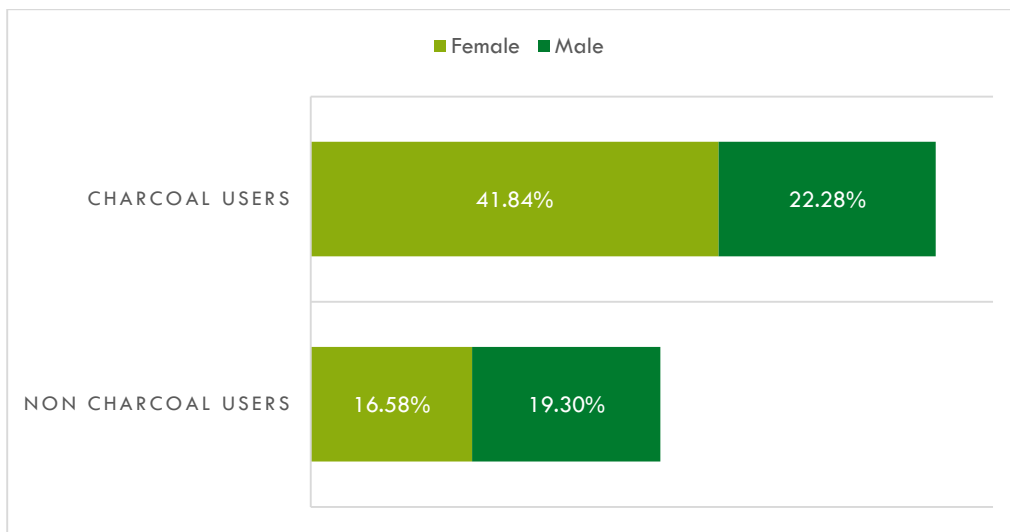


5.3.6 Energy Efficiency Practices

The Energy Commission of Ghana since the year 2015 has advocated for energy efficiency through the prudent use of appliances as presented in Figure 5.8. Among bulbs for lighting, LED is recommended as the most energy efficient compared to Compact Fluorescent Light (CFL) or LED fluorescent tube. Currently in STMA, 83% of households use LED lamps compared to CFL⁴ (7%) and LED fluorescent tubes (10%). LED is significantly more energy efficient.

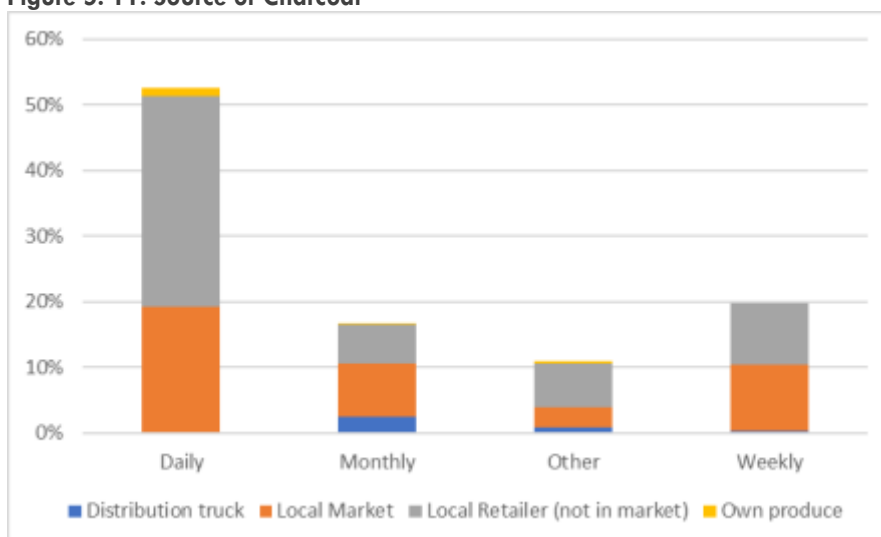
Air condition (AC) use in the metropolis is low (4%) due to its cost and energy demands. Though the energy rating was not ascertained, half of the residents with AC had an energy efficiency label and the majority (80%) of AC owners bought them new. The Energy Efficiency Labels ensure that only appliances that meet minimum energy efficiency standards enter the Ghanaian market implying that ACs with energy efficiency labels meet the minimum energy efficiency performance requirement. The absence of energy efficiency

⁴ CFLs were introduced nationally in the country between 2007-2008 with the aim of addressing the power load shedding the country was then going through during the period which was attributed to inadequate undertake fuel for the power generation. During the exercise the country was able to save over 160 MW of power (Energy Commission, 2008 National Energy Outlook).



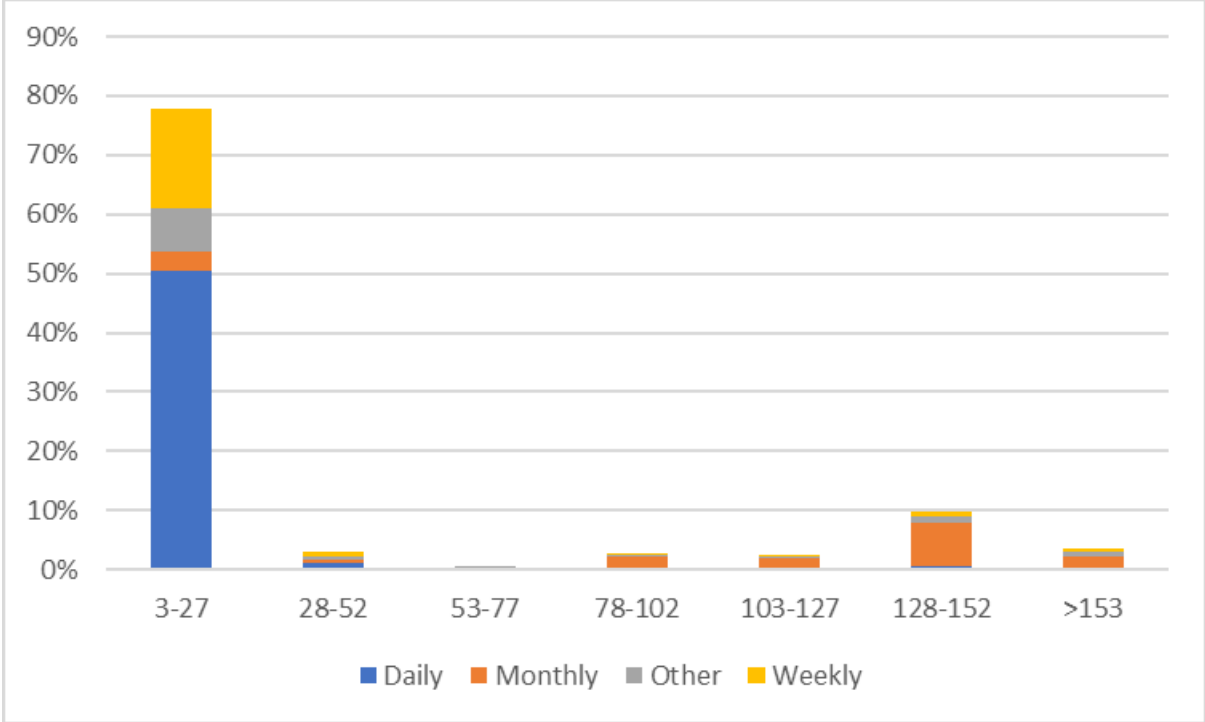
A high number of residents (54.05%) purchased their charcoal from the local retailers often situated in their communities who sell in smaller amounts and quantities (Figure 5.10). This was followed by 40.28% of charcoal users who purchased from the local market. The majority of residents (53%) buy charcoal daily especially those who buy from local retailers (32%) and markets (19%). This, given the lower incomes, signifies that most charcoal users lack the financial capacity to buy in bulk and make economic rationalisations by disposing of income to purchase charcoal only as and when the need arises even if it means paying more in the long run. This approach cannot be used for other energy sources such as LPG which requires an upfront payment to refill a cylinder. The reliance on daily purchases exposes households to risks associated with supply disruptions and price fluctuations which could impact their energy security and stability

Figure 5. 11: Source of Charcoal



Payment for charcoal is female dominated as it is mostly used by them and relatively low cost which makes it affordable. About 59% of female spouses or female household heads made payment for charcoal used in the household. Male counterparts making payment for charcoal accounted for 30%. The high share of females reflects the perceived primary and traditional role of adult females in managing household cooking energy needs and procurements. The average amount spent on charcoal daily was GHC13. However, the majority of charcoal users (78%) purchased between GHC3-27 per day as seen in Figure 5.11.

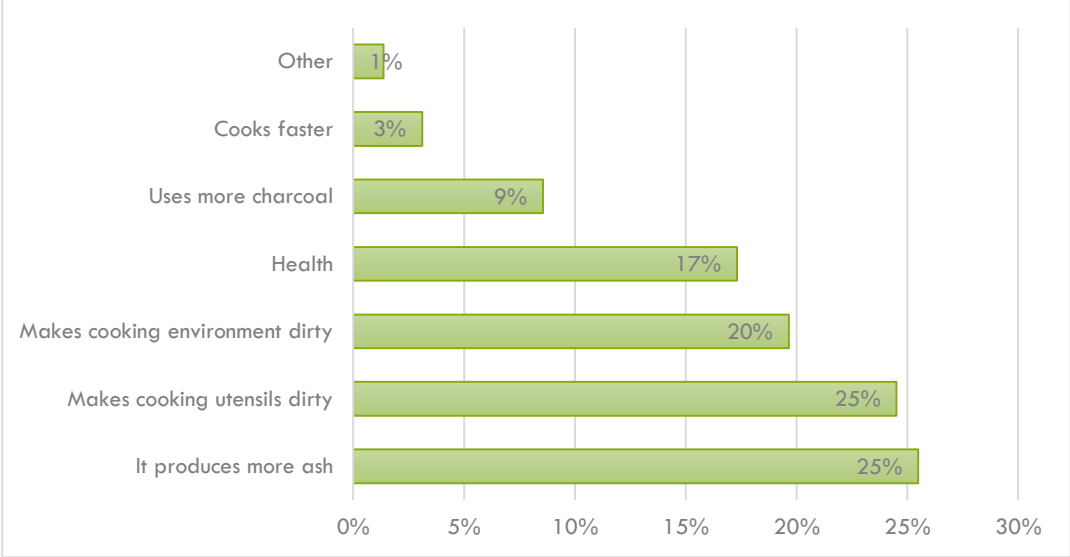
Figure 5. 12: Amount of Charcoal by period



In terms of the cooking stoves used for cooking, the majority of charcoal users (82.68%) used the traditional stove known as a coal pot, 10.52% used a form of an improved cook stove and 1.65% used both. The high reliance on traditional stoves (coal pots), underscores a significant challenge in the adoption of improved cooking technologies. This reliance is due to factors such as cost, availability, and cultural preferences.

In addition, while 42% indicated being knowledgeable about the effects of a traditional cook stove, the majority of users indicated they did not know any effects. Some negative effects reported by those knowledgeable were ash production (25%), dirtying cooking utensils (25%), dirtying the environment (20%), health effects (17%) and high consumption of coal (9%). The only positive effect cited was its ability to cook faster as reported by 9% of users as seen in Figure 5.12. The substantial portion of users unaware of the negative effects of traditional stoves highlights a critical gap in education and awareness. This gap prevents the adoption of safer and more efficient cooking methods which is compounded by the relatively high cost of improved stoves.

Figure 5. 13: Effects of using a Charcoal Cookstove



Switching to a clean cooking stove is necessary to enhance the living conditions of residents. However, there appears a high reluctance to change as 60.12% of charcoal users are not willing to switch to using only clean cooking stoves. Nonetheless, 39.88% of respondents are willing to make the change. Among those willing to switch, several clean cooking alternatives were preferred, with specific reasons provided for each choice.

For improved cook stoves, respondents highlighted several benefits. Many noted that these stoves are cleaner with less smoke, which significantly reduces smoke inhalation and associated health risks. Improved cook stoves are also perceived as safer and help in reducing household air pollution, contributing to a healthier living environment.

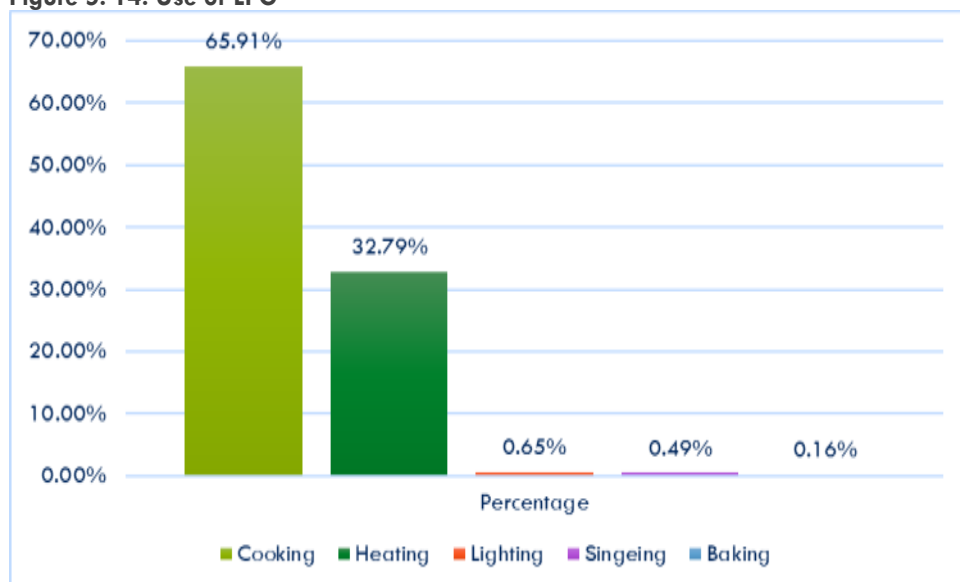
For LPG (Liquefied Petroleum Gas) stoves, respondents cited multiple advantages. LPG stoves prevent health diseases linked to smoke exposure and are considered clean to use. The efficiency of LPG stoves in cooking food faster was another important factor. Additionally, respondents found LPG to be readily available and affordable, making it a practical choice for many households.

A significant portion of respondents who are unwilling to switch provided various reasons for their reluctance. Many expressed concerns over the high cost associated with clean cooking stoves and fuels like LPG. The simplicity and familiarity of traditional charcoal stoves were also cited as reasons for their continued use. Some respondents mentioned that they have grown accustomed to using the traditional coal pot and are not interested in changing it. Additionally, there were fears regarding the safety of LPG, with some respondents scared of potential explosions.

5.4.2 Liquefied Petroleum Gas (LPG)

LPG is widely recognised for its eco-friendly properties, releasing significantly less carbon dioxide compared to traditional fuels like charcoal and kerosene. In Sekondi-Takoradi, 53.57% of residents use LPG against 46.43% who do not. Primary uses of LPG as seen in Figure 5.13 are predominantly for Cooking (65.91%), Heating (32.79%), and others (1.31%). It was common practice for LPG users to simultaneously switch to other fuels especially charcoal. For instance, 59.08% of LPG users for cooking also used charcoal and firewood for cooking (4.88%). The significant reliance on multiple fuel sources is due to not only economic factors but also convenience. For example, some women pointed out difficulties in using LPG Gas stoves for the preparation of some local meals that involved vigorous stirring like Banku and those that involved grilling. Consequently, they preferred to use charcoal stove to make it more convenient in preparing such meals.

Figure 5. 14: Use of LPG



A high majority of LPG users (99.27%) purchased fuel from established LPG fuelling stations while 0.73% relied on distribution trucks (Figure 5.14). To refill the gas cylinder at the station, 91.5% of users indicated the means of transportation was by a vehicle, 6.07% indicated they walked, 2.18% used a motorbike and 0.24% used a bicycle. Vehicle as a mode of transport to purchase gas was due to the weight of the cylinders and the distance to the fuelling stations. The predominant use of vehicles for transportation contributes to carbon emissions which should call for eco-friendly effective interventions.

Payment for LPG is male-dominated as 61% of payment was by the male household head as against 31% of female household heads. The burden of payment shifting to male household heads is attributable to the relatively high cost. The study indicates that 84% of LPG users purchased every month as against other fuels like charcoal where majority of purchases was on a daily basis. This demonstrates the cost savings as well as the convenience in use of LPG.

The usage patterns of LPG and charcoal appear to vary significantly across educational levels. For instance, as seen in Figure 5.15 the group with JHS/Middle School education shows a pronounced use of charcoal compared to LPG, while those with tertiary education have comparatively lower counts for charcoal and more for LPG. Figure 5.15 points to an association between education level and fuel choice, with less educated groups leaning more towards traditional fuel sources like charcoal, and more educated groups transitioning towards fuels like LPG. The explanatory factor could be due to relatively higher incomes associated with higher levels of education which makes LPG more affordable to the high-income groups.

Figure 5. 15: Basis of Purchase

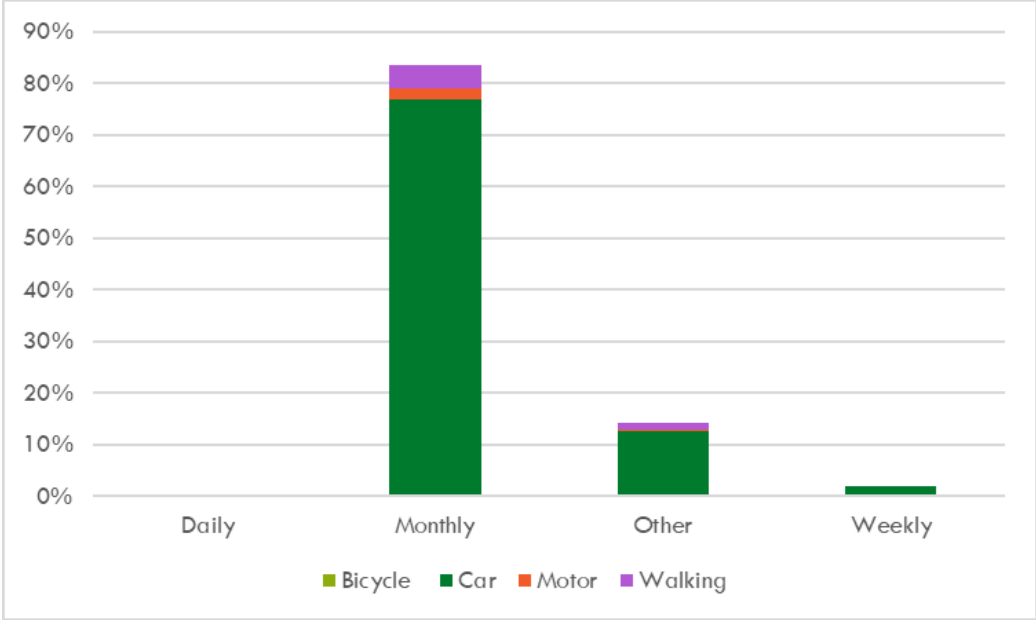
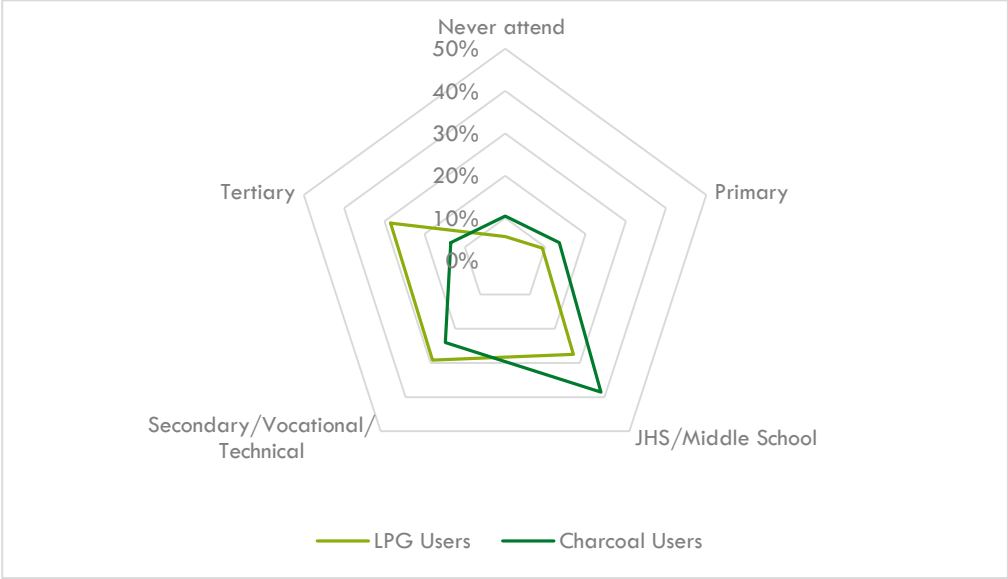


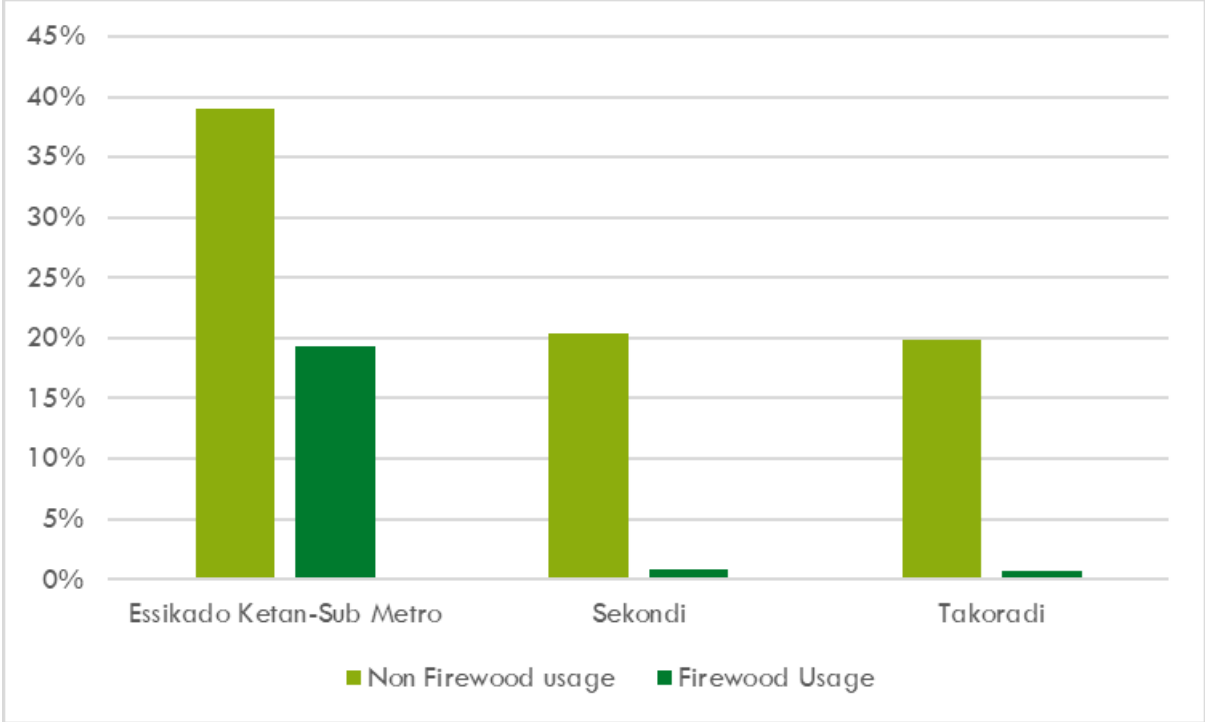
Figure 5. 16: Use of LPG and Charcoal by education level



5.4.3 Firewood

In the metropolis, 20.84% of residents reported using firewood, with the majority concentrated in the Essikado Ketan sub-metro, where a significant portion (19.68%) were unemployed. Among firewood users, 73.25% obtained it for free, while 26.75% purchased it. Firewood was particularly essential for fish smoking, an activity commonly practised in the Essikado Ketan area.

Figure 5. 17: Firewood Usage by Sub-Metro

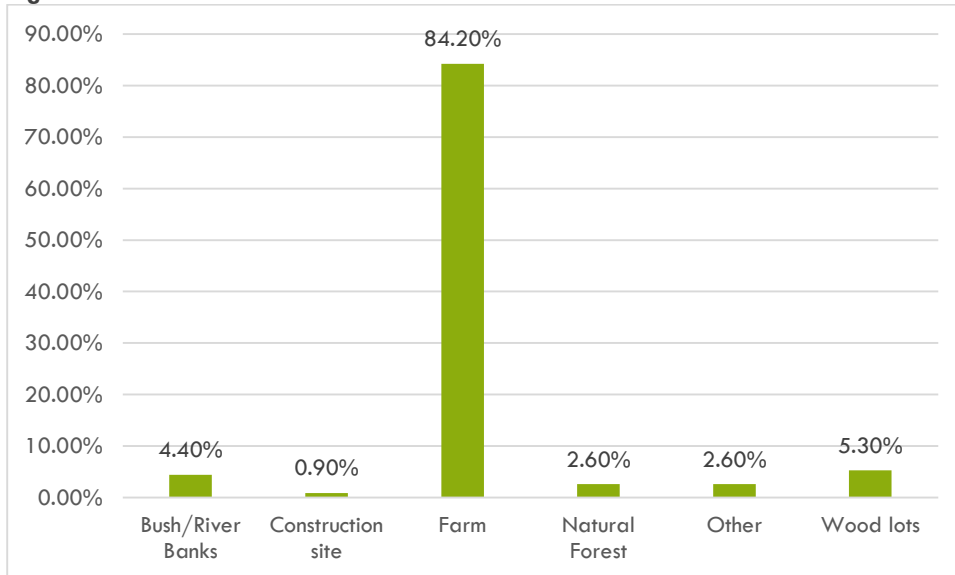


For firewood users, 62% are females and 38% males. This disparity may be due to gender norms where again women, are traditionally responsible for cooking as well as the availability of firewood as a readily accessible resource. Firewood demand was about 2.09kt in 2023 as reported by the Energy Commission (2022). For firewood users who purchased it, majority (76.2%) bought it from a local retailer, 14.3 percent from the market and other sources accounted for 9.5% as seen in Figure 5.17. Additionally, for firewood users who purchased it, majority (43.9%) did so weekly, about 16.7% daily, and 28.8% monthly. For households that got their firewood for free, about 79.8 percent got it weekly, 12.3 percent daily, and 2.6 percent monthly. Moreover, for firewood users who had firewood for free, majority sourced firewood from the farm (84.2%), compared to riverbanks (4.4%), woodlots (5.3%), natural sources (2.6%), and other sources (2.6%).

The higher reliance of women on firewood highlights the gendered nature of energy poverty. This reliance exposes women to health risks from indoor air pollution and places a significant burden on them in terms of time and labor. Addressing this issue through targeted interventions, such as promoting cleaner cooking technologies and providing easier access to alternative energy sources, would be particularly beneficial for women.

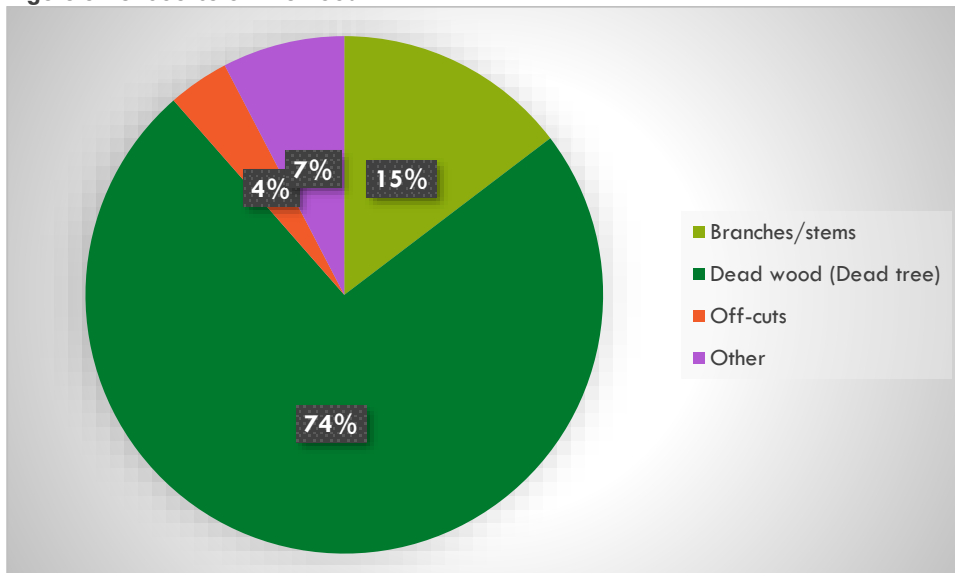
The sourcing of free firewood primarily from farms need to be looked at to ensure that potential conflict between energy needs and agricultural land use, which could have long-term implications for food security is averted. Furthermore, the continued reliance on firewood, whether purchased or collected, contributes to deforestation and air pollution, both of which have significant health and environmental consequences. Reducing the demand for firewood through the promotion of cleaner energy alternatives, such as LPG, solar cookers, or improved cookstoves, is crucial.

Figure 5.17 Free firewood sources



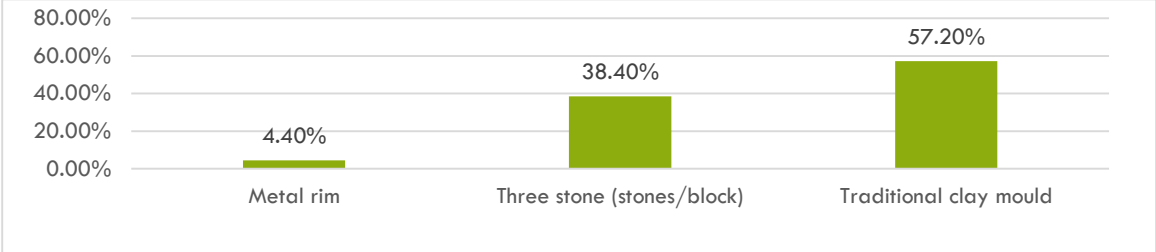
The survey data also show that, the main type of firewood used is dead wood or dead tree (73.89%), tree branches and stems account for 14.65 percent of firewood, 3.82 percent from off-cuts and 7.64 percent from other types.

Figure 5.18: Source of Firewood



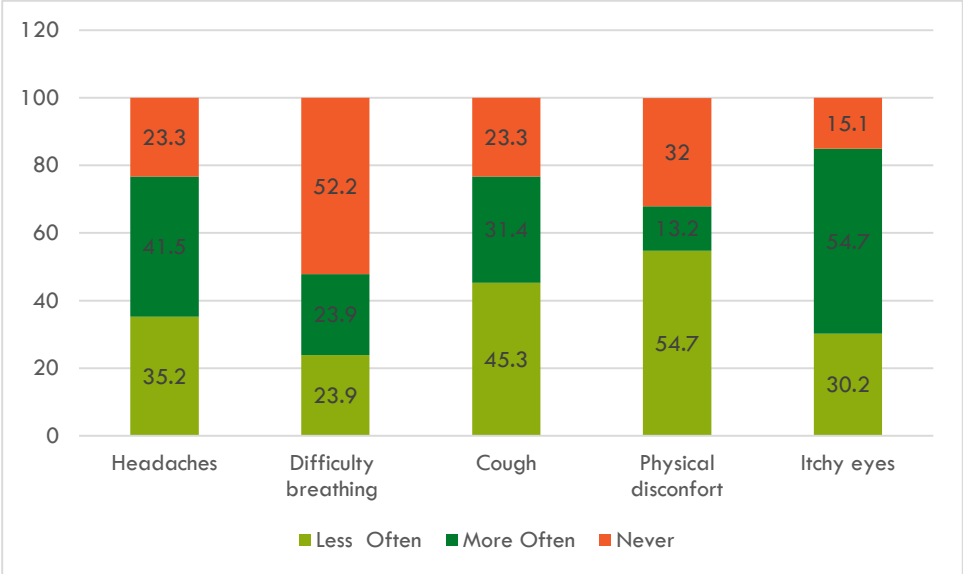
Currently, majority of firewood users (57.2%) utilise traditional clay mould stove, (38.3%) use the three stone stove and (4.4%) utilise the metal rim as seen in Figure 5.19.

Figure 5.19: Type of firewood cookstove



More than half (54.7%) of firewood users were aware of the effects of using a firewood cooking stove which include headaches, difficulty in breathing, cough, physical discomfort and itchy eyes (Figure 5.20). For effects that occurred more often, majority of firewood users experienced Itchy eyes (54.7%), 41.5 percent experienced headaches, 31.4 percent experienced cough, 23.9% had difficulty in breathing and 13.2 percent experienced physical discomfort. This finding underscores the need for targeted efforts to mitigate these negative effects.

Figure 5.20: Effects of firewood usage.



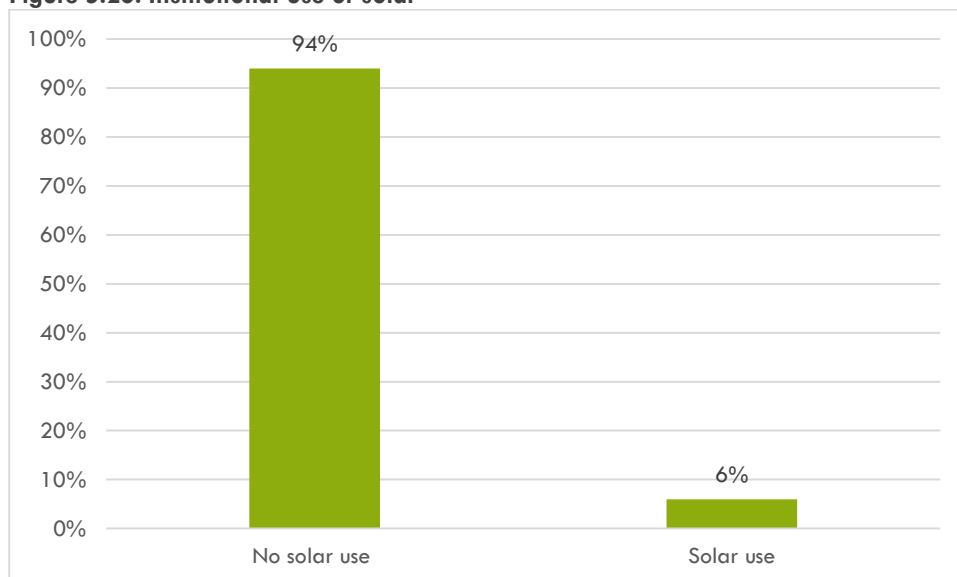
In general, wood fuel remains a popular choice in Ghana due to its accessibility, affordability, and cultural significance. In rural and peri-urban areas, where forest resources are abundant, wood fuel is readily available. Its affordability compared to LPG makes it a viable option for low-income households and small businesses. Additionally, many Ghanaian dishes are traditionally prepared using wood fuel, which imparts a distinctive flavour and aroma that is highly valued. These factors contribute to the enduring reliance on wood fuel in Ghana.

5.4.4 Solar energy use

The findings highlight a significant disparity in the adoption of solar energy between households and institutions, with only 0.11% of households utilising solar power compared to 6% among institutions. This gap underscores a critical opportunity to expand the use of renewable energy sources like solar, particularly at the household level. Households using solar are mostly high-income earners with a monthly income who had some knowledge about climate change.

Despite the global climate crisis and the recognized potential of solar energy to reduce greenhouse gas (GHG) emissions, its adoption in Sekondi-Takoradi remains minimal. This low uptake suggests barriers such as the initial cost of installation, lack of awareness, or limited access to solar technology. Addressing these barriers through targeted policy interventions, financial incentives, and awareness campaigns could significantly increase solar adoption, thereby contributing to the GHG reduction goals of the metropolis.

Figure 5.20: Institutional use of solar



6. Action Plans

6.1 Introduction

The approach to the Action Planning in the Sustainable Energy Access and Climate Action Plan (SEACAP) was designed to provide a comprehensive, systematic, and participatory framework. This section outlines the action plans that align with the overall objectives of reducing greenhouse gas emissions, enhancing energy efficiency, and improving climate adaptability in STMA. The action plans developed include specific visions, targets, and corresponding actions that are critical for achieving the SEACAP objectives.

6.2 Approach to the Action Planning

The approach integrated data-driven analysis, stakeholder engagement, and expert input to ensure that the action plans are both feasible and effective. The approach involved a structured process that began with a thorough analysis and presentation of all relevant data gathered, which gave insights into the current energy usage in public buildings and households, emission levels in target areas as well as climate vulnerabilities and risks such as flooding, coastal erosion and health impacts from climate change in STMA. The analysis and validation of data formed the foundation for setting realistic visions and quantifiable targets. Also, this helped to develop corresponding actions grounded in evidence and tailored to the specific context of the target areas such as waste, transportation etc.

This was followed by an intense engagement through a workshop with various stakeholders such as local communities, government agencies, industry representatives, non-governmental organisations and STMA staff.

a. Development of Visions, Target and Actions

Vision

Visions were developed for the three pillars; mitigation, adaptation and sustainable energy access within the SEACAP framework. The visioning process was done through a collaborative group discussion exercise with diverse stakeholders to capture diverse perspectives and insights on climate change impacts and potential solutions. This focused on key areas of concern and opportunities for reducing GHG emissions and enhancing energy efficiency. The vision for adaptation pillar was directly informed by the climate change risk assessment, which identified key vulnerabilities such as rising temperatures, and unpredictable rainfall with a vision set to address these vulnerabilities while promoting resilience and sustainability. Drawing on international climate frameworks such as the Paris Agreement, SDGs, Ghana's Nationally Determined Contributions, UNFCCC guidelines and other local sustainability initiatives (and such as STMA's intended vision for SEACAP), the visioning processes ensured the alignment with the broader global commitments to formulate forward-looking visions to guide climate action in STMA. This aimed to strengthen the relevance of the action plans in the global context and to enhance their potential for attracting international support and funding.

Targets

Targets were developed for all identified sectors within each of the three pillars. Similar to the visioning process, target setting was also developed through collaborative group discussions, with a deliberate focus on aligning with several key strategic frameworks. The analysis and validation of the data results on historic emission levels and projections for future trends, current energy uses, and climate risks and existing infrastructure helped in setting specific, measurable and realistic targets.

Actions

The actions outlined in the plan consist of specific activities designed to achieve the established targets. These actions were developed using a phased implementation strategy, organised into time phases-2025, 2030, 2040 and 2050-which correspond to short, medium and long terms. This approach facilitates manageable and measurable progress, with each phase containing actions that align with the identified visions and targets. Activities were carefully prioritised based on a predefined criterion to ensure their relevance and effectiveness as follows:

- Alignment of mitigation measures with national or sectoral policies
- Alignment of mitigation measures to local priority
- Financial feasibility
- Technology availability
- Implementation feasibility
- Human resources capacity requirement
- Synergies with other pillars

From the comprehensive list of potential activities, the top three to six actions across the three pillars were selected for incorporation into the action plan. The prioritisation was guided by a deep understanding of the local context, ensuring that the selected actions are not only effective but also implementable within the existing resource constraints and capacities.

6.3 Action Plans

6.3.1 Mitigation Pillar

The climate change mitigation for the STMA SEACAP considered three key sectors, these are the Transportation, Stationary Energy and the Waste sectors. The climate change mitigation vision for STMA is as follows;

“By 2050, Sekondi-Takoradi Metropolis aims to be a resilient, competitive and smart city by prioritising renewable energy, efficient resource use, sustainable waste management, and low carbon transport while ensuring a healthy, equitable and thriving environment that makes progress towards achieving net-zero carbon.”

The objectives to achieve this vision are as follows:

- Sustainable Transport Systems: Develop and promote low-carbon and efficient transport systems, including sustainable public transportation options in the STMA
- Reduce waste generation, promote recycling, and implement circular economy principles to minimize GHG emissions from waste.
- Increase the share of renewable energy in the STMA's energy mix, particularly solar, wind, and biomass.
- Enhance the capacity of the city to capture carbon emissions using Nature-Based Solutions

Targets for the three sectors are as follows:

Transportation:

“By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to unconditionally reduce greenhouse gas emissions by at least 25% compared to its projected 2050 BAU emissions of 202,400 metric tonnes(mt) levels while achieving an efficient transportation sector. STMA is able to achieve an additional 15% emissions reduction of its BAU emission by 2050 if adequate and affordable international support is made available.

This target could be achieved through a combination of strategies such as promoting the use of electric vehicles, improving public transportation systems, implementing sustainable urban planning practices, encouraging active transportation modes like walking and cycling, and investing in infrastructure for greener transport options.

Stationary Energy:

“By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to reduce emissions from buildings and facilities by 25% compared to 2050 BAU level of 454,310 mt CO₂e.”

This target could be accomplished through various strategies such as improving energy efficiency in buildings, increasing the use of renewable energy sources like solar or wind power, implementing green building standards and practices, promoting sustainable waste management, and encouraging the adoption of energy-saving technologies.

Waste:

"By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to reduce emissions from the waste sector by 20% of the 2050 BAU emissions of 227,420.76tCO₂e, by effective waste management towards recycling, composting, and energy recovery processes."

To achieve this target, the assembly could implement several strategies such as enhancing waste segregation and recycling programs, promoting composting of organic waste, investing in waste-to-energy technologies, encouraging sustainable consumption habits, and implementing strict waste management regulations.

Actions have been proposed to achieve these set objectives and targets. Implementing these objectives, targets, and actions can significantly contribute to mitigating the impacts of climate change in Sekondi-Takoradi and set the metropolis on a path to sustainable and resilient development.

6.3.1.1 Mitigation Action Plan

Table 6. 2. Section 1: Transportation

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
<p>Target:</p> <p><i>"By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to unconditionally reduce greenhouse gas emissions by at least 25% compared to its projected 2050BAU emissions of 202,400 metric tonnes(mt) while achieving an efficient transportation sector. STMA can achieve an additional 15% emissions of its BAU emission by 2050 if adequate and affordable international support is made available.</i></p> <p>This target could be achieved through a combination of strategies such as promoting the use of electric vehicles, improving public transportation systems, implementing sustainable urban planning practices, encouraging active transportation modes like walking and cycling, and investing in infrastructure for greener transport options.</p>											
Sustainable Transport Systems: Develop and promote low-carbon and efficient transport systems, including public transportation and non-motorized transport options in the STMA	1.1 Conduct public awareness campaigns on the benefits of using public and active transportation and mobility modes	x	x	x	x	STMA, Donor Funds	STMA, Information Services Department (ISD)NCCE, Media, Management Information System (MIS), Social Media Influencers, NRSA, Private Sector (ex. Bamboo bikes, etc.)	STMA, NRSA	Social Development	High	Number of awareness campaigns Percentage of population using public transport

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	1.2 Initiate School cycling club initiatives	x	x			STMA, MOE	STMA, GES	GES	Environment, Infrastructure and Human Settlement	High	Number of schools with cycling clubs
	1.3. Launch a Bike to work/school campaign	x	x			STMA, MOE	STMA, GES, TUC, AGI	GES	Environment, Infrastructure and Human Settlement	High	Number of students and workers using riding bicycles to school or work
	1.4 Organise an annual STMA cycling week	x	x	x	x	STMA	STMA, Public and private sector institutions, NGOs, CSOs	STMA	Environment, Infrastructure and Human Settlement	Medium	Reports on the annual celebration
	1.5 Improve the road network and create bicycling lanes and green walkways that are gender responsive and socially inclusive.		x	x	x	STMA, Donor Funds (SECO) Potential other donors: UTM,	STMA/DUR, NRSA, NCCE	STMA, NRSA, MRH	Environment, Infrastructure and Human Settlement	High	Kilometres of roads with bicycle lanes and green walkways
	1.6 Promote communal biking in Tertiary Institutions by introducing	x	x	x	x	STMA, GES, Private sector	STMA, MOE, GES Tertiary Institutions	STMA, MOE	Environment, Infrastructure and Human Settlement	Medium	Number of tertiary institutions with communal facility



Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	bike hiring initiatives										
	1.7 Provide bike parking at public facilities such as markets, schools, banks, lorry parks etc	x	x	x	x	STMA,	STMA, Transport operators	STMA	Environment, Infrastructure and Human Settlement	High	Number of public facilities with bike parking facilities
	1.8 Undertake feasibility study and implement the STMA Bus Rapid Transit (BRT) Program with dedicated bus lanes. With the goal of transitioning to nan electric BRT system by 2050.		x	x	x	STMA, SECO Potential other donors: AFDB, EU (under global gateway), Global Fund for Cities, UTM?	STMA/DUR, Transport Unions (ex. GPRTU)	STMA, NRSA, MRH	Environment, Infrastructure and Human Settlement	High	Kilometers of roads with dedicated bus lanes. Number of high occupancy buses in STMA
	1.9 Introduce a programme to improve existing public transport such as minivan fleets (Trotros) and Taxis to	x	x			STMA, Private Transport Organisations \ Financial Institutions	STMA, Private Transport Organisations	STMA, Ministry of Transport	Environment, Infrastructure and Human Settlement	High	Programme implementation report

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	be efficient and attractive										
	1.10 Public awareness campaign on the benefits of using low emission transport		X	X	X	STMA, Ministry of Transport, Transport Unions	STMA, Ministry of Transport, Transport Unions	Ministry of Transport, Transport Unions	Social Development	High	Number of awareness campaigns organized
	1.11 Undertake and implement feasibility study on Electric Vehicle uptake and charging parks in STMA	x	x			STMA, DVLA, MoT	STMA, DVLA, MoT	STMA, MoT	Environment, Infrastructure and Human Settlement	High	Feasibility report
Promote the use of vehicles and transport systems that use cleaner energies like electricity, hydrogen fuel and biodiesel	1.12 Pilot at least 10 EV charging Parks at vantage points within STMA.	x	x			STMA, Private Sector	STMA/MoT, Energy Commission,	STMA, MoT, MESTI, Energy Commission	Environment, Infrastructure and Human Settlement	High	Number of charging point in STMA by 2030 (5), Number of charging point by 2050 (10)
	1.13 Facilitate the establishment	x	x			STMA, Donor Partners	Private Sector, STMA, Energy Commission	MoT, MRH, GSA, EPA, MESTI	Environment, Infrastructure	High	Number of electronic bicycle pools

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	of 5 electronic bicycle pools and electric motorbike charging stations at vantage points in partnership with the private sector								and Human Settlement		and electric motorbike charging stations in STMA
	1.14 Transition 50 % of STMA fleet to electric Vehicles.		x	x	x	STMA, Donor Partners, MoT	STMA, MoT	MDAs	Environment, Infrastructure and Human Settlement	High	Number of STMA fleet being electric vehicles. Currently STMA owns 42 vehicles and should transition 5% of these by 2030.
	1.15 Advocate for commuter rail services for Kojokrom to Sekondi route and Sekondi to Takoradi route to be reactivated	x	x	x	x	STMA, Donor Partners, Private Sector	STMA, EPA, GNFS	STMA, MoT	Social Development	High	Number of railway trips per day



Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	1.16 Advocate for intercity rail cargo transport	x	x			STMA	STMA, MoT, MRH, Ghana Railway Company	Ghana Railway Development Authority, MoT, MRH	Social Development	High	Number of trips of rail cargo transport in STMA
	1.17 Planting and creating greeneries at 10% of lorry parks and along 30% of roads to serve as carbon sink	x	x	x		STMA, Bloomberg Philanthropies (SYCA), EU-TCSPP, EPA Green Climate Fund Donor Partners	STMA, MoT, MRH, Forestry Commission	MoT, MRH, Forestry Commission	Environment, Infrastructure and Human Settlement	High	Number of lorry parks and road corridors with trees planted to serve as greeneries and carbon sink
	1.18 Facilitate the establishment of an assembly plant for e-bikes and electric motor bikes within STMA in partnership with the private sector		X	X		STMA, Private Sector, Donors, GoG	STMA, Private Sector, EPA	STMA, MoT, MESTI	Environment, Infrastructure and Human Settlement	High	Number of assembly plant for e-bikes and electric moto bikes within STMA
	1.19 Undertake and implement feasibility studies and	X	X	X	X	STMA, MMDAs, MoT, Donors and Private Sector	STMA, MMDAs, Private Sector, Coastal Development Authority.	STMA, CODA, MoT, GPHA, MESTI, Ghana Navy	Environment, Infrastructure and Human Settlement	Medium	Feasibility study report, and meeting minutes of discussion with

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead/Collaborators on Policy	AAP	Priority	Indicators
		2025	2026-2030	2040	2050						
	marketing for the development of a Sea Transportation terminal in Takoradi and establishment of sea bus network										other MMDA's that should be involved in the project (Accra, Tema, Cape Coast, and Aflao)

Table 6. 2 Section 2: Waste (Solid and Liquid Waste)

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators	Policy	AAP	Priority	Indicators
		2025	2030	2040	2050						
	<p>Target: <i>"By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to reduce emissions from waste sector by 20% of the 2050 BAU emissions by effective waste management towards recycling, composting, and energy recovery processes and by collecting 80% of municipal solid waste, and divert 85% of all waste collected towards recycling, composting, or energy recovery processes.</i></p> <p>To achieve this target, the assembly could implement several strategies such as enhancing waste segregation and recycling programs, promoting composting of organic waste, investing in waste-to-energy technologies, encouraging sustainable consumption habits, and implementing strict waste management regulations.</p>										

Reduce waste generation, promote recycling, and implement circular economy principles to minimize GHG emissions from waste.	2.1 Strict enforcement of existing bye-laws and regulations on waste treatment	x	x	x	x	STMA	EPA, GSA, etc.	STMA, EPA	Environment, Infrastructure and Human Settlement	High	Number of companies and households being compliant
	2.2 Formalise the Borla borla operations by forming an association/cooperative for informal waste collection service providers	X	X			STMA, GoG, Donors, Private sector	STMA, GEA,	STMA, EPA	Environment, Infrastructure and Human Settlement		Meeting minutes from engagement with Borla Borla in 2025. Number of borla-borla associations formed. Enactment of a bye-law to regulate borla-borla operations
	2.3 Engage informal waste collectors on their formalisation and inclusion to the waste management sector	x				STMA, Private Sector, Borlaborla	STMA	STMA, Ministry of Sanitation,	Environment, Infrastructure and Human Settlement	High	Report on the engagement
	2.4 Implement a digital tracking system to track waste pick-up and disposal at the household level	x	x	x	x	Private Sector (ex. Boorlabird) and STMA,	STMA and Private Sector, GIZ (CitizensEye App)	STMA, Ministry of Sanitation,	Environment, Infrastructure and Human Settlement	High	Number of Waste trucks and borla-borla with tracking systems
Progressively eliminate single-use plastics from STMA	2.5 Provide education and incentives to businesses to use less plastic in their operations	x	x	x	x	STMA, Private Sector	STMA, Ghana Enterprises Authority (GEA)	STMA, Ministry of Trade, MESTI, EPA, NPAP, GIZ GoCircular Program,	Environment, Infrastructure and Human Settlement	High	Number of businesses benefiting from the incentives

	2.6 Carry out public awareness campaign on reusable carrier bags and replace 70% of plastic bags with paper/bio-degradable bags	x	x	x	x	STMA, NPAP, GIZ, Global Affairs Canada, Council of Churches, BP SYCA	STMA, ISD, NCCE, Media, ST Chamber of Commerce, Council of Churches	Ministry of Sanitation, AGI, Ministry of Trade, Ghana investment promotion Authority	Environment, Infrastructure and Human Settlement	High	Number of public campaigns
	2.7 Research and develop Incubator/Accelerator for plastic alternatives and innovative waste management solutions	x	x	x	x	STMA, Private Sector, Tertiary Institutions, BP SYCA	STMA, UMAT, TTU, KNUST, UCC, CSIR, EPA	MESTI, EPA, MoTI, MoF	Environment, Infrastructure and Human Settlement	High	Alternatives to plastics developed
	2.8 Engage with businesses on their wastewater recovery practices (ex. hotels treating wastewater for on-site use)		x	x	x	MDA, STMA	STMA, GTA, EPA	EPA, GTA, MoTI	Environment, Infrastructure and Human Settlement	High	Number of engagements Number of businesses treating waste water on-site
	2.9 Encourage the installation of biodigesters in 10% of health, hospitality and educational institutions	x	x	x	x	MDA, STMA	STMA, GTA, EPA	EPA, GTA, MoTI	Environment, Infrastructure and Human Settlement	High	Number of health facilities, educational and hospitality industries with biodigesters
Increase access to waste management services for all communities of STMA	2.10 Conduct and implement a feasibility study on the implementation of a door-to-door waste collection in low-income communities.	x	x			STMA, Donor	STMA, OGP	STMA	Environment, Infrastructure and Human Settlement	High	Feasibility report

	2.11 Procure and distribute additional waste bins for households.	x	x	x	x	STMA, Donor	STMA, OGP	STMA	Environment, Infrastructure and Human Settlement	High	Number of households with additional waste bins
	2.12 Capacity building for STMA staff on emissions reduction from waste through effective waste management practices.	x	x			STMA, Donor	STMA, OGP	STMA	Environment, Infrastructure and Human Settlement	High	Number of STMA staff with capacity on emission reduction from waste
Improve the operations of waste management facilities and policies within STMA	2.13 Redevelop and enhance the capacity of the landfill site by improving access, increasing the number of cells and upgrade the infrastructure for methane capture.	x	x	x	x	STMA, Private Sector, Donor funds (World Bank), GoG	STMA, Development Partners, Private Sector		Environment, Infrastructure and Human Settlement	High	Quality of access roads. Number of additional cells Volume of methane capture
	2.14 Revise and enforce Metro By-laws on sanitation	X				STMA	STMA, Ghana Police Service Judicial Service	STMA, MLGRD, MoH, MoSWR	Environment, Infrastructure and Human Settlement	High	Revised Sanitation bye-laws and active enforcement and collection of fines
	2.15 Revise Metro Environmental and Sanitation Action Plan (MESAP) and include emerging issues on Climate change	x				STMA	STMA,	STMA, MLGRD, MoH, MoSWR	Environment, Infrastructure and Human Settlement	High	Revised MESAP
	2.16 Develop and implement a metro-wide wastewater treatment plan for investment, which includes plans to upgrade the existing wastewater treatment plant	x	x			STMA, AfDB, Donors	STMA, Ghana Water Company	Ministry of Works and Housing, Sanitation and Environment, Health	Environment, Infrastructure and Human Settlement	High	The existence of a metro waste water treatment plan

Have a fully segregated waste system from household and streets to final disposal site (including recyclables, organics, and inorganic waste materials)	2.17 Feasibility study on the potential for the construction of a compost facility/biogas plant	x				STMA, Donors (C40 Cities Finance Facility), COPIP, Private Sector, NGOs	STMA, EPA, GAMA Private Sector, CSOs, NGOs	STMA, EPA, Ministry of Sanitation and Water Resources	Environment, Infrastructure and Human Settlement	High	Feasibility report
	2.18 Establish a compost facility/biogas plant and divert 100% of organic waste from landfill.		x	x	x	STMA, Donors (C40 Cities Finance Facility), COPIP, Private Sector, NGOs	STMA, EPA, GAMA Private Sector, CSOs, NGOs	STMA, EPA, Ministry of Sanitation and Water Resources	Environment, Infrastructure and Human Settlement	High	Number of compost facility/biogas plant established
	2.19 Public awareness campaign on waste separation at source.	x	x	x	x	STMA, Private Sector, CSOs, Religious bodies	STMA, local media	STMA, MoSWR	Social Development	High	Number of awareness campaigns
	2.20 Create an enabling environment and market for recyclable waste	x	x			STMA, Private Sector, TCSP	STMA, GSA, GEA, GoCircular	STMA, MoSWR, GEA, MoTI	Environment, Infrastructure and Human Settlement	High	Number of businesses engaged in recyclables
	2.21 Establish a plastic recycling facility within STMA	x	x	x	x	STMA, Private Sector, TCSP	STMA, GSA, GEA, GoCircular	STMA, MoSWR, GEA, MoTI	Environment, Infrastructure and Human Settlement	High	The existence of a plastic recycling facility
	2.22 Ensure that STMA's Skills Training Centre plastic recycling facility has capacity to accept 600-1000kg of plastic waste per day	x	x	x	x	STMA, Private Sector, TCSP	STMA, GSA, GEA, GoCircular	STMA, MoSWR, GEA, MoTI	Environment, Infrastructure and Human Settlement	High	Quantity of plastic waste received at the STMA Skills Training Centre

	2.23 Observance of a sanitation day by STMA through quarterly community clean-up exercises	X	X			STMA, Private Sector (ZoomLion), Donors, Council of Churches, CSOs/NGOs,	STMA, Private Sector, NGOs and CSOs	MoSWR	Environment, Infrastructure and Human Settlement	High	Number of clean up per quarter
	2.23.1 Initiate Award system for the cleanest communities within STMA.	x				STMA, Private Sector (ZoomLion), Donors, Council of Churches, CSOs/NGOs,	STMA, Private Sector, NGOs and CSOs	MoSWR	Environment, Infrastructure and Human Settlement	High	Number of communities who receive awards
	2.23.2: Public recognition for 'Household Waste Champions' and 'Zero-Waste Businesses' for practising sustainable waste management	x	x	x	x	STMA, Private Sector (ZoomLion), Donors, Council of Churches, CSOs/NGOs,	STMA, Private Sector, NGOs and CSOs	MoSWR	Environment, Infrastructure and Human Settlement		Household waste champions and Zero Waste Businesses recognized

Table 6. 3 Section 3: Stationary Energy

Objective	Description of Action	Timeframe				Source of funds	Lead / Collaborators	Policy	AAP	Priority	Indicators
		2025	2030	2040	2050						
<p>Target:</p> <p>"By the year 2050, Sekondi-Takoradi Metropolitan Assembly aims to reduce emissions from buildings and facilities by 25% compared to 2050 BAU level of 454,310 mt CO2e."</p> <p>This target could be accomplished through various strategies such as improving energy efficiency in buildings, increasing the use of renewable energy</p>											

sources like solar or wind power, implementing green building standards and practices, promoting sustainable waste management, and encouraging the adoption of energy-saving technologies.											
Increase the share of renewable energy in the STMA's energy mix, particularly solar, wind, and biomass in STMA	3.1 Formulate regulations and policies to incentivise and support businesses and households to use cleaner energy sources such as solar and biogas.	x	x	x	x	STMA, GOG,	STMA, AGI, GNFS, EPA, CADB, NGOs	GSA, MESTI, MoTI, LUSPA	AAP – Environment and human settlements	High	Number of regulations and policies formulated Number of businesses and households using cleaner energy sources such as solar and biogas.
	3.2 Capacity building and awareness raising on energy efficiency and renewable energy integration into the energy mix	x	x	x	x	STMA, TTU, UMaT,	STMA, KNUST, GTU, UENR, Development partners (GIZ, KFW, AFD), NGOs, NCCE, Media, NGO's, RAB Energy Solution Limited	STMA, MESTI	AAP – Environment, Infrastructure and human settlements	High	Number of residents in STMA with capacity on energy efficiency and renewable energy. Number of capacity building workshops. Workshop reports
	3.3 Create an enabling environment and attract investment in large-scale Renewable energy projects within STMA	x	x	x	x	GoG – Ministry of Energy, Donor Agencies, Africa Climate Change Fund (ACCF)	STMA, Ministry of Energy, NGO's, AGI, Takoradi Port, GPHA	STMA, MoE	AAP – Environment, Infrastructure and human settlements	High	Number of large-scale Renewable energy projects within STMA
	3.3.1 Private sector engagement on investing in and implementation of Renewable Energy projects in STMA	x	x			GoG – Ministry of Energy, Donor Agencies, Africa	STMA, Ministry of Energy, NGO's, AGI, Takoradi Port, GPHA	STMA, MoE	AAP – Environment, Infrastructure and human settlements	High	Number of private sector investors engaged. Engagement reports.

						Climate Change Fund (ACCF)					
	3.4 Attract Investment for the development a solar panel assembly plant with private sector within STMA		x	x	x	STMA, Private Sector	STMA, AGI, STCCI	STMA, MoTI, MoE	AAP – Environment, Infrastructure and human settlements	High	Number of private sector investors showing interest in solar panel assembly plants. Feasibility study.
To reduce the impact of GHG emissions from fossil fuel	3.5 Promote the use of green building design and low-carbon materials for construction (such as natural bricks, and recycled blocks)		x	x	x	STMA, GoG, Donor Agencies, private sector	STMA, Private sector, TCSSP, GREDA, Association of Engineers	STMA, Ministry of Energy, Ministry of Works and Housing, Energy commission	AAP – Environment, Infrastructure and human settlements	High	Number of green buildings in STMA
	3.6 Provide incentives to promote green building designs and low carbon materials for buildings	x	x	x	x	STMA, GoG, Donor Agencies, private sector	STMA, Private sector, TCSSP, GREDA, Association of Engineers	STMA, Ministry of Energy, Ministry of Works and Housing, Energy commission	AAP – Environment, Infrastructure and human settlements	High	Number of green buildings in STMA
	3.7 Establish reporting system on estimated GHG emissions for STMA through	x	x	x	x	STMA, CoM SSA, EPA, Private Sector	STMA, EPA, Private sector, Donor agencies, UTM	STMA, MESTI	AAP – Monitoring and evaluation (TBC)	High	Procedures and guidelines for reporting GHG emissions in STMA

	CoM SSA for monitoring and evaluation										
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CoM SSA is co-funded by:



6.3.2 Adaptation Pillar

The Climate Change Risk Assessment (CCRA) of the Sekondi-Takoradi Metropolis revealed that the area is exposed to and increasingly vulnerable to the impacts of climate change, such as rising temperatures, unpredictable rainfall patterns, and rising sea levels. The STMA Climate Change Adaptation Action Plan is designed to build on the findings of this vulnerability assessment, aiming to enhance the STMA's capacity to manage climate-related threats now and in the future. This plan aligns with the European Union's 2019 guidelines for developing a Sustainable Energy Access and Climate Action Plan (SEACAP) in Sub-Saharan Africa and the United Nations Framework Convention on Climate Change (UNFCCC) guidance from the Least Developed Countries Expert Group (2012). It sets out objectives and targets to achieve the STMA Adaptation Vision, which states:

“By 2050 Sekondi-Takoradi Metropolis will be a climate-resilient city by integrating sustainable practices into development planning and implementation to safeguard all citizens against climate hazards while fostering equitable economic growth and social well-being”.

The specific objectives include:

1. Strengthen infrastructure to withstand the impacts of climate-related extreme events such as flooding, heatwaves, wind storms and coastal erosion.
2. Ensure the sustainable management of water resources amidst changing climate conditions.
3. Enhance health systems to improve response to climate-related health risks, such as floods, heatwaves, vector-borne diseases, and waterborne illnesses.
4. Protect and restore natural ecosystems that provide essential services and buffer against climate impacts.
5. Support agricultural practices that improve food security and build resilient to climate impacts.
6. Increase awareness and engagement of communities in climate adaptation practices and emergency preparedness.

The table below outlines adaptation actions across several sectors, including infrastructure, water management, health, forestry, agriculture, and climate education in the Sekondi-Takoradi Metropolis. The key targets include:

- ❖ Reduce the incidence of urban flooding in STMA through improved drainage systems, green infrastructure, enforcement of development controls and regular maintenance of existing infrastructure.
- ❖ Increase water retention and harvesting capacity by 40% and reduce household water service disruptions from 43% to 20% by 2050 in urban and peri-urban areas.
- ❖ Establish early warning systems for heatwaves and climate-related disease outbreaks in 100% of public health facilities by 2050.
- ❖ Restore 50% of degraded wetlands, mangroves and green spaces in urban areas by 2050.
- ❖ Train 50% of local farmers in climate-smart agricultural practices by 2030 and increase crop yield by 25% with climate-resilient crop varieties by 2040.
- ❖ Increase public knowledge and awareness about climate change from 71% to 100% by 2050

Co-benefits

The Adaptation Action Plan provides several co-benefits in terms of mitigation, energy access, SDGs, and economic growth. By implementing improved infrastructure, water management, wetland restoration and reforestation and climate-smart agricultural practices, the initiatives reduce greenhouse gas emissions and enhance climate resilience, contributing to the mitigation targets. Expanding energy-efficient infrastructure

and promoting sustainable water management improve energy access and ensure reliable water supply, supporting SDG 6 (Clean Water and Sanitation) and SDG 7 (Affordable and Clean Energy). These actions also align with economic growth goals by fostering sustainable urban development, enhancing agricultural productivity, and creating green jobs, thereby supporting SDG 8 (Decent Work and Economic Growth) and SDG 11 (Sustainable Cities and Communities).



6.3.2.1 Adaptation Action Plan

Table 6. 4 Section 4: Infrastructure

Objective(s)	Description of Action	Timeframe				Source of funds	Lead / Collaborators on implementation	Lead / Collaborators on policy L	AAP	Indicators
		2025	2030	2040	2050					
<p><i>Target:</i> Reduce the incidence of urban flooding in STMA through improved drainage systems, green infrastructure, enforcement of development controls and regular maintenance of existing infrastructure</p> <p><i>Reduce urban flooding experienced by citizens from 67% to 30% by improved drainage systems, green infrastructure and regular maintenance of existing critical infrastructure (e.g., roads, bridges, drainage systems) by 2030</i></p>										
Strengthen infrastructure to withstand climate-related impacts such as flooding, coastal erosion, and extreme weather events.	4.1 Draft and enforce a local Green Building Code, including incentives and compliance measures, to promote permeable landscaping, water-use reduction, and climate-resilient designs for new and renovated infrastructure projects	X	X	X	X	STMA	STMA, Resident Associations, Religious groups. Ghana Green building Council	STMA	AAP: Environment, Infrastructure and Human Settlement	Percentage of new and renovated buildings meeting the requirements for permeable landscaping, climate-resilient materials, and Nature-based Solutions (NbS). Percentage of construction projects inspected for compliance with

										the Green Building Policy.
	4.2 Strengthen the capacity of Technical Sub Committee and Spatial Planning Committee members to enforce compliance of the green building codes	x	X			STMA	STMA	Ghana Green Building Council, Ghana Institute of Architects	AAP: Environment, Infrastructure and Human Settlement Social Development	Percentage increase in knowledge and understanding of green building codes among technical sub-committee members, as measured by pre- and post-training assessments. Number of enforcement actions (inspections, and, compliance reports) carried out by the technical sub-committee members post-training compared to pre-training.

	4.3 Advocate for construction guidelines at national level and implement guidelines at local level for all public infrastructure within STMA, including retrofitting roads, bridges, and drainage systems, focusing on climate-resilient materials and designs.	X	X	X	X	STMA	STMA		AAP: Environment, Infrastructure and Human Settlement	Percentage of public infrastructure projects in STMA (roads, bridges, drainage systems) designed or retrofitted using climate-resilient materials and designs. Percentage of roads, bridges, and drainage systems retrofitted to meet new climate-resilient guidelines.
	4.3 Advocate for construction guidelines at national level	X	X	X	X	STMA	STMA		AAP: Environment, Infrastructure	Percentage of public infrastructure projects in

	and implement guidelines at local level for all public infrastructure within STMA, including retrofitting roads, bridges, and drainage systems, focusing on climate-resilient materials and designs.								and Human Settlement	STMA (roads, bridges, drainage systems) designed or retrofitted using climate-resilient materials and designs. Percentage of roads, bridges, and drainage systems retrofitted to meet new climate-resilient guidelines.
	4.4 Establish a maintenance schedule for critical infrastructure including quarterly cleaning of drainage systems to ensure long-term	X				STMA	STMA, Community Organised Groups, Community Leaders, HSA, GNFS	STMA	AAP: Environment, Infrastructure And Human Settlement	Percentage of critical infrastructure (e.g., drainage systems) cleaned according to the established quarterly maintenance schedule.

	resilience and reduce flooding.									Number of flooding incidents reported in areas with cleaned and maintained drainage systems.
	4.5 Create plastic collection inspection chambers within drainage system in identified areas to trap plastic waste for easy collection.	x	x	x	x	STMA, Donor,	STMA, NADMO	Ministry of Works and Housing, CSOs,	AAP: Environment, Infrastructure And Human Settlement	<p>Number of plastic collection chambers installed within drainage systems.</p> <p>Amount (tons) of plastic waste collected from inspection chambers on a quarterly basis.</p>

	4.6 Update and implement the STMA Drainage Masterplan, starting with the identified priority areas in the Sekondi Takoradi Flood Resilience Project (FCDO), which includes the expansion of existing drainage systems and construction of new ones and NbS in identified areas.	X	X	X	X	STMA, Donor (FCDO), EU Delegation	Ministry of Works and Housing/STMA, HSA	STMA, Ministry of Water Resources, Works and Housing	AAP: Environment, Infrastructure And Human Settlement	<p>Number of priority drainage projects (expansion and construction of new drainage systems) completed as per the Masterplan.</p> <p>Percentage of drainage projects incorporating NbS in identified areas.</p> <p>Percentage reduction in the number of flood-prone areas after the implementation of the updated Drainage Masterplan.</p>
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	4.7 Promote and implement Nature Based Solutions (such as mangrove restoration, afforestation and urban green spaces) to reduce flooding, heatwaves and coastal erosion in identified priority areas.	X	X	X	X	STMA, Donor, Ministry of Works & Housing	Ministry of Works & Housing, STMA	Takoradi Techniocal University, EPA, CSOs, Forestry Commission	AAP: Environment, Infrastructure And Human Settlement	Number of infrastructure projects in priority areas using Nature-Based Solutions reduction in flooding and coastal erosion in areas with nature based solutions).
	4.8 Capture LiDAR images of STMA to inform flooding and erosion control.	X				STMA, Donor	STMA/NADMO Hydrological Services Authority, GIZ	STMA, Ministry of Water Resources, Works and Housing, NADMO	AAP: Environment, Infrastructure And Human Settlement	Percentage of STMA covered by LiDAR imagery for flood and erosion mapping Number of planning decisions or infrastructure designs that use LiDAR data for flood

										and erosion control.
	4.9 Review, update and implement STMA Disaster Management Plan	X	X	X	X	NADMO/STMA	NADMO/STMA	STMA, Ministry of Water Resources, Works and Housing, NADMO		Percentage of the updated Disaster Management Plan implemented.
	4.10 Engage and train communities in flood preparedness and response measures	x	x	x	x	NADMO	NADMO, STMA	Resident Associations, Media	AAP: Environment, Infrastructure And Human Settlement Social Development	Percentage of targeted communities trained in flood preparedness and response.
	4.11 Promote sensitisation and sand bagging within the communities for coastal protection	x	x	x	x	NADMO	NADMO, Security Services	Community Groups	AAP: Environment, Infrastructure And Human Settlement Emergency Planning and Response (including Covid -19 Recovery Plan)	Number of community members participating in sandbagging activities. Percentage increase in awareness of coastal protection

											measures among participants, measured through surveys or feedback forms post-activity.
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Table 6. 5 Section 5: Water

<p>Promote Sustainable Water Management in STMA</p> <p>❖ <i>Target:</i> Increase water retention and harvesting capacity by 40% and reduce household water service disruptions from 43% to 20% by 2050 in urban and peri-urban areas.</p> <p><i>Increase water retention and harvesting capacity by 40% and reduce household experience of loss of water services from 43% (2024) to 20% in urban and peri-urban areas by 2030.</i></p>													
Expand Increase the availability of water resources and ensure sustainable	5.1 ??			X	X	GWCL GOG STMA Devt. Partners	GOG STMA MWH, Community Water and Sanitation, GWC		AAP: Environment, Infrastructure And Human Settlement	Number of reservoirs constructed or rehabilitated in target areas.			

management of water systems amidst changing climate conditions.	5.2 Implement community-based small town water systems in identified communities.	X	X	X	X	STMA CWSA GOG Dev. Partners	GOG, STMA, CWSA, GWC	STMA, MWH, GWCL, CWSA	AAP: Environment, Infrastructure And Human Settlement	Percentage increase in total water storage capacity due to new or rehabilitated reservoirs.
	5.3 Public awareness on the use of water-saving technologies and practices in households, industries, and agriculture	X	X	X	X	STMA, GWCL	GWCL, STMA, Media, NCCE, ISD	GWCL, STMA	AAP: Environment, Infrastructure And Human Settlement Social Development	Number or percentage of households, industries, and agricultural entities reached through public awareness campaigns on water-saving technologies and practices. Percentage reduction in water consumption in sectors (household, industry, agriculture) following the

										awareness campaign.
	5.4 Enforce national and local level policies that prevent pollution and over-extraction of water resources and advocate for community cooperation and compliance	X	X	X	X	STMA, WRC, EPA, GOG	STMA, EPA, WRC, Ghana Police Service, HSA	Ministry of Sanitation and Water Resources	AAP: Environment, Infrastructure And Human Settlement	Percentage reduction in pollution levels in local water bodies due to enforcement of policies (e.g., levels of contaminants).
	5.5 Construct solar-powered mechanised boreholes in water-scarce communities and ensure effective maintenance.	X	X	X	X	STMA, GOG, CWSA, Private Sector, CSOs and NGOs, Religious bodies	LCC, STMA, WARENGO, CWSA	STMA, MWH	AAP: Environment, Infrastructure And Human Settlement	Percentage of the population in water-scarce communities with access to clean and sustainable water sources from solar-powered boreholes.
	5.6 Establish an early response system for prompt water pipeline repair and maintenance	X	X	X	X	GWCL, STMA	GWCL, STMA	GWCL, STMA	AAP: Environment, Infrastructure And Human Settlement	Average time taken to respond and repair water pipeline issues after detection.

	5.7. Establish a framework for reporting pipeline leakages and damages to GWCL	x				GWCL	GWCL	Resident Associations, Community Groups	AAP: Environment, Infrastructure And Human Settlement Social Development	
	5.8 Review, update and enforce by-laws and local plans to protect designated areas such as community ponds, wetlands, river banks.	X	X	X	X	STMA, Forestry Commission	STMA, Forestry Commission, Association of advertisers, GIZ	STMA, Forestry Commission	AAP: Environment, Infrastructure And Human Settlement	Percentage of protected areas (ponds, wetlands, riverbanks) where enforcement has led to reduced degradation or improved conservation.
	5.9 Construct water retention ponds in identified communities (Bakado and Butuah) outlined in the Sekondi Takoradi Flood	X	x			STMA, Private Sector (Butuah) AfDB, EU Delegation	STMA, FCDO, Private Sector,	STMA, GTA, EPA		Number of reservoirs constructed or rehabilitated in target areas.

	Resilience Project (FCDO)									
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Table 6. 6 Section 6: Health & Health Systems

Improve Public Health Systems for Climate Resilience							AAP	Indicators	
❖ <i>Target:</i> Establish early warning systems for heatwaves, air pollution, and climate-related disease outbreaks in 100% of public health facilities by 2050.									
Improve health systems to enhance response to climate-related health risks, such as floods, heatwaves, vector-borne diseases, waterborne illnesses, and air pollution.	6.1 Strengthen surveillance systems for vector-borne/waterborne diseases and air pollution with a focus on early detection and rapid response.	X	X		STMA, GOG, EPA, Donors (SYCA), Potential donors: USAID, JICA	STMA, GHS, UMaT, EPA	MoH, STMA, EPA	AAP: Environment, Infrastructure And Human Settlement Social Development Emergency Planning and Response (including Covid -19 Recovery Plan)	Percentage of communities covered by strengthened surveillance systems for vector-borne, waterborne diseases, and air pollution.
	6.2 Train healthcare professionals on climate-related	X	X		GHS, GOG, EPA, STMA, Dusseldorf City Partnership	STMA, City of Dusseldorf city partnership, EPA	MoH	AAP: Social Development	Percentage of healthcare professionals

	health risks and appropriate response measures.							Emergency Planning and Response (including Covid -19 Recovery Plan)	trained in climate-related health risks and response measures.	
	6.3 Upgrade and retrofit existing public health facilities to adapt to the impacts of climate change, such as designing ventilation systems, install solar systems and ensure reliable water and energy supply.	X	X	X		GHS, STMA, Development partners	GHS, GWCL, STMA, Private Sector	MoH	AAP: Social Development Environment, Infrastructure And Human Settlement	Number of public health facilities upgraded and retrofitted to adapt to climate change.
	6.4 Develop and implement a communication and dissemination strategy on climate-related health risks with up to-date information on climate hazards	X	X	X	X	STMA, GOG, EPA, NGOs/Donor Partners, SYCA	STMA, EPA, ISD, UMAT			Percentage of target population reached by early warning systems through multimedia channels.
	6.5 Implement localized, accessible early warning systems for climate related	x	x	x	x	GHS, NADMO, Donor	GHS, NADMO, EPA		AAP: Environment, Infrastructure And Human Settlement	percentage of early warnings disseminated through various media type (TV,

							Ports & Harbours Authority, Hen Mpoano			
	7.3 Implement reforestation and afforestation programs using native species to restore biodiversity, ecosystem services, and protect local wildlife.	X	X			STMA, Carbon credits, FAO, GCFFAO, GCF, SYCA, Donor or NGO grants	STMA, Forestry Commission	STMA, Forestry Commission	AAP: Environment, Infrastructure And Human Settlement	Number of hectares reforested or afforested using native species.
	7.4 Undertake community education and public awareness campaigns on the benefits of ecosystem conservation and the negative impacts of degradation.	X	X			STMA, Forestry Commission	Forestry Commission, STMA, NCCE, ISD, Community Information Centres (CIC)	STMA	AAP: Social Development Environment, Infrastructure And Human Settlement	Number of community education and public awareness campaigns
	7.5 Establish community-managed conservation areas to protect and		X			Forestry Commission, STMA, Donors	Forestry Commission, STMA	Hen Mpoano, CSOs, Community Groups	AAP: Environment, Infrastructure And Human Settlement	Number of community-managed conservation areas

	maintain restored ecosystems.									
	7.6 Promote the integration of green infrastructure (e.g., parks, urban forests) in urban planning and development.	X	X	X	X	STMA, Development partners/donors	STMA, Ghana Green building Council, IISD NBI		AAP: Environment, Infrastructure And Human Settlement	Number of new urban development projects incorporating green infrastructure (parks, urban forests)
	7.7 Reinforcement of riverbanks through afforestation	X	X	X		STMA, Forestry Commission, WRC	Forestry Commission/WRC/STMA	STMA	AAP: Environment, Infrastructure And Human Settlement	Kilometers of riverbanks afforested
	7.8 Develop sustainable eco-tourism areas, with a focus on Butua/Monkey Hill wetland area.	X	X	X		Forestry Commission, STMA, GTA, Private Sector, Donor	Forestry Commission/STMA/GTA	STMA, Forestry Commission and Wildlife Division	AAP: Environment, Infrastructure And Human Settlement Economic Development	Protection and creation of sustainable eco-tourism area, focusing on Butuah/Monkey Hill.
	7.9 Promote greening of STMA through planting, growing, and tracking 1,000,000	X	X	X	X	STMA, Forestry Commission, GOSHEN Global Vision, Tokens, Donors	Forestry Commission, STMA, GOSHEN	STMA, MLNR	AAP: Environment, Infrastructure	Number of trees planted and tracked

	trees within the STMA using an innovative online application that allows tokenising of trees.					(Bloomberg, Bank of America)			And Human Settlement	digitally within the STMA.
	7.10 Engage traditional authorities to establish and maintain mangrove plantations to serve as erosion and flood control measures	x	x			STMA, Forestry Commission, NADMO	Traditional Authorities, STMA, Forestry Commission, NADMO	CSOs, Regional House of Chiefs	AAP: Environment, Infrastructure And Human Settlement Social Development	Mangrove Plantation Establishment Rate

Table 6. 8 Section 8: Agriculture

Enhance Food Security through Climate-Smart Agriculture								AAP		
❖ <i>Target: Train 50% of local farmers in climate-smart agricultural practices by 2030 and increase crop yield by 25% with climate-resilient crop varieties by 2040.</i>										
Support agricultural practices that are resilient to climate impacts and improve food security.	8.1 Provide training and resources to farmers on climate-smart agricultural practices, such as conservation agriculture, agroforestry, and drought-	X	X	X	X	STMA, GOG, Development Partners	STMA, MOFA, EPA, Farmers cooperatives	STMA, MOFA, MLNR	AAP: Environment, Infrastructure And Human Settlement Social Development Economic Development	Number of farmers adopting climate-smart practices (e.g., conservation agriculture, agroforestry, drought-resistant crops).

	resistant crop varieties.									
	8.2 Utilise STMA demonstration farm and pilot projects to increase education and patronage on climate-resilient farming techniques and technologies with a focus on training women.	X	X	X	X	STMA, Business income,	STMA, TCSSP Farm management	STMA	AAP: Environment, Infrastructure And Human Settlement Social Development Economic Development	Percentage of farmers, particularly women, adopting technologies and techniques demonstrated at STMA farm.
	8.3 Develop and promote local seed banks to ensure access to resilient crop varieties adapted to changing climate conditions.	X	X			STMA, Development partners, GOG	STMA, MOFA	STMA, MOFA	AAP: Economic Development Environment, Infrastructure And Human Settlement Social Development	Percentage of farmers with access to resilient crop varieties from local seed banks.
	8.4 Strengthen local agricultural extension services to provide ongoing support and advice to farmers on adapting to climate change.	X	X			STMA, GOG	STMA, MOFA	STMA, EPA, MOFA	AAP: Economic Development Environment, Infrastructure And Human Settlement Social Development	Number of farmers regularly receiving advice and support from local agricultural extension services.

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Table 6. 9 Section 9: Climate Change Education and Awareness Creation

❖ Target: Increase public knowledge and awareness about climate change from 71% to 100% by 2050								AAP	Indicators
Increase awareness and engagement of communities in climate adaptation practices and emergency preparedness	9.1 Organize training workshops and capacity-building programs on disaster preparedness and climate adaptation practices for vulnerable communities.	X	X	X	X	STMA, NADMO, EPA, Development Partners	NADMO, STMA, EPA		Number or percentage of community members, particularly vulnerable groups, attending disaster preparedness and climate adaptation training.
	9.2 Integrate climate change sensitisation into community engagement and public hearings	x	x	x	x	EPA, STMA	EPA, STMA, Information Services Dept. CSOs	CSOs	AAP: Social Development Environment, Infrastructure And Human Settlement Percentage increase in climate change awareness among community members

									attending public hearings.	
	9.3 Organize public awareness campaigns on climate change impacts and encourage behavioural change and adaptation practices using social and mass media.	X	X	X	X	STMA, EPA, Development Partners	EPA, STMA, ISD, NCCE, CIC, Media	STMA	AAP: Social Development Environment, Infrastructure And Human Settlement	No of people adopting climate adaptation practices as a result of public awareness campaigns.
	9.4 Establish additional and support existing climate change clubs in schools to create awareness.	X	X	X	X	STMA, Development Partners	STMA, GES, EPA,	STMA, MoE, MESTI	AAP: Social Development Environment, Infrastructure And Human Settlement	Number of students participating in climate change awareness activities through school clubs.

6.3.3 Energy Pillar

The Assessment of Energy Access focused on two main areas: Access to electricity and clean cooking in households. This assessment was based on data collected from a survey of households and institutions in the STMA. The findings revealed that STMA has a diverse energy mix, reflecting the mix of traditional and modern energy sources that cater to the needs of both households and institutions. While electricity access is relatively high, there are still underserved areas and significant challenges related to energy affordability and efficiency. The over-reliance on traditional cooking fuels like charcoal and firewood also raised concerns about sustainability and health.

In order to address the identified issues, an action plan is developed with a clear vision specific targets and some corresponding activities. The vision aligns with the national energy policies and SDG 7, which aims to ensure access to affordable, reliable, sustainable and modern energy for all. The vision for STMA is:

"By 2050, STMA will have secure, reliable, and affordable clean energy for all citizens, aimed at achieving net zero carbon emissions and ensuring a sustainable future for generations to come."

The targets were developed with a SMART (specific, Measurable, Achievable, Relevant and Timebound) focus on addressing the energy issues identified in the assessment. For example, one target is to increase the use of renewable energy and improve energy efficiency in public buildings, as these are necessary to reduce energy costs and promote sustainability. The target setting also considered the need to address equity and inclusion, particularly for low-income households and rural communities to reduce the energy burden on vulnerable populations and increase access to clean cooking solutions.

Corresponding actions were developed to achieve these targets and the overall vision. The actions were inspired by best practices and lessons learned from other regions and countries that have faced similar energy challenges, but they were specifically tailored to the fit unique conditions and needs of STMA. For instance, the promotion of community solar initiatives and the use of public-private partnerships were based on successful models or examples from other parts of the world or regions. Improving energy efficiency in public buildings was guided by global trends in sustainable urban planning. Also, promoting improved cookstoves and cleaner fuels like LPG or biogas was identified as a practical solution to address the widespread use of charcoal and firewood, which are deeply ingrained in the local cooking culture. Similarly, off-grid solutions, such as solar-powered off grid systems and mini-grids, was explored to address the challenges of providing electricity to remote and underserved areas within the metropolis.

The table below presents the targets and corresponding activities developed for improving energy access in STMA.

6.3.3.1 Energy Access Action Plan

Table 6. 10 Section 10: Electricity access

Energy issue: Electricity access											
STMA target: Increase electricity access to 100%, serving every citizen in STMA by 2050											
Objectives	Description of actions to achieve target	Timeframe				Sources of funds	Institutions on implementation	Policy	AAP	Priority	Indicators
		2025	2030	2040	2050						
Objective 10: Attain universal access to electricity	10.1: Extend the national electricity grid to newly developed or planned settlements and improve access to the electricity grid for existing settlements.	X	X	X		STMA, GoG, Donors	MoE, ECG, GRIDCO	MoE, ECG, GRIDCO	AAP: Environment, Infrastructure and human settlements	High	% of HH having access to electricity
	10.2: Lobby for supply and distribution of adequate power meters available for all applicants within STMA.	X	X	X	X	ECG	STMA, ECG, CSOs and NGOs	ECG	AAP:	High	% of HH with power meters. % of commercial power loss
	10.3: Identify priority low-income communities with limited connectivity and collaborate	X	X	X		STMA, MPCF	STM, ECG, PURC	STMA	AAP: EIHS	Medium	% of low-income HH able to pay

	with elected officials to provide subsidies for access.										for electricity
	10.4: Advocate for an improvement of the maintenance and replacement of electricity transformers.	X	X	X	X	STMA, ECG	STMA, ECG, ACEP	ACEP, MOE,		Medium	No. of electricity interruptions per day

Table 6. 11 Section 11: Uptake of renewable energy

		Energy issue: Uptake of renewable energy									
		STMA target: Generate 25% of energy in public buildings and homes from solar by 2050									
Objective 11:	11.1: Increase use of solar energy by 25% in STMA owned public buildings, and encourage adoption in other government owned public buildings	X	X	X	X	STMA, MoE, Donors (SECO, AFD, KFW, GIZ etc.	STMA, EC, GIZ, MoE	MoE	AAP: EIHS	Medium	% of public buildings installed solar PVs
	11.2: Advocate for RE project standards to be upheld and feasibility studies to be carried out	X	X			STMA	STMA, EC, GIZ			Low	% share of renewables in final energy mix

	for large scale RE projects, ensuring that projects are sustainable.										
	11.3: Create an enabling environment and advocate for local industries to integrate RE in their energy mix.	X	X	X	X	STMA	STMA, AGI, STCCI, CSOs and NGOs, Religious bodies	STMA, ECG, GRIDCO	AAP: EIHS	Low	No. of stand-alone electricity system

Table 6. 12 Section 12:

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Energy issue: Diversify energy sources in STMA											
STMA target 1: 15% increase in the use of solar and bioenergy for grid tied and stand-alone energy systems by 2050											
Objective 12: Reduce burden on the national grid by increasing penetration of solar grid tied, stand alone and mini-grids systems in STMA	12.1: Educate the public on the benefits of the use of renewable energy grid tied and stand-alone systems	X	X	X		STMA, EC	STMA			High	No. of public awareness programmes
	12.2: Regulate solar farms in selected communities			X		EC	EC, STMA			Medium	No. of solar PV sites with permits
	12.3: Provide financial access and support for people building grid tied and stand-alone systems.	X	X	X		Financial institutions	STMA			Medium	No. of stand-alone systems provided with financial support
	12.4 Create guidelines for the implementation of grid tied and stand-alone energy systems and advocate for laws that regulate the minimum output of mini-grids by 2035	X	X	X		STMA, MLGRD	STMA			High	No. of guidelines for mini-grids adopted

Table 6. 13 Section 13: Uneven distribution of energy burden

Energy issue: Uneven distribution of energy burden											
STMA target 1: Pursue energy efficiency consumption practices in homes to increase the rate of low energy burden households from 56% to 60% by 2050											

STMA target 3: Reduce the percentage of Expenditure on Public Buildings for Electricity to 2% by 2050											
Objective 13: Minimise energy burden on homes, businesses and public sector	13.1: Public education and awareness on efficient energy practices in homes and public institutions in order to reduce the energy burden.	X	X			EC, STMA, MLGRD, Donors	STMA, EC, Media, CIC, ECG	MoE, STMA, EC	AAP:	High	No. of education programmes on energy efficiency
	13.2 Train local experts on energy audits	X				EC, STMA, Donors	EC, STMA	MoE, STMA, EC	AAP:	High	No. of local experts trained in energy audits.
	13.3 Promote and conduct energy audits for buildings and industries as well as design energy management plan and system		X			EC, STMA, Donors	EC, STMA	MoE, STMA, EC	AAP:	High	No. of buildings and industries having energy management plans and practicing energy efficiency
	13.4 Encourage the use of energy-efficient appliances in homes and public institutions as well as		X	X		EC, STMA, Donors	EC, STMA	MoE, STMA, EC	AAP:	High	No. of energy-efficient appliances in homes and public institutions.

centralizing the use of energy intensive equipment.											Quantity of electricity and money saved.
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Table 6. 14 Section 14: Unwillingness to shift to clean cooking and Low penetration of improved energy-efficient cookstove

	Energy issue: Unwillingness to shift to clean cooking and Low penetration of improved energy-efficient cookstoves										
	STMA Target 1: To increase access and uptake of clean cooking for households to 50% by 2050 within STMA										
Objective 14: Promote the adoption of clean cooking technologies	14.1: Educate and create awareness on the health, safety, economic, and environmental benefits of using clean cooking technologies	X	X	X	X	STMA, Donors, CSOs, GNFS	STMA, CSOs, EC, ECG, Fish mongers, CBOs, Clean Cooking Alliance, DAASGIFT, GHACCO	EPA, EC,		High	No. of awareness programmes
	14.2: Support NGOs/CSOs focused on clean cooking to create gender-sensitive awareness programs	x	x	x	x	STMA, NGO/CSOS	STMA		High	No. of organisations supported	

	14.3 Work with the GNFS to create awareness and training on operational aspects of clean cooking including maintenance.	x	x	x	x						
	14.4: Seek PPP to increase investment in clean cooking devices for low-income communities	X	X	X		STMA (MBSP), Donors/DP, Private sector, Energy Commission	STMA, Private sector, NGO/CSOs, Rural Technology Program (RTP)	MoTI, STMA, EC		Medium	% of the population using clean cooking devices
	14.5 Facilitate private sector participation in the distribution of clean cooking stoves using carbon finance	X				EPA, EC, STMA, private sector companies	STMA, Private sector, EPA	EPA, STMA, EC, MOE		High	Quantity of carbon credit (tonnes)
	14.6 Promotion of safe and high thermal efficient institutional stove on fish processing.	X	X			EC, STMA, private sector companies	STMA, EC, EPA	EPA, STMA, EC, MOE		Medium	No efficient stoves distributed
	14.7 Establish an ISO-compliant cook stove testing lab		X			TTU, EC, CSIR, Donor	TTU, EC, CSIR	EPA, STMA, EC, MOE		High	ISO-compliant laboratory established.

Table 6. 15 Section 15: overreliance on traditional charcoal fuel and the potential to upscale LPG use

		<p>Energy issue: overreliance on traditional charcoal fuel and the potential to upscale LPG use</p> <p>STMA Target 1: Reduce the population percentage using primarily charcoal from 42% to 10% by the year 2050</p> <p>STMA Target 2: 80% of the population to use LPG, with rural areas making up a significant portion of this growth by 2050</p>									
<p>Objective 15: Reduce the use of traditional charcoal biomass for cooking</p>	<p>15.1: Conduct a sensitisation campaign on the adverse health effects of charcoal, especially in communities with high dependency.</p>	X	X	X		STMA, CSOs	STMA, GHS NPA, NCCE	MoE, STMA		Medium	No. of sensitisation campaigns.
	<p>15.2: Facilitate the rollout of the cylinder recirculation program (CRM) in STMA communities with high dependency on charcoal.</p>	X	X	X		STMA, MoE, OMCs, NPA	STMA, NPA, CRM companies, banks			High	% communities in STMA adopted CRM
	<p>15.3 Conduct a sensitisation campaign on the benefits of LPG and safe usage, especially in communities with high dependency.</p>	X	X			STMA, NPA, Donors, EPA	STMA, NPA, LPG association	MoE, STMA		Medium	No. of sensitisation programmes held in a year
	<p>15.4 Partner with financial institutions to guarantee the supply of LPG to vulnerable households with a flexible instalment payment plan</p>		X			STMA, Private sector, Local banks, NPA	STMA, Local banks, LPG operators	MoE, STMA		High	No. of banks developed financial instruments to support LPG distribution.

	15.5 STMA to collaborate with LPG service providers to ensure the availability of CRM outlets in each community		X			NPA, STMA, LPG association	STMA, Local banks, LPG operators	MoE, STMA		Medium	No. of CRM outlet established in STMA
	15.6: Introduce briquettes and other clean alternative cooking energy source	X	X	X	X	STMA, Private sector, Takoradi Technical University, UMAT,	STMA, Private sector, Takoradi Technical University, UMAT,	MoE, STMA		Medium	% of briquette and other clean alternatives in the final energy mix No beneficiaries of the ICS financial model.
	15.7 Partner with academic and financial institutions to research and finance other cost-effective alternatives and financial models to charcoal such as briquettes.	X	X			STMA, Takoradi Technical University,		MoE, STMA			No of established financial model in STMA
	15.8: Improve monitoring and evaluation frameworks by quarterly conducting household surveys to regularly monitor progress towards the target					EC, STMA, GHACCO	EC, STMA, GHACCO			Medium	No of monitoring frameworks

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